by parentheses, and the sedges and grasses, which were well developed.

Anemone parviflora.
Aquilegia formosa.
Aconitum Napellus, var.
Barbarea vulgaris.
Arabis petraea.
Cardamine hirsuta, var.
Viola cucullata.
Lupinus arcticus.
Rubus Chamaemorus.
(Poterium Sitchense?)
Saxifraga tricuspidata.
Saxifraga leucanthemifolia.
Parnassia fimbriata.
Ribes rubrum.
Epilobium spicatum.
Epilobium latifolium.
(Heracleum lanatum.)
Cornus Canadensis.
Antennaria alpina.
Arnica latifolia.
(Senecio triangularis.)
Vaccinium parvifolium.
Arctostaphylos Uva-ursi.
Bryanthus empetriformis.
Kalmia glauca.
Ledum latifolium.
(Moneses uniflora.)
Pyrola secunda.
Dodecatheon Meadia, var.
Polemonium humile.
Mertensia paniculata.
Polygonum viviparum.
(Betula glandulosa.)
(Alnus viridis.)
Salix glauca.
Salix Sitchensis.
Habenaria dilatata.
Streptopus roseus.
Carex (2 sp.).
Deyeuxia Langsdorffii.
Festuca ovina.
Lycopodium complanatum.
Lycopodium annotinum.

The rest of the collection was made as opportunity offered, during the descent to Fort Selkirk in latitude 62° 45′, which point was reached on the 13th of July. It included the following species: —

Anemone multifida.
Ranunculus Flammula, var.
Erysimum parviflorum.
Cerastium arvense.
Arenaria lateriflora.
Arenaria physodes.
Montia fontana.
Linum perenne.
Hedysarum boreale.
Rubus arcticus.
Fragaria vesca (?)
Potentilla fruticosa.
Amelanchier alnifolia.
Parnassia palustris.
Bupleurum ranunculoides.
Galium boreale.
Aster Sibiricus.
Achillea millefolium.
Artemisia vulgaris.
Arnica alpina.
Arnica Chamissonis.
Pyrola rotundifolia, var.
Primula Sibirica.
Myosotis sylvatica, var.
Pentstemon confertus.
Pentstemon glaucus (?).
Pedicularis flammea.
Chenopodium album.
Polygonum aviculare.
Zygadenus elegans.
Hordeum jubatum.

The species new to so northern a latitude are marked by italics. The season appears to have been as forward as I found it in 1868 in the lower mountain ranges rising from the plateau of western Nevada in latitude 40°.

SERENO WATSON.

THE INTELLIGENCE OF SNAKES.

NEITHER among the scanty early references to the serpents found in New Jersey, nor in more recent herpetological literature, are there to be found statements that bear directly upon the subject of the intelligence of snakes. Gabriel Thomas, writing of West New Jersey as long ago as 1698, quite ignores the fourteen species with which we are favored. Thomas Campanius, in his history of New Sweden, published in 1702, and which is based on the notes made by his grandfather during his brief stay in Pennsylvania sixty years before, also ignores our harmless snakes, but remarks of the rattlesnake (Crotalus horridus), "It has a head like a dog, and can bite off a man's leg as clear as if it had been hewn down with an axe." What may we not expect, when such statements as this are made by men of intelligence? Assertions equally absurd are not uncommonly made, even in these later days, when a correct knowledge of our common animals is supposed to prevail.

Nearly half a century later than the date of publication of Campanius' history, Peter Kalm, the Swedish naturalist, travelled in New Jersey, and spent much time, particularly in the southern counties of the state. In his entertaining volumes, he has made many references to our snakes, although not enumerating all of them, and mentioning some that certainly do not now exist. This author relates several wonderful stories of the fierceness of the black snake, as they were told to him, and likewise gives his personal experience with this same serpent, which, to his surprise, did not accord with what he had heard. The reason is plain enough. Kalm desired to know the truth, and took the experimental way of learning it. His knowledge of the snakes was gained by familiar out-of-doors intercourse with them, and it has stood the test of time. All that was needed, when he wrote, was the moral courage to say to the narrators of the marvellous stories, 'You are mistaken;' or perhaps, more wisely, he might have kept silent. The most conscientious man, if afraid of snakes, cannot tell the truth about them; and even in the case of the truly poisonous species, it is well to remember that 'the devil is not so black as he is painted.' Stress has been laid upon the exaggerated statements of authors when treating of snakes, for the reason, that, if there were any foundation for the marvellous stories narrated, it would prove conclusively that the serpent was indeed wise. But setting aside all the literature of the subject, and going directly to the woods and fields, what evidence do we find there of the intelligence of snakes?

