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NOTES DESCRIPTIVE OF SOME GEOLOGICAL SECTIONS OF THE COUNTRY ABOUT THE HEADWATERS OF THE MISSOURI AND YELLOWSTONE RIVERS.

By F. V. Hayden.

It is not intended that these notes shall embrace a complete account of the geology of Montana. They are simply designed to render the beautiful pictorial sections which accompany them more intelligible to the general reader. That these pictorial sections may reach the public sooner, an edition of them is issued in this form. All the sections in this paper represent the scenery along the immediate valleys of the Lower Gallatin and Madison Rivers, with the exception of two, which are fine illustrations of different portions of the Yellowstone Valley.

It is hardly possible for the pencil of the artist to delineate more graphically or minutely the scenery of this interesting country than these sections do. For the geologist very little descriptive text is needed, and for the details of the geology he is referred to the Annual Reports of the Survey for 1871 and 1872.

Should the Survey continue its operations from year to year by suitable grants of money from Congress, all the region, including the Yellowstone National Park, will be re examined systematically and in detail; what we have done up to this time must, therefore, be little more than preliminary to the more thorough work that must come hereafter.

I have always regarded the junction of the three forks of the Missouri—the Gallatin, Madison, and Jefferson—as one of the most interesting geographical points along the Missouri River. Here, within a short distance of each other—a few hundred yards apart—these three great streams unite in one, forming the Missouri River. This junction is most admirably shown in Plate I, upper sketch, which is really a panoramic view of the valley with the surrounding hills. The view is taken looking west from Gallatin Bluffs. At the right hand, at *a*, the three rivers have united into one channel, just at the upper end of a cañon, or gorge through Carboniferous limestones.

In the bottom, and especially on the point between the Madison and Jefferson Rivers, are remnants of Carboniferous limestone, with a few characteristic fossils. These remnants are found at different points in the immediate valleys of these streams, showing most clearly that the broad space now occupied with the lake-deposits, between the Jefferson and Gallatin Rivers, was originally worn out of the sedimentary beds of this locality. In other words, we obtain in this way a glimpse of the tremendous magnitude of the erosive action in past times in this region.

In the background are weathered hills, rising from 600 to 1,200 feet above the valley, underlaid, for the most part, with the limestones of Carboniferous age, inclining toward the north or northeast. Other formations come in, farther and farther in the background, as the Juras-

sic, Cretaceous, and even remnants of the Lignitic group, which, by the yielding nature of the materials composing these rocks, have given rather a smooth, rounded outline to the surface over an extended area.

This sketch will serve to convey to the reader a conception of the peculiar area which may be noted on the map as included between the Gallatin and Jefferson Rivers, above their junction.

Nearly all the sections described in this paper represent portions of the surface included within this space.

Within this area also is inclosed one of the most complicated and instructive of the great mountain anticlinals.

It is only by taking this position, which seems to be borne out by the facts, that we can unravel the complicated topography of this district. Plate III represents portions of a continuous section, the left-hand end of No. 2 joining on to the right-hand end of the upper section of No. 1, the whole forming the high wall-like range on the east side of the Gallatin Valley, extending from a point below Flathead Pass to the Bridger Cañon to the northward. There is then a short distance in which no rocks older than the Lignitic group are exposed. The older groups, however, re-appear on the divide between the Gallatin and Yellowstone Valley, crossing the Yellowstone and thus form the Lower Cañon.

In Plate VII, lower section, Second Valley of the Yellowstone, looking west from Mount Delano, at the right hand, we see the Carboniferous limestones inclining at an angle of 30° to 50° to the northwest. The Yellowstone River has cut its channel through this high ridge of limestone at right angles.

We have here, then, attempted to describe briefly the east or northeast portion of this great anticlinal, which, in future surveys, will be extended far to the northeast, beyond the limits of our geological map.

The structure of this first portion of the anticlinal is well shown in section 7, through Flathead Pass, on page 82 of Annual Report for 1872.

In the section, we observe that the Silurian strata, which are shown on the west side of the ridge, dip past a vertical, while the Carboniferous limestones, which form the crest, are vertical or nearly so, while the Jurassic, Cretaceous, and Lignitic beds incline at various angles to the northeast toward the valley of Shield's River.

It is probable that the corresponding opposite portion of this great anticlinal extends along the east side of the Jefferson Valley, rising like a slanting wall 2,000 feet above the plains below. It crosses the Jefferson near the entrance of the North and South Bowlder Creeks, and through this great ridge the river has worn a vast, deep, narrow gorge called the Cañon of the Jefferson. Here the river, for a distance of five miles, flows through nearly vertical walls of limestone, rising on either side from 700 to 1,200 feet. The general dip is apparently toward the west, or perhaps southwest. A very high ridge extends nearly north and south between the Jefferson and the South Bowlder Creeks. This ridge is cut through by the Stinkingwater, a branch of the Jefferson, thus forming a broad, valley-like opening, through which the road passes from the Jefferson Valley to Virginia City. On the west side of Stinkingwater Creek, the high limestone ridge continues westward to the sources of the creek, to Red Rock Creek and beyond.

It is probable that the axis of the great anticlinal lies for the most part between the Madison and the Jefferson, forming the granite belt from Sterling to Summit at the head of Alder Gulch. The granitic axis also includes a portion of the country east of the Madison. The general trend of the axis is about northwest and southeast. We may

therefore conclude the area embraced in the drainage of the three great branches of the Missouri River—the Gallatin, Madison, and Jefferson Rivers—is broken up by a large mountain anticlinal. Its entire extent is not yet known. It probably covers a somewhat larger area, reaching over into the Yellowstone drainage, and extending north below the three forks.

The structure of this area, although apparently so simple, is very complex, from the introduction of a different force, which seems to have acted synchronously with the one that lifted the granitic nucleus, and which may have been produced by it. This is the volcanic force which has acted most powerfully all over the region. It is by the effusion of the igneous rocks that the sedimentary beds are often thrown into the most chaotic confusion, so that the regular anticlinal ridges are, in many places, entirely broken up and lost. Sometimes we find these beds in patches on the summits of the highest mountain-ranges, and again in the lowest valleys. Faulting on a large scale has been everywhere produced. Over large areas, also, the igneous rocks have been poured out, thus concealing and protecting from erosion the sedimentary beds. On the divide between the Yellowstone Valley and the source of the Gallatin, the trachyte rocks cover all the sedimentary beds, even up to the Lignitic inclusive; and here and there, where the mountain-streams have cut deep gorges into the divide, the Silurian, Carboniferous, Triassic, Jurassic, Cretaceous, and Lignitic can be seen in their order of position. Not unfrequently all the older beds, with the exception of the Carboniferous, had been worn away prior to the effusion of the trachyte, and the beds of limestone crop out along the margins of the mountains and cañons from beneath their igneous covering.

