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Professor Benedict made a significant contribution to the knowledge of the enigmatic "Proteus of the Lakes."

George Wyllys Benedict and the "Proteus of the Lakes"

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George Wyllys Benedict is known to students of Vermont history primarily as founder of the Vermont and Boston Telegraph Company (1847) and owner of the *Burlington Free Press* between 1853 and 1866, but Benedict was first and foremost a naturalist. His entrepreneurial activities followed twenty-two years of natural history teaching and research at the University of Vermont, where he was Professor of Mathematics and Natural Philosophy from 1825 to 1839, and Professor of Natural History and Chemistry from 1839 to 1847. Benedict's interests in natural history were varied, but he specialized in conchology, collecting many mollusks from the Burlington area and exchanging specimens with an extensive network of learned colleagues throughout the Northeast. Though his primary interest was in invertebrates, Benedict may have made his most valuable contribution to the scientific understanding of a peculiar vertebrate—the "Proteus of the Lakes."

The Proteus is known to modern zoologists as *Necturus maculosus maculosus* Rafinesque, or more commonly, the "mud puppy." This popular name derives from the mistaken belief that, like puppies, the Proteus can bark. Its other common names include water dog, water lizard, and dogfish, all names that hint at the ambivalent nature of this curious amphibian. The adult *Necturus* ranges in length from 7 to 17 inches; it has a variable body color, usually light gray or brown with a scattering of round spots. *Necturus* is neotenic, retaining as an adult certain juvenile characteristics, such as its red external gills. The common name *Proteus*

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was used throughout much of the nineteenth century, since it was at first thought to be a member of the same genus as the "Proteus of Carniola" of eastern Europe. Proteus refers to the fact that it was believed to undergo three metamorphoses, like the sea-god of Greek mythology, who, when seized, would assume different shapes.

The mud puppy had been known to zoologists since 1799, when Johann Gottlob Schneider (1750-1822) described a specimen he found in Johann Christian Hellwig's (1743-1831) cabinet at Braunschweig, Germany.[1] Hellwig, Professor of Mathematics and Natural Science there, had obtained the specimen from Lake Champlain, but the exact location is unknown. Zadock Thompson, in his *Natural History of Vermont* (1842), speculated that "this specimen was probably obtained at Winooski Falls, which were, for some time, the only known locality of this animal."[2] How Hellwig obtained his specimen is also unclear.

Schneider's animal was nearly forgotten for two decades; in 1821, Major Joseph Delafield collected *Necturus maculosus* at Lake St. Clair, Michigan, while surveying the northern border of the United States. Delafield brought this specimen back to his friend Samuel Latham Mitchill, president of the Lyceum of Natural History of New York. Though he was a capable naturalist, Mitchill turned to Professor Configliachi of Pavia, Italy, for assistance in identifying the specimen. His letter to Professor Configliachi was published in Benjamin Silliman's *American Journal of Science and Art* the following year. Mitchill became the first to call the creature Proteus, considering it to be a species different from that known to European naturalists (*Proteus anguinus*).[3]

During the early part of the nineteenth century, a number of exploration parties traversed the North American continent; these usually included geologists, doctors, and the occasional "professional" naturalist (though no such profession really existed) who collected plants and animals from the region being surveyed. While European botanists and zoologists looked far afield for new organisms, in North America new species awaited discovery at home. These expeditions supplied early American herpetologists with new organisms for classification. Thomas Say (1787-1843), a founder of the Academy of Natural Sciences in Philadelphia, was perhaps the first American to publish on amphibians and reptiles. In 1817 he became a member of the McClure expedition to Georgia and upon returning from that was recruited for Major Long's Yellowstone Expedition.

On the Long Expedition, Say collected the same species as Delafield had, and gave an account of the animal in 1823 under the name *Triton lateralis* Say.[4] In that same year John LeConte published some of his thoughts on the classification of the Proteus in the *Annals of the Lyceum of Natural History of New York*.[5] LeConte pointed out that Schneider

had already published an accurate description of the animal, but he also ventured the erroneous possibility that the "Proteus of the Lakes" was the larva of the "Hellbender" (*Cryptobranchus alleghaniensis*), an error that was repeated by other naturalists.

