

THE HOME LIFE OF THE COLUMBIAN GROUND SQUIRREL

By WILLIAM T. SHAW



ONE OF the most familiar summer animals of central and western Canada is the so-called gopher or ground squirrel. This animal has increased with favorable conditions of cultivated, grain-producing fields, until it has become an economic problem of great importance. The animal is a true ground squirrel belonging to a genus, *Citellus*, of wide range and abundant species in western North America. The kind given close consideration in this paper is the Columbian ground squirrel, (*Citellus columbianus columbianus*), (Fig. 1) of the Columbia Basin, an animal extending into British Columbia and Alberta from the south and west.

Though the appearance of ground squirrels during summer months is of common, every-day note, still the interest they excite in us is not fully developed until we start investigating their underground houses. Some time ago a most thorough investigation of the life of this animal was carried on by the writer at the Washington Experiment Station and the results as shown and recorded in this paper will present the home life of the interesting little rodent.

This work of investigation, which extended over a period of about five years, was most searching and during that period 163 dens were excavated in search for information on all phases of the life history, 22 of the excavations being made with a desire for direct information regarding its summer home life.

As a rule the underground houses of these animals are located on gently sloping hill sides, more commonly those facing the sun, though some dens are found on the northern exposures. The depth, texture and drainage of the soil are probably the most important factors in determining the location of the den. The squirrels seem to avoid stiff clay hill-tops and low flats even if the latter are wet only a part of the year. A fence row of snowberry shrubs (*Symphoricarpos*) is a very favorable place for a burrow. The snowberry stems in the center of the thicket are quite destitute of leaves for a foot or so up, then take on an abundant foliage, affording excellent shelter. Clumps of bushes conspicuous on north slopes, when snow is on the ground, are often a mark of the squirrel den. The two might well go together, as the squirrel throws out quantities of loose dirt, making a favorable place for plant development.

Locally there seem to be three intergrading types of summer dens; those in shallow soil, one foot to 18 inches in depth, for extending the feeding range;

those on the rimrock with 2½ feet of soil where young are frequently raised and those in deep soil where old squirrels commonly hibernate. These types consist of a series of radiating burrows very much interlaced near the center. From these are often found many short blinds, probably unfinished burrows for passing or turning places. There is no large excavated cavity. The only expansions found are those which usually occur at the intersection of burrows and these are not large, being sufficient only to accommodate the summer nest or the slightly larger brood nest. These nest cavities are typically arranged in a circle or quadrangle about a large central mass of earth which is not burrowed into to any extent. (Fig. 2). From this common center some burrows rise at an angle of 45 degrees. Others sometimes start deep and gradually rise until they are near the surface then continue radially for many feet, their function being to extend the area for safe pasture. Other burrows leading from the nests drop deep down into the lower parts of the den. The dens, though non-communicating, are often placed in colonies, the periferal holes a rod or so apart.

PATHS.—When the colony of squirrels is well established, even early in the season and especially after the young have appeared, frequently trips from hole to hole soon wear paths in the grass. Ever watchful, the ground squirrel has learned to take no risks, and when crossing a den or going some distance, it almost invariably runs in a straight line between any two burrow entrances if they are at all in the desired direction. By June, paths a few inches wide lead from burrow to burrow, and radiate from the dens into the feeding grounds. A path 90 feet long was observed, leading between two dens, without intermediate holes. On August 7-9 many paths through the dead weeds or over the green grass and clover of the flat were noted leading from the roadside to a wheat field. These paths had holes here and there along the way to dodge into in case of danger. Another path studied led from a field of winter wheat to a den at the bottom of a hill and was 54 yards long.

THE ENTRANCE.—There are two distinct types of entrances to the burrows of the Columbian ground squirrel. One is small and round and not much if any larger than the burrow itself. There generally is no loose earth around it, all the dirt having been hauled below. In the other type the mouth of the burrow has been enlarged into a funnel-shaped opening sometimes several inches

across. Upon one side of it is a mound of earth thrown out by the squirrel. (Fig. 1).