There is a striking example of this along the East Fork of the Yellowstone River, as is shown in Plate X in the "View looking up Soda Butte Creek from Camp on the East Fork of the Yellowstone." We have here 2,500 to 3,000 feet of volcanic breccia and tuffs, mingled here and there with trachyte. This is cut in every direction by little branches into the most picturesque gorges, with very vertical walls on either side, from 1,500 to 2,500 feet in height, apparently stratified and weathered so as to present a peculiar but imperfect columnar appearance. The surface-weathering is in the form of immense castles, battlements, steeples, and towers. Index and Pilot Peaks, in the illustrations in the Annual Report for 1872, page 47, convey a faint idea of the wilderness of unique forms which are presented to the eye over this great volcanic area.

This volcanic material was laid on an irregular surface of limestone mostly of Carboniferous age. Sometimes the red-beds are seen just beneath the breccia beds. From the entrance of Soda Butte Creek into the East Fork of the Yellowstone to its source, a distance of ten miles or more, the limestones crop out on either side of the gorge. Sometimes only ten or fifteen feet are exposed, then again several hundred feet in thickness are seen, with only a thin bed of breccia on the summit.

Over a considerable portion of the Yellowstone National Park, the Lignitic beds crop out here and there, from beneath the igneous covering, in a baked or partially metamorphosed condition, containing fine specimens of plants of various species.

There are also many examples of quite modern volcanic action, in which the basalts have been poured over the modern Pleiocene or lake deposits, and even the local drift.

The evidence seems to be clear that the volcanic effusion commenced far back in the past, at the commencement of the elevation of the mount-

ain-ranges, and continued periodically, even up to the present time, or nearly so.

The drainage was undoubtedly marked out at an early period. The Yellowstone and Madison Rivers rise in the main divide of the Rocky Mountains, while crowded in between them, as it were, is the Gallatin River, which fails to reach the divide with any of its sources. The Gallatin flows through a narrow channel, or cañon, most of the way from the source to its entrance into the Gallatin Valley, a distance of about forty miles. The drainage seems to have originated in a sort of depression, or sag, in the sedimentary crust; for the gorge has there worn through these rocks for nearly the entire distance, and the inclination of the strata on either side is toward the cañon. Nothing seems to have even deflected the river from its course, but it has worn its narrow way directly through highest mountains, as is shown in the six consecutive sections in Plates IV, V, and VI. The erosion of the channel, or cañon, must have commenced with the elevation of the crust, and continued on, keeping pace with the elevating forces. Obstructions from time to time have occurred, which produced in part the numerous lake-basins which we find at the present time in the valleys of all the mountain-streams.

In the previous reports of the Survey, I have treated much in detail the curious old lake-basins that are found so extensively all over the West. There is a certain group of them that might be classed under one head. They have been called Modern Lake-deposits, Lacustrine, &c. Their age is probably Pleiocene, but they undoubtedly overlap what we have usually understood as the Post-Pleiocene period, reaching almost up to the present time. There is, however, a subsequent deposit, which, on the geological map, we have regarded as fluviatile, which on account of its extent must be noted. This oftentimes conceals the Lacustrine deposits. The fluviatile deposits are entirely local, and confined to the drainage areas in which they are found. They assume importance from the fact that they date back to a period when there was much more water in the streams than at the present time, and in consequence the results of the aqueous forces were much more marked than they are now. There is another important feature, that all the placer-mining is carried on in these deposits. They undoubtedly date back so as to include what is usually understood as the Glacial period in the West. In the various mining-gulches in Montana, these fluviatile deposits are oftentimes of great thickness, made up mostly of much-worn bowlders. In Alder Gulch, for example, which is the valley of a small branch of the Stinkingwater which flows into the Jefferson, $30,000,000 of gold have been taken out. Near the source of the gulch, the bowlders are of great size, but growing gradually smaller toward its junction with the main branch until the fluviatile deposits are made up of rather fine sediments, with perhaps layers of gravel. The vast extent of this deposit conveys a dim conception of the tremendous erosion the surface has undergone in past times. There is comparatively little snow in these regions at the present time, and the streams are never so high that they produce any very marked effect on these deposits, and scarcely nothing so far as erosion is concerned, so that we are led easily to the conclusion that there was a period when the aqueous and most probably the aqueo-glacial forces acted with great power.

As we have previously stated, the Lacustrine deposits belong, in part at least, to a prior period. Perhaps the most conspicuous example of one of these lakes is found at and near the junction of the three forks of the Missouri. The junction of the three branches seems to be the north end of this basin, though immediately below the junction there

is an expansion of the valley of the Missouri, in which these deposits occur again to a considerable extent. Indeed, the river-valleys in the vicinity of the mountains may be regarded as having been made up of chains of small lakes, interrupted here and there by a cañon or a mountain-range. These lake-basins, large and small, are, for the most part, the result of erosion. In the general elevation of the country, when the crust was broken up, there were numerous depressions, in which the waters flowing down from the more elevated area may have accumulated; but it is plain that they have been slowly scooped out by water. The general fineness of the sediments would seem to indicate comparatively quiet waters during this Lacustrine period; but the original basins may have been worn out by the combined action of water and ice.

The lake-basin near the junction of the three forks extends up the valley of each of the streams for a considerable distance. It covers the entire valley of the Gallatin and Madison and the interval between the rivers for more than twenty miles above their junction. In the Jefferson Valley, Lacustrine deposits are cut off about ten miles up the river by a high ridge of limestone. This lake-deposit may be estimated to cover an area of about one thousand square miles. In Plate I, showing the junction of the three forks, we see at the right the nearly horizontal strata of Carboniferous limestone, which forms one of the walls of the cañon. This ridge of limestone seems to have obstructed the flow of the waters until the channel was worn through. It must have been much higher than at present, but was gradually worn away, the waters covering a broad surface until they centered in this narrow channel.