On the farm of the writer there have been found eleven species of snakes, which is but four less than the whole number found in New Jersey. Of these eleven species, no one is venomous; and, it may be added, all are perfectly harmless, and, indeed, cowardly. It is true that when cornered they will show fight,

but it is the veriest make-believe; and it is very questionable if there is a snake among them all which could harm the smallest child, even if disposed to do so. This is strangely at variance with the current newspaper stories, I know; but those, like the anecdotes related by Kalm, are simply not true.

Of our common snakes, the most formidable in appearance is the black snake (Bascanion constrictor), and of this species scores of most wonderful stories have been told; yet the species is really very cowardly, and not disposed to resent interference at any time. It is, however, probably the most active, as it is the largest, of our serpents, and therefore is one well calculated to exhibit evidences of the possession of intelligence, and the best to study in regard to this subject. What, then, do we learn, when we seek out these black snakes in their chosen haunts? To find them, one must proceed cautiously; for they are possessed of a quick sense of hearing, and are on the alert the moment any suspicious noises are heard. Is it for this reason that they are considered quite rare in many places where they really are abundant? They have apparently learned wisdom by experience, and, knowing that if discovered they will be pursued, conceal themselves quickly if they suspect danger. I can in no other way satisfactorily describe such actions of these snakes as I have often witnessed; and the use of the phrase 'learning wisdom,' and of the word 'suspect,' implies necessarily the possession, on the part of the snakes, of a considerable degree of intelligence. How far the black snake is cunning, I have not been able to determine; but a chance remark in Heckewelder's 'Indian nations' would seem to indicate that the Indians had long been convinced that it was a cunning serpent, and I am disposed to accept their testimony in such matters as essentially correct. Heckewelder says the Indians gave to Gen. Wayne the name of 'Black Snake,' "because they say he had all the cunning of this animal, who is superior to all other snakes in the manner of procuring his food. He hides himself in the grass, with his head, only, above it, watching all around to see where the birds are building their nests, that he may know where to find the young ones when they are hatched."

Assuming this to be true, we have here an instance, not only of cunning, but of a very excellent memory. This seems incredible; but Mr. Romanes, in his volume on animal intelligence, remarks that snakes "are well able to distinguish persons, and that they remember their friends for a period of at least six weeks." If, therefore, a tamed snake can remember a person for six weeks, there is nothing very remarkable in its retaining the localities of birds' nests for a shorter period; for, between the building of the nest and hatching of the eggs, less than half that time elapses. The elaborate treatises on the power of black snakes to charm birds and squirrels may be passed by in this connection. That these snakes frighten little birds out of their wits by staring at them is occasionally true; but that the snake intentionally 'charms' its prey, as has been so elaborately and pathetically described, is sheer nonsense. Still, considering the black snake in a practical way, and seeing him under ordinary, not extraordinary, circumstances, it must be admitted that he possesses a considerable degree of intelligence. Indeed, the fact that this snake has, notwithstanding incessant persecution, been able to hold its own in the most thickly settled neighborhoods, is of itself a conclusive argument that it possesses decided intellectual power. It has at least sufficient wit to elude a host of enemies.

A far more abundant species, and one that is even better known and more dreaded than the black snake, is the harmless and very resentful hog-nosed snake (Heterodon platyrhinos). It has a variety of common names, — such as 'adder,' 'viper,' and 'flat-head,' — of which the last alone is at all appropriate. It is true that it flattens its head, hisses loudly, springs menacingly, and snaps fiercely; but it is harmless nevertheless.

As an object of study, it presents much that is of peculiar interest. Without fangs, or even teeth of sufficient length to produce a wound beyond a mere pin-prick, it presents the outward appearance, and has the pose and movement, of the deadly rattlesnake. Wholly unable to inflict the slightest injury, it has always puzzled me to understand why it should not, like all our other snakes, seek safety in flight. May we hold that it realizes the full meaning of the peculiar powers of the venomous serpent it mimics so admirably, and trusts to its being mistaken for a rattlesnake? Indeed, this mimicry has been perfect in some instances that I have witnessed; inasmuch as the tail of the snake was rapidly vibrated against dead leaves, and so produced a sound that was strikingly similar to that of the rattlesnake. This similarity was, of course, accidental, as it was by mere chance that dry leaves were lying about; but, at various other times, I have noticed that the tail was held in the same position, and vibrated in precisely the same

manner, as that of the rattlesnake. In these instances I thought I detected a faint whirring sound, or a buzzing; but on this point I am not positive.