The single entrance is sometimes converted into a double entrance which would have the advantage of greater safety in case of pursuit. These two entrances join into the same burrow a foot or so below the surface. A still further development of this type of hole has resulted in the formation of a protective entrance, in which the burrow terminates in four, five or more shallow troughs spreading out over the surface of the ground. (Fig. 3). This is undoubtedly a means of protection for the fleeing squirrel when closely pursued by an enemy. In most cases such protective entrances have no fresh dirt thrown about them, the dirt being hauled down through the burrow. These protective troughs are sometimes found on the mounds of loose earth cast out of a burrow. They are usually started about a month after the squirrel comes from hibernation. The number of entrances to a squirrel den is sometimes large. Careful count of the number of entrances to sixty dens gave an average of 11.16 entrances per den, the number varying from two entrances for a small den to 35 entrances for a large den.

THE DEPTH OF BURROWS.—The depth of the burrow is taken as the distance from the surface of the soil to the top of the burrow and is usually determined and limited by the sub-soil or by the hardpan, as they seldom go far into these harder strata. (Fig. 4). However, even in deep soil outlying burrows are sometimes shallow at the distal ends, probably because the soil is easier to dig nearer the surface. One large, open burrow was followed for 20 feet in a more or less straight line at an average depth of 4 feet. One burrow was found at a depth of 5 feet on a hardpan and another at a depth of 2 feet 3 inches. Sometimes outlying burrows will run more or less continuously in one direction for many feet. Usually they interlace towards the center of the den. Some of the very complicated dens show a great interlacing of burrows. One den was excavated where two burrows crossed so closely that there was not one inch of earth between them.

It is a matter of common observation that ground squirrels have the habit of returning to the surface for a cautious look after being chased into the den. This habit was noticed in young squirrels only 24 days old. This survey seems to be for the purpose of reconnoitering leisurely the situation from which it fled in haste. If forced to go down a second time, it remains there indefinitely. It is not surprising then to find a pocket in the side of the burrows where it can turn around without the necessity of going down to a nest

cavity or a point of intersection of burrows. Such pockets are usually within a few inches of the exit, especially in long radiating burrows.

THE SUMMER NEST. This type of nest is usually located at the juncture of burrows and is not elaborated. It generally consists of a little dead, dry wild grass matted down, though sometimes in spring it is roofed over, and it probably serves as a resting place for the squirrels during the day.

Some of these nests in undisturbed ground are located as near the surface as seven inches, probably for the heat they gain in early spring when the deeper soil is damp. Deeper nests probably serve for hot summer weather. Not infrequently these nest cells, as well as the cells of brood and hibernation nests, are empty suggesting that the nest material has been transferred to a more desirable location in the den. Such transfer was frequently observed among captive squirrels. The depths of different nests in a given den vary considerably, six nests in one den being located at depths of 18, 19, 22, 24, 30 and 31 inches respectively, or at an average depth of 24 inches. Observations made of nests in a burrow in deeper soil showed an average depth of 3 feet 2 inches, the depth to different nests varying from 1½ feet to 5 feet. Although the soil of this region is naturally provided against flooding by large numbers of earthworm burrows extending even as deep as eleven feet, the summer nests are frequently placed on the upper, drier side of the den to guard against the excess moisture.

THE DURABILITY OF DENS.—These dens are very durable, especially in clay soil. Very perfectly preserved burrows unused for at least eight years were exposed by street grading in Pullman. An excavation of a den equally old showed several open and other plugged burrows. The nose prints in the plugs were as distinct as if recently formed. This tends to show how easy it would be for them to reinhabit a territory if they were not held in check. In many cultivated fields, slight, broad elevations still remain, indicating the position of old squirrel dens. In periods when the squirrels are less disturbed they sometimes return and in a very short time open the entrances and transform these old dens into used ones.

A TYPICAL DEN.—Early in these investigations, a fairly large, fresh den located in a pasture above the high water mark on a sloping hill side, facing the northwest, was excavated for study (Fig. 2). The greatest depth of any burrow was two feet. The burrows dropped at an angle of about 45 degrees to this depth, where they met the clay sub-soil and seldom went much deeper. At intervals, especially at or near the intersections of these burrows, the tunnels were enlarged from the

average diameter of $3\frac{1}{2}$ inches to a diameter of from 7 to 10 inches but were not much increased in height though they were somewhat. The total length of burrows was 63 feet 8 inches.

Two of the nests found were old ones. One old nest was reconstructed and two new ones were found on the upper side of the den, which is significant from the view point of drainage. Other dens were excavated and similar conditions were found.

