April 5, 1871.

Vice President, Dr. Chas. T. Jackson, in the chair. Thirty-nine persons present.

Rev. Edwin C. Bolles of Salem, Joseph Stone of Charlestown, Thomas C. Felton, Walter Ela and W. G. Farlow of Cambridge, Richard W. Bender, Sidney E. Sargent, William R. Nichols, Fletcher M. Abbott and S. Dana Hayes of Boston, were elected Resident Members.

Prof. Edward S. Morse presented the following paper:—

On the Adaptive Coloration of Mollusca.

Naturalists have long recognized the curious cases oftentimes occurring, of the resemblance between the color of an animal and its immediate surroundings. It had been supposed that climatic influences, or peculiarities of food, or greater or less access to light had something to do with these coincidences. Mr. Alfred R. Wallace has shown that the varied phases of these phenomena could not be explained by such agents, and in a paper "On Mimicry and other protective resemblances among Animals," published in the *Westminster Review*, July, 1867, and since made widely public in his work on "Natural Selection" he shows that the singular resemblances between the colors of animals and their surroundings are mainly brought about by the protection afforded them through greater concealment. Many very interesting examples are then cited from the Vertebrates and Articulates in support of these views. Briefly may be mentioned as examples, the almost universal sand color of those animals inhabiting desert tracts; the white color of those animals living amid perpetual snows; the resemblance seen again and again between the color of many insects and the places they frequent. Among the hosts of examples cited by Mr. Wallace as illustrating plainly the views he advances, may be mentioned the many species of *Cicindela* or tiger beetle. The common English species, "*C. campestris*, frequents grassy banks and is of a beautiful green color, while *C. maritima*, which is found only on sandy sea shores, is of a pale bronzy yellow, so as to be almost invisible." He then states that a great number of species found by himself in the Malay Archipelago, were similarly protected. "The beautiful *Cicindela gloriosa*, of a deep

velvety green color, was only taken upon wet mossy stones in the bed of a mountain stream, where it was with difficulty detected. A large, brown species (*C. heros*) was found chiefly on dead leaves in forest paths; and one which was never seen except on the wet mud of salt marshes, was of a glossy olive so exactly the color of the mud as only to be distinguished when the sun shone, by its shadow. Where the sand beach was coralline and nearly white, I found a very pale *Cicindela*; wherever it was volcanic and black, a dark species of the same genus was sure to be met with."

But little attention has been given to adaptive coloring among the lower invertebrate animals. Darwin, in his last work on the "Descent of Man" calls attention to the statements of Hæckel that the transparency of the Medusæ and other floating animals is protective since their glass-like appearance renders them invisible to their enemies, though Wallace also alludes to this same feature (p. 258). Mr. Edward Burgess informs me of a species of Acaleph, *Polyclonia frondosa*, on the coast of Florida, which lives in the mud and is brown in color. Darwin while admitting that the transparency of these animals unquestionably aids them to escape the notice of their enemies, yet doubts whether the color of Mollusks affords similar protection. He says, "The colors do not appear in most cases to be of any use as a protection; they are probably the direct result, as in the lower classes, of the nature of the tissues, the patterns and sculpture of the shell depending on its manner of growth." Vol. I, p. 316.

In glancing over our New England Mollusca, however, it seems that we do have very clear evidences of protective adaptations among them, not only in their form, but more particularly in their color. It would seem strange indeed if this were not so since so many species of Mollusca form an important portion of the food of many fishes,[1] and also of certain species of birds.

[1] In an inlet near Salem the writer observed a school of minnows swimming along the bottom and as they approached a certain point darting right and left in great alarm. For some time the disturbing cause could not be found. On closer examination, however, a Cottus was seen to open his large mouth and take in several of the little fishes. The Cottus was so perfectly protected by its colors, that it was only recognized when the capacious mouth opened, and only then were the minnows alarmed. Just beyond in their track was a rusty tin fruit can, the little tin remaining on it reflecting the rays of the sun, and from this harmless object they all turned affrightedly away.