By 1826, complete confusion reigned with regard to the puzzling amphibian. This confusion stemmed partly from incomplete knowledge of this particular animal, but also from the fact that herpetological studies were in their infancy. It was only in 1825 that J. E. Gray had separated reptiles and amphibians into two distinct classes.[6] Moreover, all the major herpetological works were by Europeans who had never seen the American species that they described in the field.

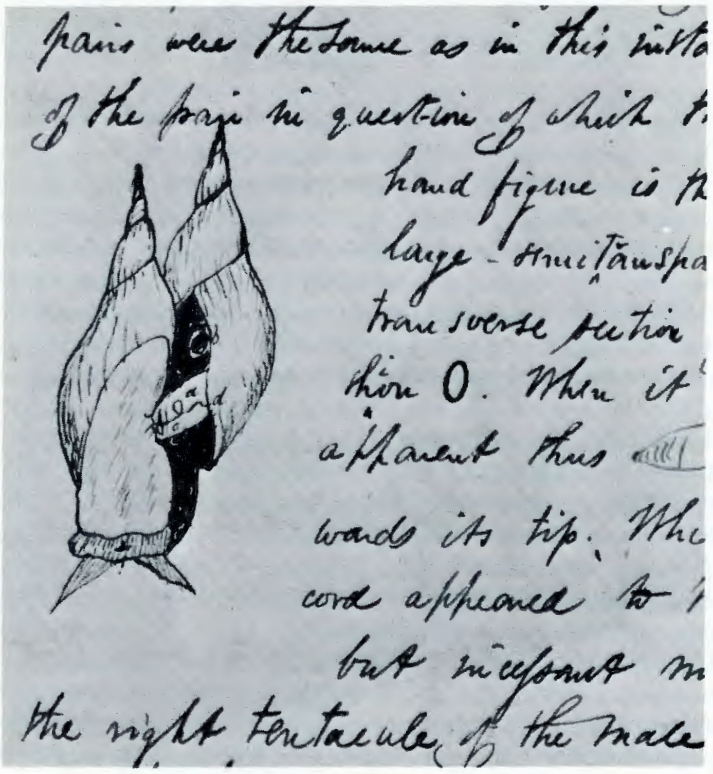
The discovery of a variety of neotenic salamanders in the late eighteenth and early nineteenth centuries posed a number of puzzling taxonomic problems for zoologists. Along with the Proteus, there are other unrelated salamanders that retain certain larval features throughout their life. These include the axlotl (Mexican Indians' name for neotenic Tiger Salamanders), the Hellbender, Amphiumas, and Sirens—all of which were being discovered in new localities throughout North America. Taxonomists differed as to whether the juvenile forms of these salamanders were distinct species, or, if not, of which adult species they were juvenile forms. In 1826 Silliman's *Journal* published a monograph on these "doubtful Reptils" by Daniel Henry Barnes, Recording Secretary of the Lyceum of Natural History of New York.[7] In his monograph Barnes, who became interested in the Proteus through his association with Dr. Mitchill, placed the "Proteus of the Lakes" (called by him *Proteus lateralis*) in the same genus as the European species (*Proteus anguinus*). Barnes's description was quite accurate in most respects, though he, like other naturalists who had preceded him, lacked any observations of the living animal.

Barnes had gone to the falls of the Winooski in the summer of 1825 to obtain specimens, and though the fishermen there informed him that they often caught six or seven in one night, that was only in the spring. Barnes went home empty-handed, but not before he had alerted his friend Professor G. W. Benedict, newly arrived in Burlington, to his researches. Benedict and Barnes knew each other from correspondence on conchological matters, and it was only natural that Barnes would have asked Benedict to secure specimens of the Proteus for him.

On July 6, 1827, Benedict wrote to Barnes to tell him that although the fisherman whom Barnes employed in this task had failed to catch any, Benedict had found a "gentleman" at the falls who had obtained seven of the "water lizards" for him. These Benedict kept alive for several days, though he felt from their confined situation (all of them had hooks and lines in their stomachs) that he learned little of their habits. Knowing that Barnes had never seen them alive, however, Benedict made a number

of remarks on the internal and external appearance of the animal. Benedict concentrated on comparing his observations with the plate, done by Issachar Cozzens, Jr., another New York Lyceum member, that accompanied Dr. Mitchill's 1824 paper in Silliman's *Journal*.