Owing to the comparatively short period of activity of this animal, it is natural that the breeding season should occur very soon after the squirrels come from hibernation. So prompt are they in this that the adult squirrels are out and rutting before the young of the previous season are up from hibernation.

THE BREEDING SEASON.—Breeding commences shortly after the adult females have appeared from hibernation and continues actively for a period of about three weeks, in conformity with the appearance of the young squirrels of the previous season. It is influenced by local conditions, such as those represented in north and south slopes, and, as in birds, is retarded by unfavorable weather conditions.

RELATIVE NUMBER OF MALES AND FEMALES.—It was desired to determine the relative number of males and females at large. This was done by taking a census between June 10 and July 10 of the year 1910, at the season when they would, in our judgment, be the most uniformly distributed as a species. The squirrels were collected by being shot in the fields at various times during the day. In all, 28 squirrels were taken. Of these, 17, or 60 per cent, were females and 11 were males. These figures are relatively the same as those given on a much larger scale by Foster, (1911, p. 2) *Bulletin of Washington Experiment Station*, in which he records 69 per cent of females to 31 per cent of males out of 545 squirrels examined.

RUTTING.—The rutting period is one of great activity for the squirrels. Then the colony is thrown into a state of the most intense animation, and what appears to be the most confused condition of the squirrel community manifests itself at this time.

PERIOD OF PREGNANCY.—The excitement of the rutting season has scarcely quieted down when the female begins to select a den suitable and secure, for nesting purposes. During the brief gestation period of 24 days she must do this and construct a nest for the reception of her very helpless young. For the first few days of this period she feeds quietly. Now by chance she may be observed carrying material for the nest and soon she becomes quite antagonistic towards other females. Her desire for seclusion seems to grow, especially during the two or three days before parturition, when she eats very little. After parturition the female takes on a gradual activity which grows more pronounced with the rapid development of the young, for it is necessary that she provide nourishment for them. This necessitates the constant gathering of food during the entire day. In 1911 this period, as determined by the presence of embryos and fetal scars, was found to extend between March 20 and April 14.

THE BROOD DEN AND ITS LOCATION. The brood den, selected by the squirrels is very often found on a warm southern exposure, where the soil is shallower and drier, and on which the vegetation is more advanced. It is frequently chosen in some old uncultivated pasture or wild land and is simply an old summer den, a portion of which is used for the brood nest, often located 12 to 15 inches below the surface. The excavation for the nest, about 9 by 9 by 8 inches, is usually made at the intersection of burrows, though sometimes greater privacy is secured by plugging one of its entrances. Communication burrows from these nests frequently drop down to deeper parts of the den.

(Concluded in the October issue)

NOTE.—*The Canadian-Field Naturalist* is again fortunate in being able to present its readers with illustrations of varied interest. Those which appear in this number are published through the kind assistance of Messrs J. H. Fleming, W. E. Saunders and P. A. Taverner, the Geological Survey of Canada and the Canadian National Parks Branch.—EDITOR.



FIG. 1.—The Columbian ground squirrel at the entrance of a burrow leading to its underground home. These animals, when frightened into their den, have the habit of returning in a few moments to reconnoiter the situation from which they may have fled in haste.