In the lower section on the Gallatin River, the Carboniferous limestones are exposed from beneath the lake-deposits in a nearly vertical position. The deposits are much scattered over the surface as we pass up the stream, but the limestones crop out everywhere, showing the character of the basis-rocks. These limestones all present unmistakable marks of having been worn down to their present condition. The modern lake-deposits all hold a horizontal position, or nearly so, and from this fact we infer that there has been no very marked change in the general elevation of the country since their deposition. In Plates VIII and IX, there is a connected series of four sections along the immediate margin of the Madison River, extending from its mouth to the southern border of the basin near the foot of the mountains, a distance of thirty miles. Section No. 8 shows the east wall of the channel of the Madison, as it has been worn out of the Lacustrine deposits. Commencing at the left of No. 4, the horizontal strata may be followed on sections 3, 2, and 1, until the granites of the higher mountain-ranges are uncovered by erosion.

The system of terraces is well exhibited, as well as the myriads of small gullies, or gorges, which are worn out of the sides. In the lower terrace of section No. 1, the vertical schists are seen cropping out from beneath the Lacustrine beds. These Lacustrine sediments are composed, for the most part, of silica and alumina, the former predominating. There is some lime in portions, doubtless derived from the wear of the Carboniferous group. The prevailing color is light brown-gray or nearly white, perhaps in some instances a cream color.

There is a remarkable similarity in the color as well as the composition of these deposits all over the West, in Montana, Oregon, New Mexico, or Texas. The forms which result from weathering are much the same, even though of a different age. The Santa Fé marls, which cover so broad an area in New Mexico, the Arkansas marls, in the valley of the Upper Arkansas River, the Loup Fork group, on the Loup Fork

and Niobrara Rivers, are singularly alike, indicating their derivation from the same source. The metamorphic rocks all over the West are composed mostly of quartz and feldspar, the former predominating. It is from the decomposition of these rocks that most of the Lacustrine sediments are derived. Judging from the character of the sediments, there were no violent currents in the channels of the streams in Lacustrine times, unless near their source. The sediments do not seem to differ essentially in fineness where they lap over the flanks of the granite hills at the upper side of the basin.

The filling-up of the basin also caused the channel above to be full, so that the fine matter would be distributed over the basin very equably, and settle quietly at the bottom, as in any of our small fresh-water lakes of the present time. The thickness of the deposits in this basin may be estimated at from 1,200 to 1,500 feet. The height of the divide between Madison and Gallatin Rivers ranges from 600 to 1,000 feet above the beds of those streams, so that it is probable that the estimate of the aggregate thickness as 1,500 feet is rather under than over the true one.

The writer was unable to find any of the vertebrate remains in this basin that have usually been obtained from this formation in many other places. Many persons living in the country informed me they had seen remains of turtles, fragments of skulls, and bones of other animals in various places, but the time at my disposal did not permit me to make a careful search. In the side gorges, or gullies, of the Madison, we found most beautiful specimens of silicified wood in great quantities, some of which might be said to be opalized.

In the valley of the Jefferson, near its source, there is one of these small expansions of the valley, in which there is a considerable thickness of the Lacustrine sediments. In 1871, I found there a species of *Helix*, and the jaws of a vertebrate animal of the genus *Anchitherium*.

In the American Journal of Science for February, 1876, Messrs. Grinnell and Dana discovered a lake-basin near Camp Baker on Dry Creek, which is evidently one of great interest. In this basin they seem to have found a variety of vertebrate remains, representing two epochs, Miocene and Pleiocene. I am not aware that the lower beds of the White River group had been previously observed in Montana. It is quite possible, as the gentlemen suggest, that the Pleiocene lake on Deep River was connected with those near Fort Ellis and the Three Forks. We may, with perfect confidence, connect them all, for they can be traced with very short interruptions from the sources of the Madison and Yellowstone Rivers and their branches to the points where the rivers leave the mountain-districts for the plains. It may be remarked here that these peculiar Lacustrine deposits are found for the most part only in the mountainous portions; that in the plains, if they ever occur at all, they are of older date. In the valley of the Sweetwater River there are isolated patches of the Pleiocene marls distributed over the Miocene deposits, very similar to those on Deep Creek; but there are here low granite ridges on either side, showing that the foundation-rock on which the modern Tertiary deposits were laid down in that region is granite or gneiss. These same modern Lacustrine deposits occur in the North and Middle Parks, Colorado.

The lower section of Plate VII, "The Second Valley of the Yellowstone," is an illustration of one of the oval Lacustrine basins so common along the rivers. It is about thirty miles long, and will average about thee miles in width. The lake-sediments have been swept out of the basin to a great extent, but there are quite large remnants remain-

ing, which show clearly that there was originally a considerable thickness of them. At the upper end, broad sheets of basalt have flowed over it, protecting the lake-deposits from erosion. This basin has been entirely scooped out of the mountains, which originally extended across much as we now see them on either side. All over the valleys are remnants of the various rocks, changed and unchanged, just rising above the surface. At the right are seen a group of Carboniferous limestones, which extend directly across the Yellowstone River. The channel which the river has worn through these rocks is called the Lower Cañon, or the Gate of the Mountains. The cañon is about three miles in length, leading into a comparatively small oval expansion, which was originally a lake, and thence into the plains. Inasmuch as all the sedimentary strata from the Lower Silurian to the Lignitic inclusive seem to have been alike involved in the movements of the crust that elevated them to their present position, we infer that these movements were a subsequent event. There is also evidence for the statement that the unchanged rock, prior to this time, extended uniformly over nearly or quite the entire area of Montana. There is no positive proof that the metamorphic rocks were anywhere exposed. The members of the survey searched in vain for any proof of unconformability of position in any of the unchanged strata. Therefore, the vast erosion which has taken place in this region must have occurred during the crust-movements and subsequently. I have before stated that these lake-basins are largely due to erosion. We must conclude, therefore, that depressions were produced during the crust-movements, which received the drainage from the higher lands around, and that the waters thus accumulating gradually carved out these basins as we find them at the present time. These depressions may have been limited in area at first, and may or may not have been produced by the disturbance of the strata; but it is probable that in most cases it is due to the latter cause. We may state, however, in this connection, that the channels of any of the rivers of the West do not necessarily lie along any fissures, anticlinal or synclinal depressions; but the rivers seem to have, in the majority of cases, cut their way directly across the line of fracture, thus carving out deep gorges through the loftiest mountain-ranges. There are numerous examples where rivers seem to have avoided natural depressions, where it would appear that the waters must flow, and cut narrow channels through the hardest rocks. The Gallatin, as well as the Yellowstone, is a remarkable example of this statement. In their entire course, they run almost directly across the line of fracture of the mountain-ranges in the vicinity. The Yellowstone has worn out the enormous second canon with walls 1,000 to 1,500 feet from the granite nucleus. A little to the northwest, the Gallatin flows between walls of granite 2,000 feet high on either side. Still we must admit that in order to produce such results they must have had an original foothold, as it were, to commence their work. The evidence seems to be clear that, during the Tertiary period, and subsequently, the aqueous forces were much more powerful and widely extended than at the present time. All the water-courses and lake-basins, of the West indicate the existence then, of bodies of water compared with which our present rivers and lakes are but rivulets and ponds. We do not find the Miocene lake-deposits underlying the Pleiocene in the vicinity of the mountain-districts. They are found at a long distance from the principal centers of disturbance. We may suppose, therefore, that there were really three important periods which should be considered: First, when the channels of the rivers and the lake-basins were

