Apparently Chicago receives the same precipitation as the surrounding prairie region. Unfortunately no hourly readings of relative humidity are available and the period of bihourly values shown in Table CXII. is much too short to establish with any degree of accuracy values for the various hours. A table of average monthly and annual relative humidities for 15 cities in the United States is given, but no mention made of corresponding temperatures. As it stands, the table is without value for comparative purposes.

The authors give generous credit to all who have helped in the work. The Geographic Society of Chicago has done well in making accessible data which otherwise might have remained buried in official files. The general make-up of the book is good.

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SPECIAL ARTICLES

SOME OBSERVATIONS ON THE FOOD HABITS OF THE SHORT-TAILED SHREW (BLARINA BREVICAUDA)

Of the six species of short-tailed shrews of the genus *Blarina* occurring in the United States, *Blarina brevicauda,* called the large blarina or mole-shrew, is the only one found north of the Austral region, and consequently is the only representative of the genus here in Massachusetts. It inhabits deciduous woodlands and fields, where it makes shallow tunnels that are often marked on the surface by little ridges.

This shrew is described as follows on page 11 of North American Fauna No. 10, U. S. Dept. of Agriculture:[1]

> General characters.—Size, largest of the subgenus (total length about 125 mm.); skull largest and heaviest of the American Soricidæ; pelage glossy. Color.—Sooty-plumbeous above, becoming ashy-plumbeous below, varying with the light; paler in summer; glossy in fresh pelage.

It has a stout body, nose rather long and tapering, external ears not visible, eyes very small, front teeth chestnut colored at tips, and tail about one quarter the length of the head and body. It depends on the highly specialized senses of touch, hearing and smell for guidance in probing about and searching for food, the eyes being very slightly developed.

General works on natural history speak of the diet of shrews as being chiefly worms, larvæ of insects and small mollusks.

Audubon and Bachman,[2] in speaking of the Carolina shrew (*Blarina brevicauda carolinensis*), an animal somewhat smaller than the short-tailed shrew, say:

> In digging ditches and ploughing in moderately high grounds, small holes are frequently seen running in all directions, in a line nearly parallel with the surface, and extending to a great distance, evidently made by this species. We observed on the sides of one of these galleries a small cavity containing a hoard of coleopterous insects, principally composed of a rare species (*Scarabœus tityus*) fully the size of the animal itself; some of them were nearly consumed, and the rest mutilated, although still living.

Merriam[3] says that "it subsists upon beechnuts, insects, earthworms, slugs, sow-bugs and mice." He also speaks of its feeding on chrysoledes and the larvæ of insects. He quotes Mr. John Morden, in the *Canadian Sportsman and Naturalist,* Vol. III., 1883, in which the latter describes the mouse-killing and eating propensities of the short-tailed shrew and draws these conclusions:

> According to my observations, the little mammal under consideration eats about twice or three times its own weight of food every twenty-four hours, and when we consider that their principal food consists of insects, it is quite bewildering to imagine the myriads one must destroy in a year.

Merriam proceeds to tell of an encounter between a short-tailed shrew weighing 11.20 grams and a deer mouse (*Peromyscus leucopus*) weighing 17 grams, in which the former was victorious, and after eating an ear, the brains, side of the head and part of the shoulder of the mouse, weighed 12 grams. He says:

[1] U. S. Dept. Agriculture, North American Fauna Series No. 10, p. 4, 1895. "Revision of the Shrews of the American Genera *Blarina* and *Notiosorex,*" by C. Hart Merriam.

[2] Audubon and Bachman, "The Quadrupeds of North America," 1849.

[3] Merriam, "The Mammals of the Adirondack Region," 1884.

If left without food for a few hours he will eat corn from the cob, beginning at the outside of the kernel, but it is very clear that he does not relish his fare. He will also eat Indian meal and oats when other food is not at hand. Slugs and earthworms he devours with avidity, always starting at one end, and manipulating them with his fore paws. But of the various kinds of food placed before him, he shows an unmistakable preference for mice—either dead or alive.

Rhoads[4] writes:

It is known that they (*Blarina brevicauda*) subsist to some extent on vegetable food, chiefly nuts, but they do only indirect damage to agriculture by disturbing the roots of plants.

He also states that they eat "salamanders, other batrachians, and reptiles which haunt their burrows."

Shull[5] found that this shrew eats house mice, May beetles (*Lachnosterna*) and their grubs, moth larvæ, other insects and pupæ, earthworms, snails of the genus *Polygyra*, sow-bugs and beef. "Carrots, crackers, roots of grasses and other plants," he says, were never touched as food.