Photo from life by WILLIAM T. SHAW

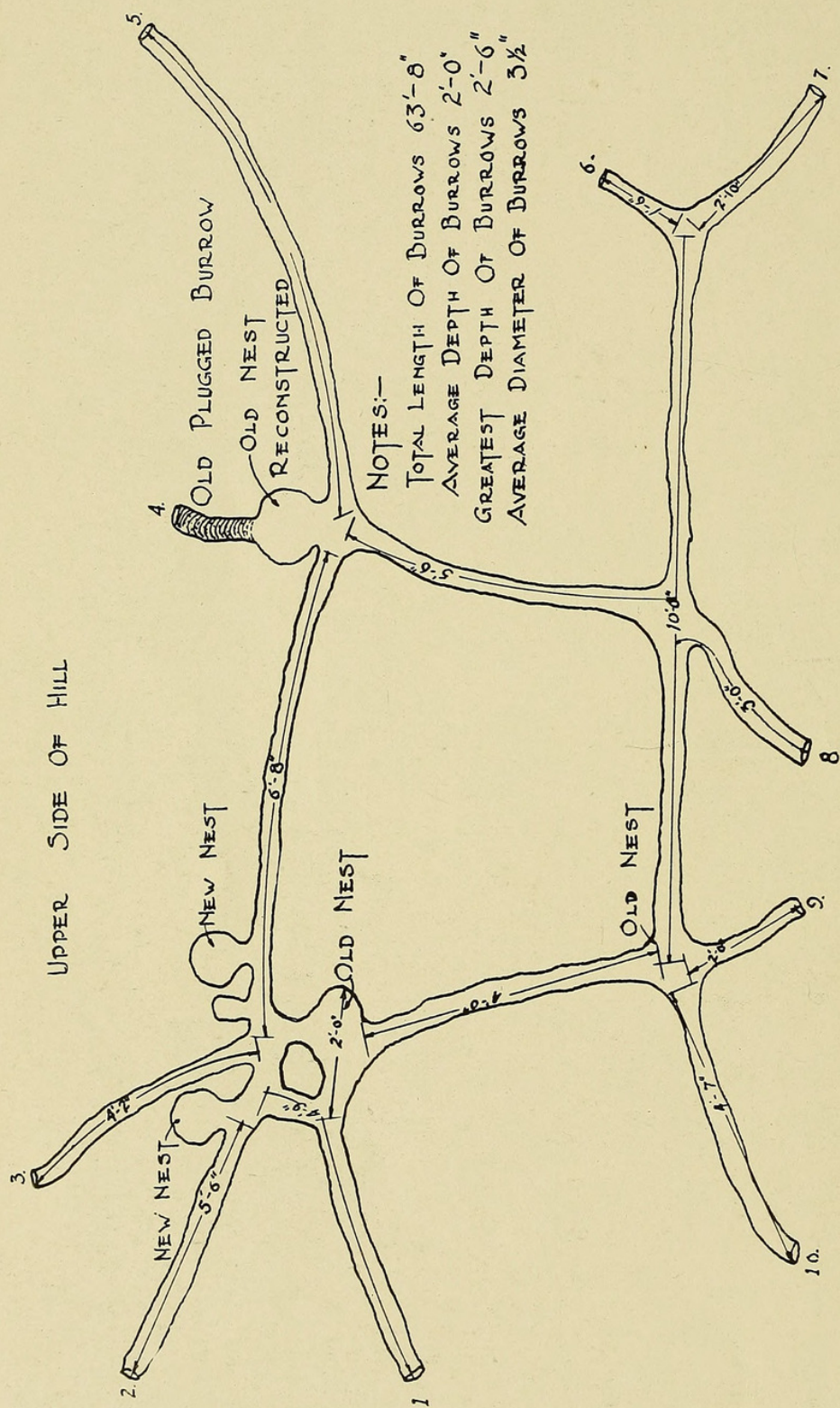


FIG. 2.—In sketch, the den of this ground squirrel shows a series of burrows and small nest chambers. This sketch shows in an interesting way that the animal appreciates the danger from flooding and has placed his nests on the high side of the den. (Original.)



FIG. 3.—Having been pursued for ages by enemies such as hawks and coyotes, the squirrel has learned to provide his burrow entrances with safety devices in some form or other, one of which is shown in this illustration as a series of radiating troughs all leading to the burrow mouth. It is evident that a burrow mouth of this nature would be much easier found in times of great haste than a small round hole.