Mimicry on the part of snakes is a ready way of explaining some of their habits; but, even when accepted, it remains to be shown how it originated. Is there any evidence that in former times the hog-nosed snake and rattlesnake were intimately associated? I find none, and certainly at present the two species are not found together. I have endeavored to detect something in their habits, haunts, and anatomy, that could throw light upon this question, but as yet all in vain. I can only say that the snake is in appearance a deadly rattler, but that it has neither the rattles nor the fangs. A veritable impostor is he, sailing under false colors throughout his whole life. How far has conscious mimicry had to do with this? If any thing, a high degree of intelligence is implied; but, even if the peculiar habits of the species were acquired without reference to other snakes, does not the fact that it relies upon worthless means of safety imply that it recognizes them as calculated to strike terror in the breast of its tormentor? That this snake should generally refuse to seek safety by running away, but depend upon actions which cause no harm to its enemies, seems, at first glance, to be the height of stupidity; but, when we recall the fact that it is a perfect imitation of the defensive movements of a venomous species found in the immediate neighborhood, then the question arises whether it may not be conscious imitation. If so, this snake, which is really quite sluggish in its movements, may be far more cunning than we suspect.

There is another species that to a certain extent imitates the rattlesnake, but whether intentionally or not, remains to be determined. This is the milk snake (Ophibolus doliatus). This species, when found in the woods coiled upon a heap of dead leaves, will often closely imitate the peculiar rattle of the Crotalus by vibrating the tail with great rapidity, and in such a manner as to strike the leaves beneath it. This I thought to be accidental in the case of the hog-nosed snake, but believe to be intentional in this instance. I do not go so far as to state that it is an intentional imitation of the rattle of the Crotalus, but that the snake vibrated its tail against the dead leaves that a decided volume of sound might be produced. This implies that it believed that a defensive pose at the time, coupled with a rattling sound, would cause the intruder to withdraw: at least, it depended upon them rather than upon running away, when surprised. We certainly have, in such cases, exhibitions of choice, on the part of snakes, between two means of defence when overtaken by enemies. Does not the exercise of choice between two equally available means of accomplishing an object imply the possession of a considerable degree of intelligence? A beautiful green snake (Liopeltis vernalis), which I kept in semi-confinement for several months, exhibited many evidences of considerable intelligence. It became very tame, and evidently recognized me. Although allowed considerable liberty, it did not seem to be very active during the day, but was restless in the evening. It seemed to be more sensitive to cold than any of our other snakes, and remained under its little blanket when the day was rainy, or a strong east wind prevailed. It fed upon flies, which it would take from my hand, seizing them very leisurely, and swallowing them deliberately. There was nothing of the snap and gulp of a salamander or toad about the process. When, however, the snake went fly-hunting on its own account, there was a very different state of affairs. There was still great deliberation, but only until the moment for action arrived; and then, with a snap, the fly was gone.

Occasionally this pet snake would creep among a number of pots of flowers, and coil about the green branches. At such times it would frequently extend some three or four inches of its body outward and beyond any support, and thus remain, as rigid and apparently lifeless as a twig. This, probably, was a habit common to the snake when free; but why it should be indulged in under such changed surroundings, I cannot imagine. Certainly it was not for the sake of seizing its food; for I noticed that the snake, after taking a hearty meal, would assume this position, and that it did not ordinarily assume it when asleep. In its proper home, such a habit, on the part of a small snake of this color, would render it for the time very secure against such enemies as were guided only by sight. Even when standing very near the rose-bush upon which my pet rested, I found it, when in this position, a very inconspicuous object.

If this position, then, was assumed as a means of safety, it is a habit indicative of much cunning; for it acquires thereby the best chances for seeing about it, with the least probability of being noticed.

Of the seven other species of snakes found here, I have nothing special to remark. It is sufficient to say that the general impression

which these snakes give me, as I chance upon them in my rambles, is, that they are cowardly but cunning. Blessed with acute hearing and sharp sight, they use both of these faculties to the best advantage in the two important events of their daily lives, — the capture of their food, and eluding their enemies. After thirty years of familiarity with the snakes found in this neighborhood, I can truly say of them, as serpents they are *wise*, and add, they are harmless as doves.