worn out, the aqueous forces operating with great power, and transporting the sediments down into the Miocene lakes of the plains; second, when the waters set back up toward the sources of all the mountain-streams, producing that quiet condition in the lake-basins that enabled the finer sediments to settle upon the bottoms of the Pleiocene lakes, with the strata regular and horizontal as we find them at the present time; the third period may be regarded as the one when the local drift-deposits were made. This period was one in which the forces operating were those of water and ice, or what is understood as the Glacial era of the West. The channels of all the rivers were deepened, and the Lacustrine deposits were in part removed and carried down into the plains.

It was during this period that the terraces and fine sections were here formed, which are so admirably shown in Plates VIII and IX. The deposits of this third period are immense in many localities, concealing all the basis-rocks and giving the peculiar slopes to the base of the mountains as they graduate into the plains. In the mountain-valleys, as, for instance, in the oval lake-basins between the lower and second cañons of the Yellowstone, high bowlders of granite, 25 feet in diameter, have been brought down from the mountains and lodged on the surface of the terraces at different elevations above the present river-bed. The remnants of the layers or floor of basalt that, since the deposition of the Lacustrine sediments, have flowed over the valley, exhibit abundant proofs of glacial action in the very smooth crust, which even now is like enamel. On this basaltic floor, 50 to 100 feet above the bed of the Yellowstone River, many of these large bowlders now rest. Worn masses of smaller size are scattered thickly all over the surface. The greater portion of the local drift is composed of rounded bowlders, varying from a few inches to several feet in diameter, with a small proportion of sand and clay mingled with it. It is at the bottom of this deposit, near what is termed by the miners the bed-rock, that placer gold is found.

It is not pretended that the three periods named above can be defined by arbitrary lines by any proofs that have been left on the surface at the present time. The first period must have commenced either during or at the close of the Miocene era; and there is nothing that indicates any remarkable abrupt break in the sequence of events up to the present time. There was undoubtedly a constant variation in the intensity of the forces that were in operation during all these periods. During the Miocene and Pliocene periods, the animal remains which were preserved in the Lacustrine sediments indicate a comparatively mild climate. The cold period must have approachd gradually, reaching its greatest intensity, covering the mountains and filling the valleys with immense bodies of snow and ice, which slowly melted away, leaving the peculiar lake-basins at the sources of the mountain-streams and morainal deposits, as proofs of its former existence. It is probable, also, that it was during the decrease of temperature, while the waters were subsiding to their present condition, that the terraces were formed. It is not the purpose of this article to present anything like a complete view of the geology of Montana. It is intended simply to render more plain, if possible, the meaning of the beautiful pictorial sections which accompany it. As representations of the varied forms of the scenery in Montana, and, indeed, to a limited extent, in any other portion of the West, they are unsurpassed.

Some of the plates have already been described incidentally in these notes. Plates II and III are closely connected, though not intended to be absolutely parts of the same section. They were sketched from dif-

ferent points of view. The traveler, as he passes up the valley of the Gallatin, toward Bozeman, from the three forks, sees on his left hand, to the east, a high ridge, which rises up like a wall. The abrupt side is toward the valley, and an examination of its structure shows that it is a part of an anticlinal ridge. In Plate III, the right-hand end of Section 1 joins on to the left end of Section 2, and thus a connected view is obtained from below Flathead Pass at *a*, far south to Mount Ellis at *i*. North of Bridger Cañon, the strata are lifted up so that on the west side of the ridge, toward the Gallatin, the metamorphic rocks are exposed, while near the summit of the ridge the Silurian and Carboniferous strata are nearly vertical. From the summit of the ridge, the Triassic, Jurassic, Cretaceous, and Lignitic beds may be seen inclining at various angles, sloping off eastward toward Shield's River. The aggregate inclination of the strata in this ridge is about northeast. Proceeding northward, we find near Flathead Pass that the Silurian beds lie at the base of the ridge, and have been elevated so that they pitch past a vertical 30° to 50°, as is so well shown by the cross-section in the Annual Report of the Survey for 1872, page 84. These two pictorial sections serve to show the weathered forms of these ridges as seen at a distance, rather than the details of structure. The vertical furrows, with here and there a gorge cut directly through the ridge, forming what are called passes in this country, are well shown. From near Flathead Pass southward for several miles, the Silurian beds are lifted up in such a way that the entire series can readily be made out. From the right-hand end of the lower section in Plate II, the Silurian beds extend southward for about eight miles, then the Carboniferous strata overlie them, and are clearly exposed. This section extends along the east side of the Gallatin, and forms the bluffs which have been cut by its waters. The surface erosion of the beds is exhibited with remarkable clearness and perfection. In the Silurian and Carboniferous groups the characteristic fossils are very abundant. They are described in the Annual Report of the Survey for 1872. No Jurassic fossils were found in this immediate vicinity; but near the Yellowstone River, about thirty miles to the southwest, and at Spring Cañon to the southward in the same ridge, they are very abundant.

In Plate III, Section 2, the passes of Bridger Cañon and Spring Cañon are quite important from the fact that through one of them the Northern Pacific Railroad must run on its way from the Yellowstone Valley. These are rather narrow gorges cut by the little streams through the ridge, thus exposing an excellent though complicated section of the rocks. The foothills are composed of the Lacustrine deposits, which jut up against the sides of the mountains, sometimes nearly to their summits, apparently without any disturbance, unless it be of a local character. Mounts Delano and Cowen are on the east side of the Yellowstone Valley, their summits rising far above any point on the divide. Mount Ellis, 8,419 feet, is capped with Carboniferous and Jurassic rocks. Bridger Peak, 9,002 feet, is capped with Carboniferous limestones, and Liberty Peak is a portion of the same ridge.