Photo by WILLIAM T. SHAW

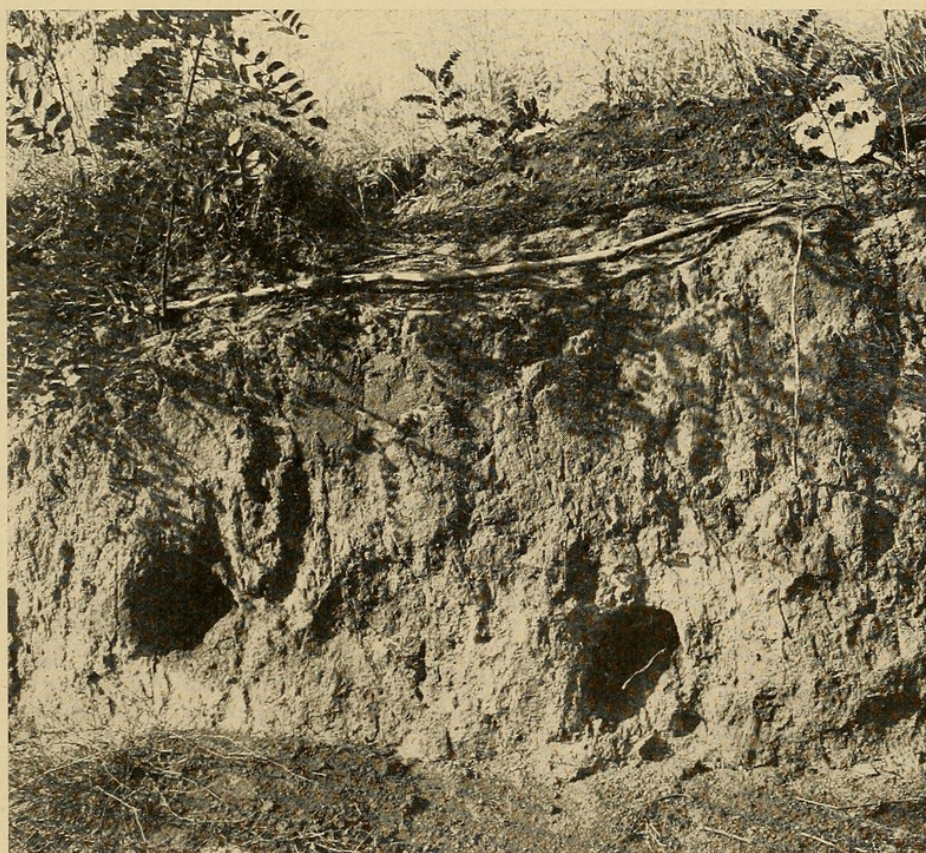


FIG. 4.—As a rule the depth of the burrows is determined by some hard, underlying stratum into which they do not like to dig. The lighter lower stratum here shown is of a hard, gritty, slightly cemented material.