Noting that the color of the living subject was very different from that depicted by Cozzens, Benedict gave an accurate description:



G. W. Benedict's sketch of a mating pair of "mud puppies" from a marsh "south of the wharf in Burlington," September 12, 1839. Courtesy of Special Collections, University of Vermont.

> The ground color on the sides and back is bluish gray, but so thickly spotted with minute dull yellow spots as to appear, at a little distance, grayish-yellow — the belly approaching nearly to white. Spots of dirty blue considerably darker than the ground and about one-fourth of an inch in diameter, are scattered all over, usually without any regularity, though occasionally presenting rows.[8]

This was the first published description from a living specimen rather than one pickled in alcohol.

Benedict went on to point out that Cozzens's figure erred in other respects: the forehead was flatter and the eyes were nearly twice as far apart as they were represented on the plate. He also compared his observations with the only other illustration of the Proteus that then existed in the scientific literature—a plate from volume one of the *Annals of the Lyceum of Natural History of New York.*[9] In that figure, Benedict pointed out, the head was sharper and the snout narrower than in his living animals; more importantly, there was a great difference in the Proteus's most striking feature—the branchiae or external gills:

> Those figured in the Annals of the Lyceum are pretty well drawn, but the filaments are longer in the living animal and more expanded. These *tufts* were of a DEEP AND SPLENDID CRIMSON . . . The animal keeps these in motion AS A FISH DOES ITS GILLS. In bringing them *down to the neck*, the filaments are brought pretty close to the fleshy branchiae, on elevating them the fimbriae dilate and float, as it were, *presenting from the beauty of their color and gracefulness of their motion*, AN APPEARANCE BEAUTIFUL BEYOND DESCRIPTION.[10]

Benedict's major contribution to the study of the Proteus is an anatomical one, and one on which Barnes had dwelt at length in his 1826 review. Benedict had enlisted Professor William H. Sweetser of the University of Vermont Medical School to dissect one of the specimens, and upon doing so found there to be thirty-eight vertebrae, nineteen of which belonged to the back and neck. He closes by saying that he believed the specific name (*lateralis*) to be insufficient, since the characteristic which that name described, a dark lateral line through the eye, did not appear in all individuals of the species. Though he did not propose a new name, he did suggest that the name be changed.

These observations were important enough so that a week later Barnes sent Benedict's letter, with some introductory and concluding remarks, to Professor Benjamin Silliman, who published it in his *Journal* in 1828. The first half of the article was the text of Benedict's letter, which Barnes followed by saying that it ". . . was written with a modest apology that it might *possibly* interest *me*, and was not intended for publication; but as it contains important information which the scientific world ought to possess, I know the author will pardon me for giving it the present direction."[11] Barnes concurred with Benedict on the inappropriateness of the specific name *lateralis*, and proposed that the name *Proteus maculatus*, which simply means spotted, be adopted instead.

Through Barnes, Benedict had made a significant contribution to the knowledge of the enigmatic "Proteus of the Lakes," and perhaps most importantly, he had made his observations on animals from what seemed to be the same locality as those of Schneider's original 1799 description—

the falls of the Winooski. There would be a fourteen-year hiatus between this contribution and the next one.

The scientific discussion of *Proteus maculatus*, "alias" *Proteus lateralis*, continued with the publication of a new edition of Georges Cuvier's *Le Regne Animal* in 1829.[12] Cuvier, who in his 1817 edition had not treated the Proteus at all, included it in the 1829 edition as *Menobranchus lateralis* Harlan. Though brief, his description is accurate, except that Cuvier, like other naturalists before him, overestimated the size of the Proteus.[13]

Despite this error, Cuvier's plate of the *Menobranchus lateralis* confirms that he was describing the "right" animal. This was the first accurate colored illustration of the animal, and though Cuvier was one of the standard authorities in vertebrate zoology, this illustration seems to have passed largely unnoticed by colleagues in North America, as shown by the next series of publications dealing with the Proteus.