Stone and Cram[6] relate the following observation:

One that I caught in a trap had already, when I found it, disposed of the raw meat which had served as bait, and when confined in a cage immediately seized upon whatever meat was offered it, whether raw or cooked, without discriminating between kinds. Beef, pork and cold chicken—all went the same way, while the fury of his appetite was being appeased.

They also write:

I believe that they get the greater part of their food at this season (winter) by burrowing about among the dead leaves beneath the snow in the forests, gathering the dormant insects that habitually pass the winter in such places.

Seton[7] states that the diet of the short-tailed shrew is chiefly insects and worms, but that it will eat "any kind of living food it can find and master, preying largely, . . . on field mice, which equal or exceed it in weight." He believes dormant insects form a large part of its sustenance in winter. He gives the following list of stomach contents findings from short-tailed shrews, taken at Cos Cob, Connecticut:

No. 1. Earthworms, almost whole; membranous wings of beetle.
No. 2. Connective tissue, cartilage and muscle.
No. 3. Earthworm setæ, parts of insects; some of its own hair, probably swallowed with food.
No. 4. Earthworms.
No. 5. Earthworm setæ.
No. 6. Insects.
No. 7. Insects.
No. 8. Legs of Isopod.
No. 9. Muscles and setæ of earthworms.
No. 10. Earthworms.
No. 11. Earthworms and insects.
No. 12. Isopod legs and insects.
No. 13. Earthworms, insects, connective tissue and striated muscle, probably of some small rodent.

Shull reports the findings of two stomach contents as follows:

1. An insect larva.
2. Meadow vole.

In speaking of the short-tailed shrew, Corey[8] quotes Dr. John T. Plummer[9] as follows:

It was given flesh of all kinds, fish, coleopterous as well as other insects, corn, oats and other kinds of grain, all of which appeared to be acceptable food. "The corcle of the grains of maize was always eaten out, as it is by rats and mice." When water was put into the box the shrew "wet his tongue two or three times and went away; but when worms were dropped into the cup, he returned, waded about in the water, snatched up his victim, maimed it, stored it away, and returned repeatedly for more till all were secured." A full-grown living mouse was put into the box, which was at once fiercely pursued by the shrew, attacked and killed. Another mouse met with the same fate.

This habit of attacking mice is well known among those who have studied into the matter. Merriam and Morden have vividly described

[4] Rhoads, "The Mammals of Pennsylvania and New Jersey," 1903.

[5] Shull, "Habits of the Short-tailed Shrew, *Blarina Brevicauda* Say," *American Naturalist*, Vol. XLI., No. 488, pp. 496–522, August, 1907.

[6] Stone and Cram, "American Animals," 1905.

[7] Seton, "Life Histories of Northern Animals," 1909.

[8] Corey, "The Mammals of Illinois and Wisconsin," Publication 153, Zool. Ser., Vol. VI., Field Museum of Natural History, Chicago, Ill., 1912.

[9] *Am. Jour. of Sci.*, Vol. XLVI., 1884.

such encounters, but Kennicott[10] is the only writer who has described an encounter in which the shrew was attacked by the mouse. He says: "When attacked by a meadow mouse (*Arvicola scalopsoides*), etc. . . ." Shull states, in speaking of short-tailed shrews kept in confinement, that house mice were captured when they entered the shrews' burrows, while voles were pursued and cornered above ground, and that most of the killing was done at night.

While the observations referred to above were regarding house mice (*Mus musculus*), meadow mice (*Microtus pennsylvanicus*) and white-footed or deer mice (*Peromyscus leucopus*), the writer found that red-backed mice (*Evotomys gapperi*) were no exception, for on two occasions a short-tailed shrew which the writer had under observation, overcame and killed a red-back without apparent injury to itself. Morden states that it took about ten minutes for a short-tailed shrew to overcome and kill a meadow mouse larger than itself, and Merriam found his 11.2 gram shrew was half an hour in tiring and half an hour in killing a 17-gram deer mouse. In the encounter witnessed by the writer, it required twelve minutes for the shrew to kill the mouse after getting its first hold. On another occasion the shrew, which weighed 15 grams, captured and killed during the night a red-backed mouse, weighing 29 grams and seemed uninjured after the encounter.