Photo by WILLIAM T. SHAW

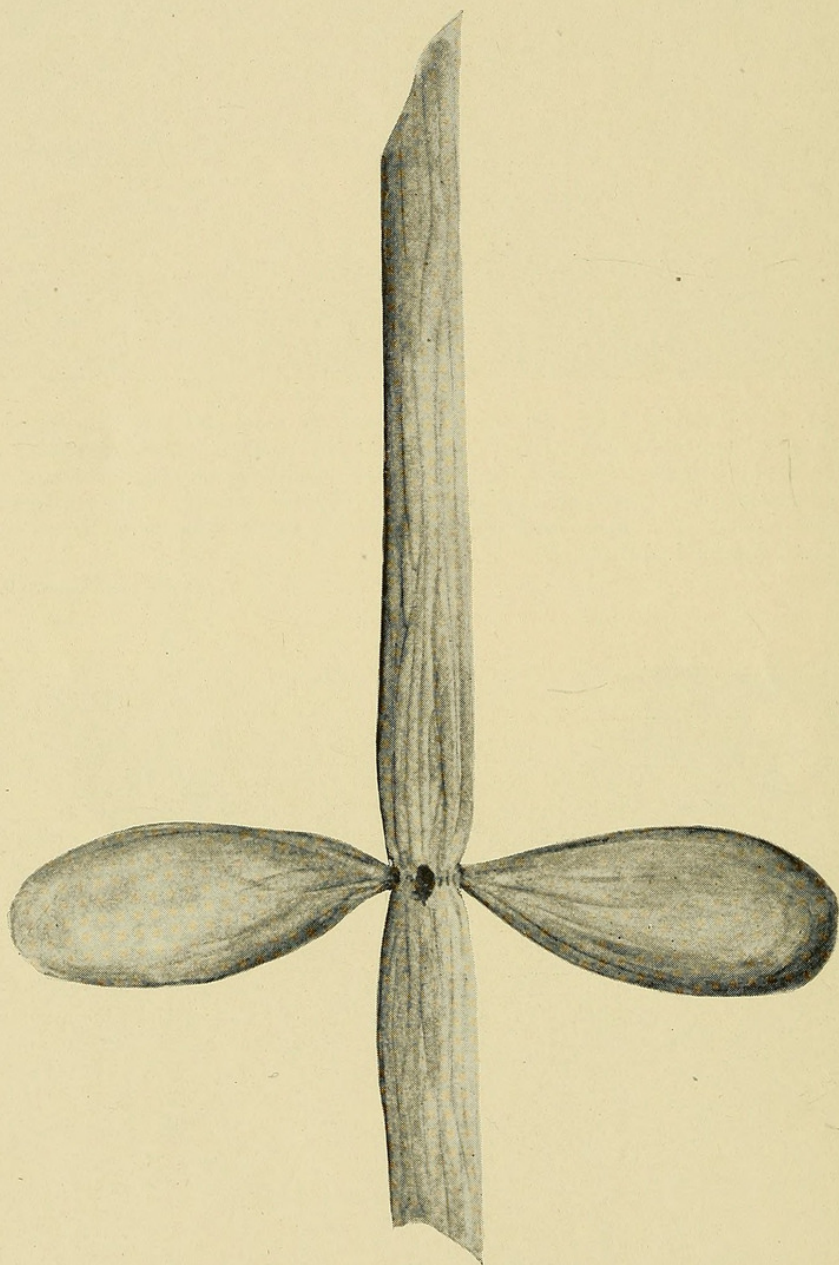


FIG. 1.—*Equisetum arcticum* Heer, a fossil plant which probably figured in the Dinosaur bill of fare.

THE FOOD VALUE OF AN *EQUISETUM* FROM THE LANCE FORMATION OF SASKATCHEWAN*

By PROFESSOR EDWARD W. BERRY
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IT MAY well be doubted if it is ordinarily possible, in the absence of anatomical characters, to distinguish between most fossil species of *Equisetum*, and the literature of systematic paleobotany contains a very large number of so-called species based on fragments of stems or rhizomes. Where these have a stratigraphic value they are doubtless justified, on the well known principle that analysis should precede synthesis. Where, however, a variety of so-called fossil species have been described from a similar or identical geological horizon, it may be an advantage, at least from the botanical standpoint, to consider many such illy-characterized fragments that have been described as representing a single botanical species. The justification for this is the well known extensive geographical range of most of the existing species of *Equisetum*.

The late Oswald Heer described *Equisetum arcticum* from the Tertiary of Spitzbergen in 1868 and subsequently identified somewhat doubtful remains from Grinnell Land as the same species, which has also been recorded by Penhallow from Red Deer River, and possibly also from Porcupine Creek and Great Valley in Canada. A pronounced feature of the Spitzbergen material was the numerous and large tubers on the rhizomes. These are well shown in Heer's second contribution to the fossil flora of Spitzbergen.†

During the summer of 1921, C. M. Sternberg, working for the Geological Survey, collected what appears to be this same species of *Equisetum* from an exposure on Rocky Creek, Saskatchewan (Sec. 15, Township 1, Range 5, West of 3). These have the largest tubers that I have ever seen on an *equisetum*—they are bigger than good-sized lima beans, and as large as some of the tubers which, in the uplands of Bolivia and Peru, are considered sufficiently good potatoes to warrant their cultivation and marketing.

The tubers of *Equisetum arcticum* are borne in clusters at the nodes of the rhizomes or underground stems, and one specimen from Rocky Creek shows a verticil of three of these at a single node. Heer figures four somewhat smaller tubers at a single node in one specimen from Spitzbergen. The sandy clays of the Lance formation are packed

with these tubers at the outcrop on Rocky Creek. They are flask-shaped and run up to 4 centimeters in length by nearly 2 centimeters in maximum diameter in the somewhat flattened condition in which they are preserved.

The most interesting feature in connection with their occurrence in Saskatchewan is their association in a series of "somber" clays and sandstones, which Sternberg calls the Lance formation, with dinosaurian remains. The collector mentions only the genus *Triceratops* as in actual association with fossil plants, but speaks of Dinosaurian remains as very common throughout these beds in this section, and as the other herbivorous forms were probably not far away when *Triceratops* was around, it occurred to me at once that here we have a promising article of diet on the Dinosaurian bill of fare.

It has always been a subject for speculation as to what the herbivorous dinosaurs fed on, and although some seem to have been well fitted by nature for browsing, others, like *Trachodon* and its allies, would seemingly have found it difficult or impossible to have availed themselves of hard or coarse food such as leaves or grasses. Other students have indulged in speculation regarding the few calories in such types of food and have compared this with the great bulk of a large number of the dinosaurs, and have sought to calculate the prodigious amounts of such low-grade food that an individual would consume.