These works were all published in 1842, a banner year for zoological studies in the United States. First, James Edward DeKay's three-volume *Zoology of New York*[14] appeared. DeKay's description of *Menobranchus lateralis* (like Cuvier, he adopted Harlan as his authority) is flawed, erring in its account of the color and length of the animal. In addition, the colored plate that accompanies the description seems to be that of the *Cryptobranchus*, rather than a *Menobranchus*. DeKay does not list Barnes's 1828 article in his references, so perhaps he was unaware of Benedict's observations, which might have guided him to another choice of specimens to illustrate.

Strangely, DeKay missed the mark on *Menobranchus* despite his correspondence with zoologists Zadock Thompson and John Edwards Holbrook, who possessed accurate information about the animal. In the preface to Part IV of his *Zoology of New York*, DeKay thanks Thompson for supplying several fish specimens, noting also that Thompson was in the process of publishing his *Natural History of Vermont*. In his preface to the previous section (Reptiles and Amphibians, Part III), DeKay acknowledges the assistance of Holbrook, whose five-volume *North American Herpetology* was about to be published. DeKay's correspondence with Thompson must have been restricted to ichthyological matters and his pre-publication review of Holbrook's work cannot have been complete. Otherwise, he should have noticed how different Holbrook's plate of the *Menobranchus* was from his own.

Holbrook, Professor of Anatomy at the Medical College of South Carolina in Charleston, had his own problems with the Proteus. Having studied under a number of French zoologists, who specialized in the study of reptiles, Holbrook had been encouraged by them to prepare a monograph on the reptiles and amphibians of the United States. The work,

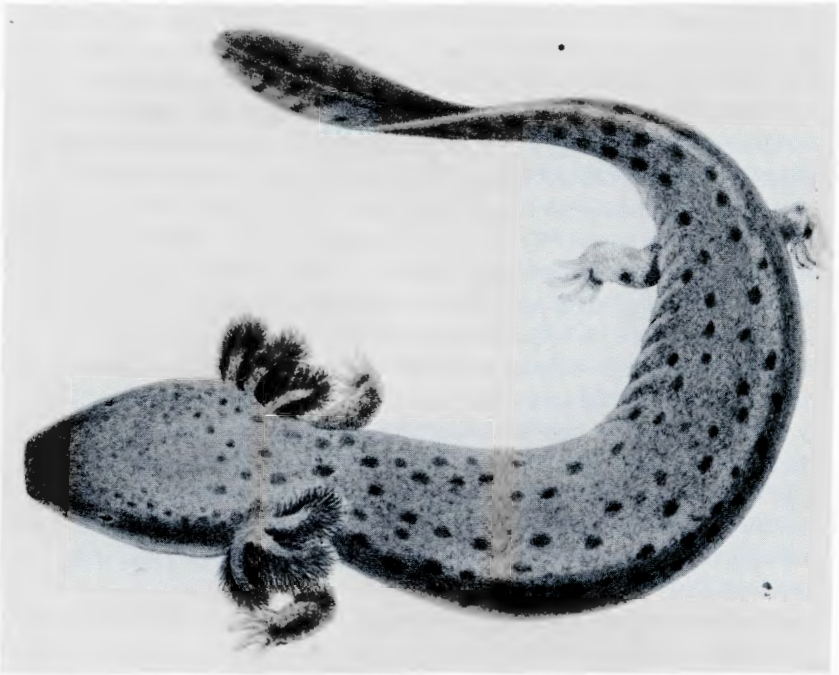
which appeared in three volumes between 1836 and 1838, included a description and plate of *Menobranchus* that did not correspond at all with the real creature. There were other problems with the volumes, and nearly all the copies were recalled, to be replaced with a second edition in 1842.

Although his teaching and administrative duties prevented continuing research on the Proteus, George Wyllys Benedict maintained an interest in the animal, enough so that his "Household Accounts" book for June 30, 1836 lists an entry: "To cash for proteus $0.25."[15] Benedict bought specimens from the fishermen at Winooski Falls, perhaps with the intention of publishing some account of the animal himself. As yet unsolved was the question of whether *Menobranchus* breathed solely via its gills, or whether its lungs were also functional, a question which Barnes had mentioned in his 1828 article as one that he hoped Benedict would "finally settle . . . [as] he has, what few other competent persons can have, the means at hand, and we hope that zeal and industry will not be wanting."[16] The "means at hand" meant Benedict's proximity to a good location for collecting live specimens. However, almost all of his "zeal and industry" went into university matters, and Benedict's pen was silent on this and other scientific questions.