In Plates IV, V, and VI, and the upper portion of Plate VII, we have seven sections that are connected, and represent the east side of the Gallatin Cañon from its opening into the valley on the Lacustrine basin to a point nearly to the source of the river, a distance of about twenty-five miles. The four sections of Plates VIII and IX might have been connected also, as there is but a short interval between them. At the left hand of Section No. 1, we see the rounded foothills underlaid with gneissic rocks. The lower end of the cañon is at *a*. The direction is about

north and south, as will be seen by examination of the map. We will commence at the lower or north end of the cañon, and follow up through the several continuous sections and note the principal points of interest. At *c c*, the Carboniferous limestones appear with their peculiar type of weathering. The distant hills are underlaid by the granitic or metamorphic rocks. The limestones seem to have dropped down so that a fault of some importance exists. These Carboniferous limestones rest on Silurian beds. In Section No. 2, still farther up the cañon, we find the Silurian arenaceous limestones forming a rugged escarpment at the base, while on the rather rounded hills the Carboniferous limestones crop out. These hills rise about 1,000 feet above the bed of the river. We thus see that the metamorphic rocks, the Carboniferous and Silurian limestones, present three quite distinct types or forms of erosion, thus giving considerable variety to the scenery.

In Section No. 3, Plate V, the Silurian beds overlaid with Carboniferous limestones continue and pass over the summits of the hills, while from beneath them rise up the reddish feldspathic quartzites, which have weathered into peculiar sharp pinnacles. The river runs for about three miles through a narrow gorge, with vertical walls on either side rising up a thousand feet or more, beset with these sharp angular pinnacles. Above this point, the surface features are softened down, the rocks partially covered with earth, but cropping out in numerous places.

On looking at the geological map of Montana, &c., prepared from the results of the Survey in 1872, it will be seen that there is a small stream flowing into the West Gallatin on the west side, one branch of which rises in Lone Mountain, and the other branch in the Sphynx. Near the mouth of this stream, a high ridge of limestone crosses the Gallatin with a trend about northwest and southeast. On the east side of the Gallatin, the sharp ridges rise up to a height of 1,500 to 2,000 feet, with an inclination 50° southwest. Section No. 5, Plate VI, shows this ridge as it appears on the east side of the river, with the somewhat rounded granitic hills below, on which the limestones lean. The river has cut its channel directly through this ridge, and on the bottom, the worn edges of the upturned shales may be traced across the channel with perfect distinctness. In the section we see the Carboniferous limestones at *b* underlaid with Silurian rocks, resting directly on the granites; and lying against the Carboniferous beds are the Jurassic at *c c*, and at *d* patches of Cretaceous, which seem to have dropped down, as it were, in a sort of Jurassic synclinal.

The Silurian and Carboniferous, with a portion of the Jurassic group, appear to have been lifted up by a vertical force that broke the beds as if they were layers of lumber. In the depression which seems to have been produced by this movement, the Jurassic and Cretaceous beds are seen; but at a distance of about five miles, where, as shown in section No. 6, the Carboniferous limestones rise from beneath the Jurassic in a nearly horizontal position, it would appear that the elevation of the metamorphic rocks, pushing off, as it were, from the sides the sedimentary beds, produced a depression which formed an excellent reservoir for the drainage of the higher lands around, thus giving origin to a stream of water on both sides of the Gallatin. In the background in section 5, we see the group of volcanic peaks which form the divide between the Gallatin and the Yellowstone Rivers. In section 6, the rounded grassy character of the summits of the hills shows the more yielding nature of the Jurassic beds. It is not certain that the true red beds occur in this immediate vicinity. In section 7, we find another dropping-down or faulting of the strata. At *b* the Carboniferous limestones are

nearly horizontal, while at *c c* the Jurassic beds present a reversed dip, forming a kind of synclinal valley. At *d d* are caps of volcanic material by the eruption of which these remarkable dislocations of the beds may have been produced. There is here an open valley for a short distance where the Gallatin again flows between high vertical walls of Carboniferous limestones with a dip of not more than 1° to 3°. These limestones are weathered into remarkably picturesque forms, castles with pinnacles, turrets, &c. Great quantities of fossils were found here which fixed the age of the rocks beyond any doubt. Plate X is composed of two isolated but very characteristic views of the scenery of this portion of Montana. The upper sketch represents with remarkable perfection the forms produced by erosion of the immense volcanic breccia beds about the sources of the Yellowstone. The sketch was taken from a point looking up Soda Butte Creek, a branch of the East Fork of the Yellowstone.

This small stream may be followed to its source, near the head of Clark's Fork, between nearly vertical walls of volcanic breccia, stratified, 1,500 to 2,000 feet in height. From beneath these mountains of breccia, beds of Carboniferous limestones crop out here and there, sometimes only a few feet above the bed of the stream, again rising to a height of several hundred feet. The hundreds of high mountain-peaks, 10,000 to 12,000 feet elevation above sea-level, which form the divide between the Yellowstone River and the sources of Clark's Fork, Stinkingwater, and Grey Bull Rivers, are composed of volcanic breccia, underlaid with Carboniferous limestones.

This sketch may be said to represent a type of most remarkable scenery, which covers a large portion of the country about the sources of the Yellowstone and the western branches of the Big Horn. Similar forms have been carved out of the breccias and trachyte around the sources of the East Gallatin near Mount Blackmore, of which Palace Butte is an example. A more detailed description of the East Fork and Soda Butte Creeks can be found in the Annual Report of the Survey for 1872, Chapter III, commencing on page 44.

The sketch of the terraces of the middle valley of the Madison may be found described in considerable detail in the same report on page 62. A more connected view is here presented, with the high range of mountains which forms the high divide between the Madison and the West Gallatin Rivers. The middle valley is an expansion or basin about fifty miles in length, and with an average width of five miles. The lower thirty miles presents the most remarkable system of terraces I have ever seen in the West, and I regard them as one of the wonders in this wonder-land. This valley was once the bed of a lake, and the Lacustrine deposits lap on to the base of the mountains at an elevation of about 400 or 500 feet above the bed of the river. The surface of the terraces is composed of superficial drift or the usual Quaternary deposits of this country. Underneath them, especially at the lower end of the basin, the Lacustrine deposits are seen.

From our study of the mountain-ranges in Montana, as well as in other portions of the West, it would appear that the outflow of the igneous rocks is synchronous with their elevations. This is especially the case with those ranges which have a granite nucleus.