Equisetums are gregarious plants which would probably have been present on the Lance river flats in great abundance, their rhizomes would ramify near the surface of the mud or sand, and if they formed tubers as abundantly as the fossils appear to indicate, they would seem to offer a highly concentrated food. These tubers contained a percentage of starch as high as, or even higher than, that contained by the modern potato, and although all animals do not thrive on a starch diet, some, such as hogs, can live almost wholly on a starch diet and transform it into fats, and there is no legitimate basis for thinking that dinosaurs might not do the same.

I am reproducing an illustration of a specimen of the Saskatchewan *Equisetum*, natural size, to show the size of its tubers, and there follows the synonymy of *Equisetum arcticum*, in which I have included a number of supposedly different, named forms from the Laramie, Hanna, and Fort Union formations, that appear to me to represent the

*Published by permission of the Director of the Geological Survey of Canada.

†Heer, O., *Kgl. Svenska Vetensk.-Akad. Handl.*, Bd. 8, No. 7, pl. 1, 1870.



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Photo from life by WILLIAM T. SHAW

UPPER SIDE OF HILL

1
2
3
4
5
6
7
8
9
10

NEW NEST
NEW NEST
NEW NEST
OLD NEST
OLD NEST
OLD PLUGGED BURROW RECONSTRUCTED

NOTES:-
TOTAL LENGTH OF BURROWS 63'-8"
AVERAGE DEPTH OF BURROWS 2'-0"
GREATEST DEPTH OF BURROWS 2'-6"
AVERAGE DIAMETER OF BURROWS 3 1/2"

NOTES:—

1
TOTAL LENGTH OF BURROWS 63'-8"

AVERAGE DEPTH OF BURROWS 2'-0"

DEPT. OF BIRDS 2-6

ERAGE DIAMETER OF BURROWS 3½

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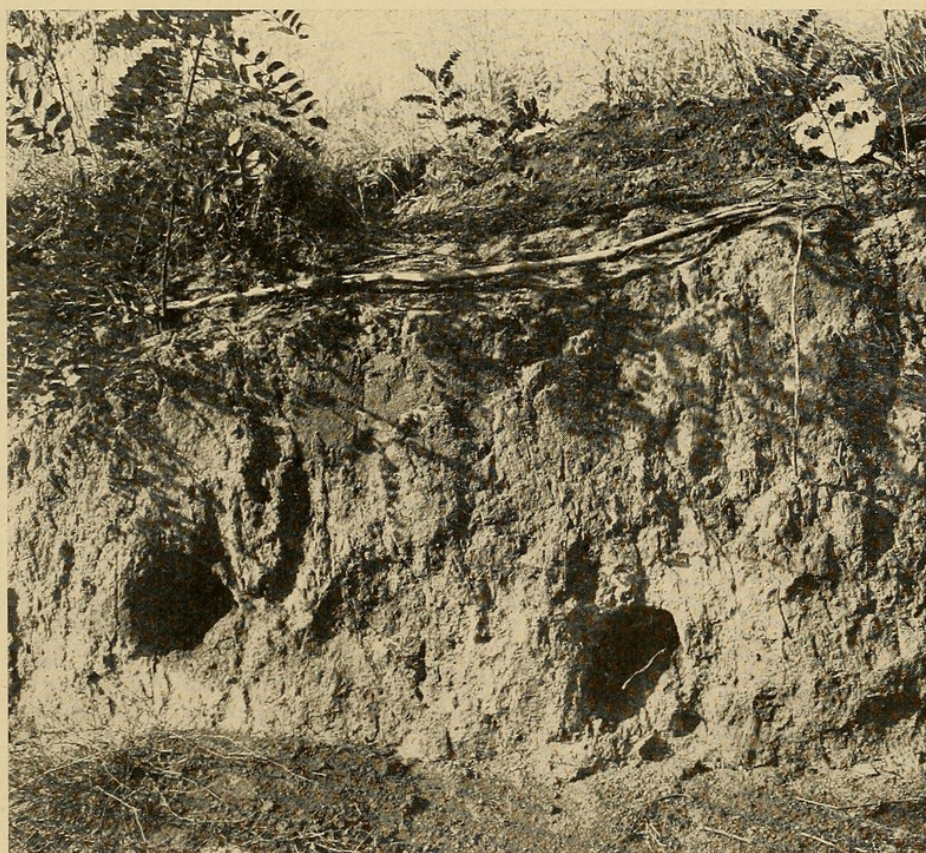


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Photo by WILLIAM T. SHAW



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