In this connection it would be interesting to inquire into the food of fishes in respect to their colors. Those fishes feeding upon Mollusca would certainly not require such protection for concealment as those living upon more active prey.

In a general way we recall the sombre colors of the shells of most species, varying through different shades of yellow, brown and green, in this respect resembling the sand, mud and rocks, or sea weed in or upon which they live, and we then recall by groups the land snails of our woods with their almost uniform brown tints, like the dead leaves or rotten wood in which they live.

The fresh water snails have similar shades to match their peculiar habitats.

The fresh water mussels, colored likewise brown, greenish or black, accord with their places of refuge.

Among the marine forms we notice the adaptive coloration of certain species very well marked. The common *Littorina* of the coast swarms on the bladder weed, the bulbous portions of which are olive brown in color, or yellowish according to age. The shells of the *Littorina* found upon it, present in their varieties these two colors and are limited to these colors, though now and then delicately banded specimens are seen.

Purpura lapillus, which generally hides beneath overhanging ledges, or is concealed under flat rocks, has generally a dirty white shell, with now and then a specimen bright yellow, or banded with brown. We are not aware of any fish that feeds upon this species, though in the almost universal white color of the species an adaptive color may be secured in resembling the white barnacles which oftentimes whiten the rocks by their numbers.

In pools left at low tide where the rocks are often clothed with the red calcareous algæ we find the little red Chiton. Certain *Mytili* are green. The young of the large *M. modiolus* has a rough coat of epidermal filaments looking like the aborescent growth of some Algæ or Hydroid.

The few species common to the mud flats exposed by the retreating tide are colored black or dark olive. *Ilyanassa obsoleta* has the shell black, while the soft parts are quite dark. A related form, *Nassa trivittata*, lives in more sandy places and has a similarly colored shell. *Rissoa minuta*, inhabiting mud flats, has a shell dark olive, or nearly black, while other species of *Rissoa* are much lighter in color. The fronds of the large Laminarian are frequented by *Lacuna vincta* and its variety *fusca*. The first is greenish or purplish horn color, with darker bands, while the variety *fusca* is uniformly dark brown or chestnut; the colors in both cases quite match the Laminarian upon which they are found. Another species of the same genus,

Lacuna neritoidea, Mr. Fuller has observed spawning on bladder weed and its yellowish tinge accords well with its surroundings. *Margarita helicina* I have found in numbers on the large Laminarian and on sea weed at low water mark, and its color is decidedly protective; while other species of *Margarita* dredged in deep water on shelly ground are whitish, pearly, or red.

The protective coloring of certain species is well seen upon stones dredged in deep water, the various mollusks adhering to them, closely resembling the calcareous algæ and the stones themselves.

Species peculiar to sand beaches are of various sand colored shades, as for example *Machœra*, *Mactra*, *Cochlodesma*, *Cyprina*, the little *Solenomya* and *Solen*. On muddy ground we notice certain *Tellinas* and other species with white shells. It has been supposed that those species hidden from the light were generally white, and this would seem to be the case when we recall *Mya*, certain species of *Teredo*, *Tellina*, *Pholas*, and other species. Yet we do have cases where the shell is oftentimes conspicuously banded or marked. It might appear that in those species living buried in the mud or sand, the shell was protected by a very thin epidermal layer, and that this layer was eroded, thus exposing the white shell; there are certain species, however, living buried in the mud or sand which have an epidermal coat very thick and dark brown or black, such examples are seen in *Solenomya borealis* and *Glycymeris siliqua*.

It has been noticed that the same species occupying different stations are differently colored. Dr. A. A. Gould noticed this in regard to *Astarte castanea*; those thrown up from deeper water are darker colored than those found in quiet sandy places. In his report on the Invertebrate Animals of Massachusetts, first edition, p. 78, speaking of the shells found in the sandy harbor of Provincetown, he says: "The color of all the shells in that harbor is remarkably light."