It is difficult to conceive how a shrew, with its very limited vision (the eyes being probably of service only in distinguishing light from darkness) can capture an uninjured mouse in the freedom of the woods (the box in which the shrew and mice were confined was 18 in. $\times$ 20 in.) yet this shrew had a systematic method of attack, and always opened the skull of its victim in the same general location, which would seem to indicate that it had had experience in such encounters, or else had acquired the knowledge by heredity, which would also indicate a long series of such battles by its ancestors. An exception to its habitual method of opening the skull was observed one day when an adult Norway rat (*Epimys norvegicus*) freshly killed, was placed in the box. Instead of entering the cranial cavity between the eye and ear, as usual, it opened the throat and worked into the brain through the base of the skull.

An interesting habit which this shrew exhibited, and which may illustrate one method of capturing mice under natural conditions, was noted as follows: Whenever a live mouse was placed in the box with the shrew, the latter at once secreted itself under some small pile of leaves or moss. In the course of a few minutes the mouse, while exploring its new quarters, would jump on the pile under which the shrew was concealed, whereupon the shrew would spring up and try to get hold of the mouse. This was attempted on several occasions, always, however, without success.

Animal food in any form seemed acceptable, while only a limited variety of vegetable matter was eaten. It ate grasshoppers (*Melanoplus femoratus*) and crickets (*Gryllus* Penn.) with avidity; raw beef sparingly, preferring the fat; and small amounts of American cheese. One morning when no other food was at hand, it devoured the abdominal contents of another shrew of the same species, freshly killed. As soon as other food was placed in the box, however, the remains of the dead shrew were at once and permanently deserted, which would indicate that this animal did not become cannibalistic except under stress of circumstances. In speaking of this habit it may be of interest to quote Merriam's observations on the long-tailed shrew (*Sorex personatus*), a much smaller animal. He writes,

> I once confined three of them under an ordinary tumbler. Almost immediately they commenced fighting, and in a few minutes one was slaughtered and eaten by the other two. Before night one of these killed and ate its only surviving companion, and its abdomen was much distended by the meal. Hence, in less than eight hours one of these tiny wild beasts had attacked, overcome and ravenously consumed two of its own species, each as large and heavy as itself!

Another shrew under observation devoured

[10] Kennicott, Report of the Commissioner of Patents for 1857. Agriculture, "The Quadrupeds of Illinois Injurious and Beneficial to the Farmer."

a small garden toad, but allowed a large one (40 grams est.) to remain in the box for five hours unmolested, at the end of which time the toad was removed.

Professor Cope[11] writes of a Carolina shrew overcoming a water snake (*Tropidonotus sipedon*) two feet in length, in a night, which shows the courage and fighting qualities of this little beast.

To test the keenness of the senses of this shrew, a skin of a meadow jumping mouse (*Zapus hudsonius*), dried some months previously, was placed in the box. It was at once furiously attacked, but was removed as soon as torn about the head, because of the presence of white arsenic inside. So vigorous was the attack that the mouse skin was repeatedly lifted from the floor with the shrew still clinging on, biting and tearing. It would have been interesting to see how long the ill-directed attack would have been continued.

Moles and shrews have been often accused, by farmers especially, of being agents of destruction about gardens and of subsisting on the vegetable food found there. In all probability the only damage committed, by this species of shrew at least, is done indirectly, as referred to above, by disturbing roots while burrowing about for insects or worms. The following experiment, which bears on this matter, was carried out with the same results on two different occasions. The box being cleared of all food, the following twenty-one varieties of common vegetable matter, most of it freshly gathered, were put in: cabbage, cauliflower, lettuce, potato, carrot, parsnip, string-bean, pole-bean, summer squash, turnip, beet, sweet corn, rhubarb, kohlrabi, tomato, cucumber, peach, pear, canteloupe, banana and olive. At the end of nine hours (first experiment), the shrew was found curled up in one corner of the box, weak and listless, while not one of the vegetables had been touched, with the exception of the olive, which had been nibbled. (This may have been eaten to get the salt, as the olive had been kept in brine.)

[11] Cope, "On a Habit of a Species of *Blarina*," *Am. Nat.*, Vol. VII., No. 8, pp. 490–491, Aug., 1873.

When the experiment was tried the second time, the shrew remained eleven hours without food, and showed quite a marked constriction about his abdomen at the end of that time. These results seem to vindicate the short-tailed shrew from the charge of being a garden thief.