The igneous rocks are of different ages. The evidence about the sources of the Missouri and the Yellowstone is that the igneous material was formed more or less through all the periods from the very commencement of the general elevation of the country, which culminated in our present mountains. It may not at all times have come to the

surface; but through the vast erosion which has taken place subsequently, the igneous rocks of different ages have been exposed to view.

Over a considerable portion of Montana, Northwestern Wyoming, and the greater part of Idaho, the igneous material, with the accompanying tuffs and breccias, conceal the sedimentary as well as the metamorphic rocks; and they are only exposed to view in the deep gorges of the streams which are produced by erosion. So uniform are these conditions, that one would suspect an intimate connection between the movements of the vast masses of metamorphic rocks which usually form the nuclei of our mountain-ranges and the production of the igneous matter. Is it probable that the movements are so deep-seated as to reach down to melted matter already in that state, and thus affording it access to the surface, or was there sufficient heat generated by the friction of vast masses of rocks upon each other to produce the igneous rocks, as well as the force which has ejected such a vast amount of tuffs and breccia, as we find about the sources of the Yellowstone?

I am not now prepared to discuss this subject, but will simply state that our observations all over the West tend to show a most intimate relation between the eruption of igneous rocks and the elevations of the regular mountain-ranges. Again, an interesting series of observations has been made by the Survey from its commencement, which has been published from time to time in the annual reports, in regard to the channels of our rivers. We find that the channels of our large rivers have not been determined by special lines of depression or fractures, and that there is no necessary connection between them.

It is not an uncommon occurrence to find the channel of a river passing directly through a mountain-range or a ridge, when by a slight flexure it could have occupied a special depression or valley. The West Gallatin River, as is shown in section No. 5, Plate VI, cuts a cañon 1,500 to 2,000 feet in depth, through Sedimentary and Archæan rocks, for several miles, when by an easy flexure, as the surface now appears, it might have occupied areas of special or natural depression.

Nearly every cañon through which any of the rivers or smaller streams of Montana pass, and they are very numerous, present the same peculiarities. The Jefferson Fork presents striking examples of this kind, while the Missouri River below the junction of the three forks, the numerous gorges or cañons are plain illustrations of this statement. We must conclude that since the channels of these streams were marked out, the mountains have been elevated at least the amount of the present height of their summits above the beds of the streams; that the surface at that time was more favorable for the concentration of the drainage-waters along the line of the present cañon, as it passed over what are now the very summits of the mountains, or ridges; that the erosion of the river-channels kept pace with the slow, uniform, long-continued elevation, and thus these enormous gorges may be accounted for.

In my Annual Report for 1872, page 85, I called attention to this feature, and it is undoubtedly applicable to all the great rivers of the West, to the Snake and Columbia Rivers flowing through the vast basaltic walls to the Pacific Ocean, to the Colorado of the West, that has worn out its cañon for more than two hundred miles from half a mile to a mile in depth, and to the Missouri and Yellowstone Rivers from their sources to their entrance into the plains. In the Annual Report for 1872, I made the following remarks:

Another interesting point I have reserved for discussion at a more favorable time is the formation of cañons and valleys of rivers, which enter into the scenery of the country as a most conspicuous feature. The fact that the streams seem to have cut

their way directly through mountain-ranges instead of following synclinal depressions indicates that they began the process of erosion at the time of the commencement of the elevation of the surface. This is shown all along the valley of the Yellowstone, and more conspicuously in the valleys of the Madison and Gallatin, which have carved immense cañons or gorges directly through two of the loftiest ranges of mountains in Montana. We believe that the course of these streams was marked out at or near the close of the Cretaceous period; and as the ranges of mountains were in process of elevation to their present height, the erosion of the channels continued. The details of the observations which contributed to form this opinion would occupy a chapter or two.

I would be glad to find the leisure at some future period to extend these observations in detail all over the country west of the Mississippi, so far as it has been explored. It should be done by some one; but as these notes are intended simply to convey brief descriptions of the sections accompanying them, it cannot be done at this time. The sections, however, will, I think, be acknowledged by all geologists and geographers to convey marvelously true pictures of the surface features of a remarkably interesting region.

NOTES ON THE TERTIARY AND CRETACEOUS PERIODS OF KANSAS.*

By B. F. Mudge.

The State of Kansas is about four hundred miles long from east to west and about two hundred miles (three degrees) in width from north to south. Its average altitude above the level of the sea, by the List of Elevations by H. Gannett, United States Geological Survey, Miscellaneous Publications No. 2, is not far from 1,780 feet. The lowest point is at the junction of the Kansas and Missouri Rivers, and is 750 feet. The highest is in Cheyenne County, about 4,000 feet. The altitude of Monotony station of the Kansas Pacific Railway on the west line of the State is 3,792 feet. The Atchison, Topeka and Santa Fé Railway station at Syracuse, Arkansas Valley, also near the west line, is 3,425 feet.

By inspection of the map of the State, it will be seen that the rivers drain the country in a southerly and easterly direction. As there is not a waterfall on any of the streams 7 feet in height, the descent is gradual, averaging 7½ feet to the mile. The State is so well drained that there are very few valleys with stagnant ponds, and there is not a peat-swamp of fifty acres within its boundaries.

STRATIGRAPHICAL GEOLOGY.

A general vertical section of all the formations seen in Kansas would be in descending series as follows:

I.—Quaternary system:

- Alluvium.
- Bottom prairie.
- Bluff or Loess.
- Drift.

II.—Tertiary system:

- Pliocene.

III.—Cretaceous system:

- Niobrara.
- Dakota.

IV.—Carboniferous system:

- Permian.
- Upper Carboniferous.
- Coal-measures.
- Lower Carboniferous.

* There has been no State geologist during the past ten years, and the information embodied in this sketch was nearly all obtained while engaged in other duties. In relation to the classification of fossils, I have consulted the works of Lesquereux, Meek, Marsh, and Cope.

In this paper we propose to describe only the Tertiary and Cretaceous deposits, as they are a part of the formations first described in the reports of the United States Geological Survey under Dr. F. V. Hayden. It will be seen by inspection of the map that they occupy the western two-thirds of the State. The outlines of the formations cannot be given in detail where the scale is so small. But one feature must be kept in mind. It is this: The dip of the strata in all parts of the State is so slight, averaging about five feet to the mile, that, as you travel to the northwest, the more modern strata, or deposits, are always seen first on the tops of the hills, and gradually descend into the lower grounds and disappear under the still more recent deposits. Thus, on the border of the Pliocene Tertiary and Cretaceous there is a belt about twenty miles in common, where the former occupies the higher and the latter the lower portions of the country. In this way the Tertiary covers about 9,000 square miles of Kansas, consisting of 6,000 covering the entire northwest part of the State and 3,000 interspersed with the Cretaceous along its southeastern boundary.