Charles C. Abbott, M.D.

PRESENTATION OF THE RUMFORD MEDALS TO PROFESSOR ROWLAND.

The special business announced for the meeting of the American academy of arts and sciences on the evening of Feb. 13 was the presentation of the Rumford medals, which, at the annual meeting in May, had been awarded to Prof. Henry A. Rowland of Baltimore. Before presenting the medals, the president of the academy, Professor Joseph Lovering, made the following address: —

The medals awarded to Professor Rowland have been struck at the Philadelphia mint, and appropriately engraved under the direction of the Rumford committee. Their delivery to the recipient has been postponed for several meetings, under the hope and expectation that Professor Rowland would find it convenient to be present, and receive the medals in person. His attendance with us now is warmly welcomed, and adds greatly to the interest of the occasion. I ask your kind attention to a brief statement of so much of the scientific work of Professor Rowland as justifies the award of the Rumford premium, and of the relation in which these researches stand to the present condition and needs of physical science.

Astronomy, at least that part of it which relates to celestial mechanics, has presented for many generations unchallenged claims to a precision not attainable in any other science. The comparative simplicity of its problems, involving only the familiar and measurable units of mass, space, and time, has enabled it to attain and to hold this distinguished position, in spite of the fact that all the senses except vision are excluded from its study. If it has received any assistance from the experimental laws of mechanics, much more have these laws been illuminated by the motion of the planets, where friction and other resistances do not interfere.

After Grove, in 1842–43, had published his lectures on the correlation of the various physical forces; after Mayer, Helmholtz, and others had published their conclusions (the deductions partly of theory, and partly of experiment) that these different forces were mutually convertible; and after the view first seized in prophetic vision by Bacon, Locke, and Winthrop, was experimentally established by Rumford, Davy, Joule, and numerous coadjutors, and with ever-increasing clearness, that the assumed caloric was imaginary, and that heat was only one kind of motion in ordinary matter, — then it was possible to introduce unity, harmony, and precision into all the physical sciences by making the familiar units of measurement universal. As other forms of energy (mechanical, electrical, magnetic, chemical, capillary, radiant, and gravitation) can be converted, directly or indirectly, into heat-energy, heat has become a universal standard of energy, current everywhere in science, and redeemable. Hence it has become of prime importance to determine the mechanical equivalent of heat: the amount of heat, for example, which corresponds in energy to a given mass falling through a given height in a given latitude. In this way heat and all its dependencies will be measured by the units of ordinary work. For more than forty years, physicists in difference countries, and by various methods, led by Joule, have been engrossed with this measurement, reaching results which have slowly but happily converged towards a common agreement.

Professor Rowland, after a historical and critical review of the methods and results of older cultivators in this rich field, has turned up the soil anew, deepening the furrows.

The fruits of his long and patient labor were made known to the academy in 1879, in vol. xv. of the Proceedings. New apparatus was devised; the comparative merits of mercurial and air thermometers were discussed; and the various constants of science which enter into the case were re-examined. The research is a model of ingenious and conscientious experimentation, and was not published until it had received from its author the same severe criticism which he had applied to the work of others. That his final conclusion harmonizes so well with the best of Joule's, increases our confidence in both. A larger discrepancy might have given a greater show of originality; but science would have paid for the novelty by a loss of security, and another revision of the whole subject would have been entailed upon it.

When Newton announced his dynamical theory of the solar system, as simple as it was comprehensive, it made slow headway against the fanciful hypothesis of Descartes which was intrenched in all the universities of Europe. And yet Newton's theory reposed upon a firm mathematical foundation; while that of Descartes submitted to no quantitative tests, and contradicted all the known laws of mechanics. The history of astronomy from that time almost to the present moment tells of ever new victories achieved by the combined attacks of the telescope and mathematical analysis in the province of celestial mechanics, presenting the law of gravitation as supreme dictator to planetary and sidereal systems. But these triumphs, complete in their details, and grand in their cosmical range, were limited to questions which concern the distances, motions, dimensions, and masses of the heavenly bodies. The law of gravitation can assign a value to the quantity of matter in planets and binary stars; but it asks and can answer no question in regard to the quality of this matter,