An exception to its non-vegetarian habits, however, was found to be made in regard to rolled oats. These it ate at first sparingly and with little relish, but later lived on them exclusively for fifty-two hours and at the end of that time seemed as vigorous and contented as ever. Seton speaks of taking a female short-tailed shrew whose stomach was full of corn meal unmixed, and owing to the unusually slow process of putrefaction in the animal, he reasons that it had been on that diet for some time. Merriam writes of one he had in confinement that was "very fond of beechnuts and thrived when fed exclusively on them for more than a week." Judging from these findings, dry vegetable food seems to be preferred to succulent varieties.

The writer's shrews did not exhibit the ravenous appetite attributed to the species by some observers. They did not pursue their prey persistently, and having captured it, seemed satisfied, for the time being, with a small amount of food. Shull gives two thirds of a meadow vole or one house mouse as the average daily diet. This is a higher average than that made by the shrews under observation, as two thirds of a house mouse, or its equivalent, was amply sufficient. They drank small quantities of water frequently. However, within the twelve hours immediately following an eleven-hour fast, one ate 16 grams of animal food (more than the equivalent of its own weight—15 grams), which fact demonstrates their latent capabilities in that direction. Quoting Seton again, he says:

> Numerous experiments and observations on captive animals prove that the *Blarina*, like its smaller kin, has an enormous appetite which must be satisfied, or in a very few hours the creature succumbs.

The writer found an uninjured shrew of this species, dead in a cage trap seventeen hours after setting it, showing that death by starva-

tion took place in something less than that time.

The favorite diet of the animals under observation was, without question, freshly killed mice. Shull, estimating four of these shrews to the acre, figured that on a farm of one hundred acres, they would, in a year, devour 38,400. Realizing the vast amount of damage these rodents are capable of producing in agriculture and considering also the almost exclusively carnivorous habits of the *Blarina brevicauda,* one must admit a great economic value for this shrew.

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The Limit of Uniformity in the Grading of College Students by Different Teachers[1]

In the University of Missouri our grades have, since five years ago, been defined by the frequencies of their permitted occurrence: according to our definitions 25 per cent. are superior, 50 per cent. medium and 25 per cent. inferior grades.[2] We hoped thereby to diminish or even exterminate the divergence of marking then existing. We actually reduced this divergence; but only two thirds. We failed to exterminate it. One third of the former lack of uniformity persists, as may be seen from my previous report in Science, and we ask the question: Why does it persist?

It seems that the chief cause is the inability (call it unwillingness, if you wish, but nothing is gained by any name) of the teachers to differentiate between the performances justly to be expected of a freshman and a senior. For simplicity's sake I speak of two college classes only. Instead of recognizing the relatively superior work of certain freshmen among the freshmen, the teacher compares their work with the work of seniors, and then, of course, finds it to be but weak. And, instead of recognizing that some of the seniors are much less accomplished than other seniors, the teacher compares the weaker senior's accomplishment with that of the freshman and finds it quite remarkable. The result is a widely spread tendency of teachers to report an excess of inferior grades in freshman classes and an excess of superior grades in senior classes. This seems to explain that persistent fraction of the lack of uniformity which we could not eradicate.

Here is the example of an individual teacher in history whose total distribution of grades is approximately that prescribed by the university:

	25% Sup.		50% M.	25% Inf.	
	%E	%S	%M	%I	%F
Underclassmen	1	16	51	25	7
Upperclassmen	6	30	40	20	4

Is there any remedy? It seems simple. Let the teacher differentiate more between the work of freshmen and that of seniors. Assign to the freshman such tasks as are appropriate to the condition of the student who has just left the high school, and to the senior tasks which approach in difficulty, in the requirement of initiative, of resourcefulness, the tasks which the research work of the graduate school keeps ready for the senior as soon as he has his diploma.

But this remedy is not as simple and easy of application as it looks, for the average college teacher seems to be incapable of making the differentiation required. Instead of comparing, rather, freshmen with high-school pupils and seniors with graduate students, he compares freshmen with seniors in the performance of an identical task given to both. However, we must have patience with the teacher. His own task is not small. There are three influences from which he can not easily free himself. (1) Freshmen and seniors, after all, belong socially to one group, that of college students, and neither to the group of high school pupils nor to that of members of the graduate school. (2) He is in mental contact with both freshmen and seniors all the time, but usually no longer with high school pupils and not, probably, with graduate

[1] Read before Section L—Education—American Association for the Advancement of Science, Atlanta, December, 1913.

[2] Compare two former papers: "The Grading of Students," Science, 28, pp. 243–250, 1908; "Experiences with the Grading System of the University of Missouri," Science, 33, pp. 661–667, 1911.