The library at the University of Vermont had a copy of the first edition of Holbrook's *North American Herpetology*, and Benedict had seen that Holbrook's illustration was incorrect. When Benedict learned (probably early in 1842) of a forthcoming new edition, he sought to correct the error. Though a capable illustrator himself (his pencil sketches accompany some species accounts in his journals), Benedict found someone much better prepared to illustrate the subtle hues of the Proteus—the Right Reverend John Henry Hopkins, first Episcopal Bishop of Vermont.

Along with his other talents, Hopkins had quite impressive credentials as an illustrator of natural history. As a boy of fifteen in Philadelphia, he had brilliantly executed the coloring of the plates for the first volume of Alexander Wilson's *American Ornithology*. In 1838, after the Crash of 1837 spelled financial disaster for him, Hopkins had tried to raise money by publishing a student's guide to landscape illustration.[17] That Benedict paid Hopkins for the illustration seems doubtful (there is no such entry in Benedict's account books), and Hopkins may have been glad to do the drawing simply because he was an avid amateur naturalist himself.[18]

Before sending Hopkins's illustration to Holbrook, Benedict showed it to his fellow naturalists in Burlington. On April 30, 1842, he read a paper on the Proteus before the College of Natural History, a natural history society founded by Benedict in 1826. The record of the College of Natural History states that along with presenting the paper ". . . he exhibited to the College a living specimen and several pictures among which



The accurate drawing of Menobranchus maculatus *done by Bishop Hopkins at Professor Benedict's request.* Courtesy of Special Collections, University of Vermont.

was a very beautiful and accurate one drawn by Bishop Hopkins from the specimen . . . exhibited to the Society."[19] The other pictures were likely the erroneous ones that existed in the literature, from Silliman's *Journal*, volume 7, the *Annals of the New York Lyceum*, volume 1, and Holbrook's *North American Herpetology*, since university circulation records show that Benedict borrowed these and three other publications relating to the Proteus (volumes 4 and 13 of Silliman's *Journal* and volume 1 of Edwin James's *Account of an Expedition from Pittsburg to the Rocky Mountains, 1819-1820*, which contained Thomas Say's account.)[20]

Though the correspondence between Holbrook and Benedict has not survived, Holbrook received Bishop Hopkins's rendering of the Proteus, along with observations on the animal by Benedict; the new edition of *North American Herpetology* included a plate of *Menobranchus maculatus* Barnes by Hopkins.[21] In the preface to the volume, Holbrook acknowledges his indebtedness to "Professor BENEDICT of Burlington, for some excellent remarks on the *Menobranchus maculatus*."[22] Holbrook based much of his description on Benedict's observations, quoting

directly from Benedict's lyrical passage describing the gills of the Proteus, first published in 1828.

Holbrook was also indebted to another Burlington naturalist for his description of the Proteus's habits. The passage concerns the breathing apparatus of the Proteus, the mystery that Daniel Barnes had hoped his friend Benedict would solve:

> When kept in a vessel containing a large quantity of water, or in which the water is frequently changed, it manifests but little disposition to rise to the surface for atmospheric air; but when the quantity of water is small, or not often changed, it soon finds the air in the water insufficient for its purposes, when it ascends to the surface, takes a mouthful of air, and sinks again with it to the bottom.[23]

This first "experimental" observation on the mode of respiration in this peculiar neotenic salamander proved that its lungs, though functional, were clearly auxiliary to its external gills for the purpose of breathing. The passage is in quotation marks, but no reference is given. Who made the observation? Although Holbrook does not cite the work, this passage is almost a verbatim quotation of the description in Zadock Thompson's *History of Vermont, Natural, Civil, and Statistical*, which appeared shortly after Holbrook's *North American Herpetology*. It seems most likely that Benedict sent Thompson's remarks along with his own and Hopkins's illustration.