II.—TERTIARY SYSTEM.

PLIOCENE.

This geological area has been but little examined, and consequently our knowledge of its local features is quite limited. Professors Cope and Marsh have both, in their visits to the Cretaceous, made some casual notices of the southern portion, without spending time in searching for its fossils.

During the summer of 1874 and 1875, we spent much time along the line of its union with the Niobrara, and thus became acquainted with its outlines and a few of its fossils. The line of demarkation, at most points, is very clear and well defined. In numerous places we have found the fossil bones of the mammalia of the Pliocene within ten vertical feet of the marine shells and fish of the Cretaceous; and in slides we frequently found them intermingled. The contrast was remarkable, as hardly a single type was common to both.

The material of the Pliocene deposits consists of sandstone of various shades of gray and brown, occasionally whitened by a small admixture of lime. The lower strata are usually composed of finer sand than the upper, and much more loose and friable in their texture. The overlying beds are of coarser ingredients, consisting of water-worn pebbles of metamorphic rocks—quartz, greenstone, granite, syenite, and sometimes fragments of fossil wood from an older formation. These portions of the deposit, when crumbled and the finer parts washed away, have much the appearance of drift, and have been mistaken for it.

The sandstone is usually friable, crumbling on exposure to the atmosphere. When more compact, its mechanical construction is so irregular as to render it almost entirely unfit for a building-material. When firmly consolidated, it forms the hill-tops of the table-like eminences along the line of the boundary of the Pliocene and Cretaceous formations.

At Breadbowl Mound, Phillips County, it is about 400 feet above Deer Creek, and at Sugarloaf Mound, in the western part of Rocks County, it is about 300 feet above the Solomon River. In these hills, as in many others, the upper strata belong to the Pliocene, while the

bases are of the Niobrara. Farther west it forms the whole of the visible outcrop, and the mounds are not so prominent.

On Prairie Dog Creek, in Norton County, it is 400 feet in thickness, and in the extreme northwestern part of the State we have reason to believe it is still thicker. The various strata are not clearly defined or regular in line of deposit, and the continued thickness cannot be easily discovered. The formation, like all others in the State, appears to dip slightly to the northwest. It is conformably, or nearly so, upon the Cretaceous.

In the southern portion of the Pliocene, in the vicinity of Fort Wallace and Sheridan, the hill-tops are covered with a stratum about 8 feet in thickness, very hard and siliceous. The material varies from coarse flint-quartz to chalcedony. The latter mineral shades from milk-white to transparent, sometimes presenting a semi-opal appearance. The so-called moss agate is found in the upper few inches of the stratum.

Over a considerable portion of the Pliocene no fossils are to be seen; but at other points they are somewhat abundant. They are of modern type, represented by bones of deer, beaver, a large animal of the ox kind, two species of the horse, less in size than small Indian ponies, a wolf, ivory from the elephant or mastodon, bones of the rhinoceros and camel, and also remains of undertermined character. In addition to these mammalia, we find the bones and carapace of a large fresh-water turtle 5 feet in length.

All the bones are firmly fossilized, and most of them changed to a hard, compact silica. The most interesting of these is the ivory. In the process of petrifaction, the tusk must have been so softened as to admit the intermixture of black oxide of manganese in solution, which then crystallized in delicate sprigs. The ivory was next silicified into nearly pure quartz, with the usual hardness of that substance. Thus we have the ivory converted into the so-called moss agate. Some fragments could not be detected, by the ordinary observer, from the usual specimens of that gem.

This ivory is found in fragments in the extreme upper portion of the deposit, and we were at first inclined to call it Post-Tertiary; but the peculiar fossilization, similar to some of the other bones, induces me to think that it belongs to the close of the Pliocene.

The remains of the horse are apparently the most common, the teeth and jaws being found from Smith County to the vicinity of Ellis, in Ellis County. One is a species of the celebrated three-toed horse, having three hoofs coming to the ground. In the northern part of Ellis County, our party, in 1875, found the feet, with the three toes in excellent preservation.

In most cases the bones are badly broken, and much of the skeleton missing. A full and careful examination of the Pliocene of Kansas will undoubtedly furnish some valuable fossils, illustrating the mammalia of the period, and give to science some new species.

The Eocene and Miocene have not yet been discovered in Kansas, unless the specimen of the three-toed horse, found in Ellis County, should prove to be the *Anchitherium* of the Miocene. It was imbedded in the lowest part of the deposit, within 10 feet of the Niobrara limestone. Further examination of this formation is desirable.

II'.—CRETACEOUS SYSTEM.

1.—NIOBRARA.

2.—DAKOTA.

The Cretaceous in Kansas covers an area of over forty thousand square miles, or more than half of the surface of the State. The Pierre and Fox Hill groups of Hayden, and all equivalents of those periods, are entirely wanting. The Benton group also appears to be absent. The Cretaceous is, therefore, represented in Kansas by the Niobrara and Dakota only. The line of demarkation between the Pliocene and Cretaceous is well defined and sharp. Adjoining the Permian easterly, it is not so clear; yet some recent examinations, made in company with Prof. O. St. John, show that the boundary is not difficult to trace. We have never been able to find any fossils of the Jurassic or Triassic, the beds of the Cretaceous resting conformably or nearly so on the Permian.

That portion south of the Arkansas River has been little examined, either by myself or others, but appears to be represented by the Fort Hays and Dakota groups.

1.—NIOBRARA.

a.—Niobrara.

b.—Fort Hays.