A very evident case of protective coloring is seen in the three species of *Crepidula* found on our coast. *Crepidula fornicata* is drab, variously rayed and mottled with brown, and it lives attached to stones near the roots of the large Laminarian or upon stones clothed with algæ of similar colors, or attached to the large *Mytilus*. *Crepidula convexa*, a much smaller species, lives on the roots of sea weed. Prof. Perkins records its occurrence on the black shell of *Ilyanassa obsoleta*. This *Crepidula* has a very dark brown shell, according well with the dark color of its various places of lodgement. *Crepidula plana* or *unguiformis* lives within the apertures of the shells of larger

species of Gasteropods, as *Buccinum*, *Natica*, *Busycon* and others. The shell of this *Crepidula* is absolutely white.

There are many species that undoubtedly receive protection in allowing foreign substances to grow upon their shells, and these species, oftentimes covered by a dense growth of calcareous or other algæ, are difficult of detection by the experienced collector.

There are also certain species that habitually accumulate foreign substances upon their shells. The little *Pisidium ferrugineum* possibly finds greater immunity from danger in its habit of accumulating a ferrugineous deposit on that portion of the shell most conspicuous. *Nucula delphinodonta* has likewise a similar habit. The delicate *Lyonsia arenosa*, with its habit of entangling particles of sand in its epidermal filaments, undoubtedly finds protection in this peculiarity.

It was not the intention to go outside of New England species in citing these examples, but in this connection I cannot forbear mentioning the tropical genus Phorus. The species are said to frequent rough bottoms and to scramble over the ground like the Strombs and not to glide evenly. This peculiar manner of moving would render them very conspicuous, and it is curious to observe that most of the species attach foreign substances to the margins of their shells as they grow, so that when a shell has attained its growth it is almost completely concealed by fragments of shells large and small, spines of Echini, bits of coral and stones.

These few observations are offered (and they might be multiplied) with the belief that if there is any truth in the theory of protective coloring as advanced by Wallace, the various colors of Mollusca in many cases can be explained, and the occurrence of varieties in color are also accounted for by the same theory.

Mr. Edwin Bicknell remarked that animals in preying upon each other were attracted more by the sense of smell than that of sight. He had noticed on one occasion, when jelly fishes were stranded, that numerous carnivorous snails, *Lacuna vincta*, were seen moving from all points towards them. He thought they could be directed only by a acute sense of smell.

Dr. B. Joy Jeffries called attention to the probability that the animals which prey upon those supposed to be protected by want of color, or by being of the color of their

surroundings, can not perhaps be accorded a power of color perception; and suggested that form and light may govern them in hunting for their prey. He also explained the difference between the red eyes of the albinos and others. With the opthalmoscope one sees in other eyes the same red reflections as in albinos.

Prof. A. Hyatt alluded to the color of the common Unios, or Anodons, as probably protective, and the well known case of the Melanias of the Western rivers, which are hardly distinguishable by the unpracticed eye, and to the peculiar and marked variations of the Siluroid fishes of the same region, which agree in color very closely with the ground on which they live.

Mr. Hyatt then continued, however, that he by no means desired to endorse the Darwinian doctrine of Natural Selection. A belief in evolution and the derivation of all higher forms, from lower and simple organisms, perhaps from inorganic matter itself, by means of secondary natural forces, is perfectly consistent with opposition to the Darwinian theory. According to this theory, new characteristics and therefore new kinds and species of animals arise by the survival of the fittest, as in a recent instance cited by the "*American Naturalist*," where a new race of deer is supposed to be in course of formation in the Southern Adirondacs. In this case, certain full grown bucks, about thirteen years ago were produced, with short stabbing horns like the young deer. These were thus enabled to drive away the branching horned forms during the rutting season, and to leave a larger number of descendants. These and their descendants, in turn enjoying similar advantages are, it is stated, gradually supplanting the branching horned deer in the Southern Adirondacs. The facts have been disputed and need the confirmation of farther observation and experience, but they form, perhaps, one of the best illustrations of the theory of natural selection ever recorded. Assuming, however, that it is true, and that a new species of deer is now being evolved in this region, what does natural selection really account for? It must account for the preservation and perpetuation of the branching horned variety, as well as the rise of the straight horns. The Anoplotherium of the Eocene, which has always been considered