Today the mud puppy is still largely a mystery to the lay public, every year turning up in newspaper accounts as the "strange animal unknown to science." In truth, it is known intimately to contemporary scientists, as it has now been the subject of detailed anatomical, embryological, and life history studies for over a century. These sorts of studies could not begin, however, until the mud puppy's proper taxonomic place had been determined. As with any branch of natural history, the key to classification is correct and close observation, which, in the case of the mud puppy, began with Benedict's studies of the living animals procured from the Winooski. His research, coupled with the illustration by Bishop Hopkins, paved the way for the modern scientific work on an animal that had confounded so many early naturalists.

[1] Schneider, J. G., *Historia amphibiorum naturalis et litteraria*. (Jena, 1799), Fasc. I, p. 50.

[2] Thompson, Zadock, *Natural History of Vermont*. (Burlington: Chauncey Goodrich, 1842).

[3] Mitchill, S. L., "The Proteus of the North American Lakes," *Am. Jour. Sci.*, 4 (1822): 181-183.

[4] James, Edwin, *Account of an Expedition from Pittsburg to the Rocky Mountains, 1819-1820*. (London: Longman, Hurst, Rees, Orme and Brown), Vol. I, pp. 5-7.

[5] LeConte, John, "Description of a new species of Siren, with some observations on animals of a similar nature," *Annals of the New York Lyceum of Natural History* 1 (1) (1823): 52-57.

[6] Gray, J. E., "Synopsis of the Genera of Reptiles and Amphibia, with a description of some new species," *Annals of Philosophy* (1825).

[7] Barnes, D. H., "An arrangement of the genera of Batrachian Animals, with a description of the more remarkable species; including a monograph of the Doubtful Reptils," *Am. Jour. Sci.*, 11 (1826): 268-297.

[8] Letter from G. W. Benedict to D. H. Barnes quoted in Barnes, D. H., "Note on the doubtful Reptils." *Am. Jour. Sci.*, 13 (1828): 67.

[9] Harlan, Richard, "Observations on the Genus *Salamandra*, with the Anatomy of the *Salamandra gigantea* (Barton) or *S. Alleghaniensis* (Michaux) and two New Genera Proposed," *Annals of the New York Lyceum of Natural History*, 1 (2) (1825): 222-234.

[10] Barnes, 1828, pp. 67-68.

[11] Barnes, 1828, p. 68.

[12] Cuvier, Georges, *Le Regne Animal*, (Paris: Fortin, Masson, etc., 1829).

[13] Cuvier, 1829, p. 165. Cuvier notes "L'espèce la plus connue (*Menobranchus*) vit dans les lacs d'America septentrionale, et devient fort grande; atteint dit on, deux et trois pieds." The first edition of Cuvier's work was published by Detervilk in Paris in 1817.

[14] DeKay, J. E., *Zoology of New York, or the New York Fauna*, (Albany: W. and A. White and J. Visschner, 1842).

[15] "Household Accounts, 1836-1849," Benedict Papers, Wilbur Collection, University of Vermont, hereafter UVM.

[16] Barnes, 1828, p. 70.

[17] Hopkins, J. H. *The Vermont Drawing Book of Landscapes*, (Burlington: Chauncey Goodrich, 1838).

[18] Hopkins was known to have transplanted a variety of wildflowers to the Vermont Episcopal Institute at Rock Point, and he enjoyed more than anything taking walks with his children there. The records of the University of Vermont's natural history society, the College of Natural History, UVM, show Hopkins as a dues paying member for the years 1838-1839.

[19] Record of the College of Natural History, UVM, April 30, 1842, UVM Archives.

[20] University Library Circulation – Faculty (1839-1844), UVM Archives.

[21] That Holbrook attributes this name to Barnes is odd, since nowhere is there a published description by Barnes using this name. Zadock Thompson repeated this error in his account of the Proteus in *Natural History of Vermont*. It is also worth noting that Holbrook fails to cite Cuvier, who gave an accurate plate and description, nor does he cite Rafinesque (1819), whose *Necturus maculosus* eventually became the accepted name. In fact, in the early nineteenth century work on the Proteus, only Europeans such as Cuvier cited Rafinesque. American naturalists generally ignored this eccentric genius's scientific work. Hopkins's illustration is Plate 37, Volume V, Holbrook, J. E., *North American Herpetology*, (Philadelphia: J. Dobson, 1842).

[22] Holbrook, 1842, p. v.

[23] Holbrook, 1842, p. 113.