The Niobrara, or its equivalents in time, is well represented. It is divided into two clearly-defined portions, by a massive bed of limestone or yellow chalk, which when fully exposed, where it has not suffered from abrasion, is 60 feet in thickness. It is seen in the valley of the Smoky, southwest of Fort Hays, as well as seven miles west of that place, and at various points to the northeast, crossing the Solomon just above the Forks, near Osborne City, and entering Nebraska in Republican Valley, near where that river crosses the State line. It is composed of layers of yellow chalky limestone, from 1 to 3 feet in thickness. It makes an excellent building-material, working easily, yet sufficiently compact to be used for stores or dwellings. At Hays, the school-house and court-house are built from it; and ten miles west of that place the Kansas Pacific Railway has opened a quarry for supplying stone for use along its line. It also burns to a good quicklime. The massiveness and persistence of this stratum make it a well-defined geological horizon. Below this line, as well as in it, vertebrate fossils are few, while above it they are numerous and of varied type. Its fossils are *Inocerami*, fragments of *Haploscapha*, *Ostrea*, with occasional remains of fish and Saurians. The vertebrates are always so rare that we never wasted our time in hunting them in this stratum; still our largest Saurian, *Brimosaurus* of Leidy, was found in it in Jewell County.

a.—Niobrara proper.

The Niobrara in Kansas differs from the same deposit on Niobrara River. The upper portion, which we shall call Niobrara proper, or simply Niobrara, is very unlike the lower, which shades imperceptibly into deposits like the Benton. The two divisions differ in a very marked

degree both in the character of the fossils and in physical appearance. This Niobrara occupies a belt of the country next adjoining the Pliocene, about thirty miles in width in the northern part of the State, but gradually widening to more than twice that extent in the Smoky Hill Valley. At the latter district, it extends from the western line of Ellis County to the Colorado boundary. It is composed of chalk and chalky shales. The former is of various shades of color from buff to pure white, and is seldom sufficiently hard to be used as a building-material. Some of the buildings at Fort Wallace were constructed of it, but did not prove substantial. The whiter portions are almost pure carbonate of lime, and cannot be distinguished from the best specimens of foreign chalk. Professor Dana, in the last edition of his Manual of Geology, p. 455, says there is no chalk in North America except in Western Kansas.

G. E. Patrick, professor of chemistry in the Kansas University, has published, in the Transactions of the Kansas Academy of Science, an article on this chalk, from which we extract the following remarks, with his analyses:

Examined under the microscope, it appears perfectly amorphous—a simple aggregation of shapeless particles. The Rhizopod shells, which almost universally occur in the chalk of the Old World, sometimes comprising nearly its entire substance, seem to be quite wanting in our Kansas chalk. With a good microscope, and a high power, I have been unable to detect a trace of them.

The amount of impurity varies, of course, in different samples of the chalk, but in no specimens that I have seen does this amount exceed 15 or 16 per cent. Two samples yielded, upon analysis, the figures given below. No. 1 was a fine specimen of snowy whiteness; No. 2 had a little yellowish tinge, and was as poor a sample as I could select.

	No. 1.	No. 2.
Moisture	.34	.58
Insoluble in acids (silica, lime, and alumina)	.69	11.40
Alumina (little oxide of iron)	.43	.97
Ferrous carbonate	.14	2.83
Calcium carbonate	98.47	84.19
	100.07	99.97

This chalk is found at various strata, in thickness varying from one to eight feet. It differs in purity and other features, in the same stratum, in different localities. Unlike the European chalk, it never contains flint nodules.

The shales of this division contain lime mingled with clay and sand in varying proportions. They are harder than the chalk, requiring the pick in extricating the fossils. They are of all shades of slate-color, sometimes bleaching on exposure to the weather. Near Fort Wallace, some strata are so much like the Benton in Nebraska, that Professor Hayden, on a hasty inspection, mistook them for a portion of that group. (Final Report on Nebraska, p. 68.)

These shales, in some localities, are traversed by seams, from one to six inches in thickness, of firm, pure calc-spar, usually in flat crystals. Inclosed in these seams are small crystals of barite. At Sheridan, Wallace County, we find the latter spar in the dark shales. One beautiful crystal, of a rich amber-color, weighed eight and one-fourth pounds.

The darker shales also sometimes contain numerous small lenticular nodules of pyrites, frequently in fine crystals.

This Niobrara is from 75 feet in Trego and Ellis Counties to 200 feet in Rooks County. The fossils are scattered very similarly in all this thickness; some localities will furnish more from the chalk, while others will give more from the shales. We hunt for fossils in all alike, and on the whole with equal success.

A few marine plants are found, but no land vegetation, except an occasional fragment of fossil wood. The absence of terrestrial plants is the more remarkable, as extinct birds and numerous amphibians indicate that dry land must have existed.

One fine species of crinoid of a new genus was occasionally found by our party in 1875. No radiate had before been seen in the Kansas Cretaceous.

Of mollusks, the most common are *Ostrea congesta* and *Inoceramus problematicus*. Less common, but still seen in many strata, are fragments of the large *Haploscapha*, with occasionally a perfect specimen. Another large bivalve we have never seen described measures from 30 to 33 inches in length. It is thin, with a transverse fiber like the *Inocerami*, and always lies crushed flat in numerous fragments, but lying in their normal position. A few *Gryphea;* also fragments, frequently weighing ten pounds, of a large *Hippurites* near *H. Toncasianus*. Near Sheridan, we recently discovered a bed of *Baculites ovatus*. Almost all the shells and fragments are covered in part by the *Ostrea congesta*, which abound everywhere.

But the great feature of this subdivision of the Cretaceous consists in its varied and rare forms of vertebrate fossils. Two seasons, of six months each (1874 and 1875), have been spent by myself with two assistants in collecting these vertebrates for Yale College, and yet the deposit is but partially explored, and we are constantly discovering new forms.

The least interesting are the fish, which have, however, given us many new species and some new genera. The small ones are nearly entire, but the larger are represented only by well-preserved portions of the skeletons. Teeth of Salachians were quite common. At one locality over 400 were collected in an area of 30 inches, and apparently from the jaws of one individual—a *Ptycodus*—and all in excellent preservation. Professor Cope, in his "Cretaceous Vertebrata," has described thirty-six species, and some twenty others have quite recently been found. In 1872, only twenty-four species had been collected from Kansas. The most novel is a new genus (three species), which had a snout appended to the skull, like the sword of the sword-fish, but conical in shape, composed of a compact bundle of fibers. In the largest species, this snout is about fifteen inches long and one and a half in diameter at the base. Professor Cope has a representation of a portion of the jaws in Plate XLVIII, figs. 3–8, under the name of *Erisicthe nitida*. But, unfortunately, his specimen did not embrace the snout or much of the skull, so that a correct idea of the fish is not obtained from his description. Professor Marsh has a dozen specimens, recently obtained by us, from which a more detailed description may be made.

In individuals, the fish were quite numerously represented. In the season of 1875, our party saw, according to my note-book, 1,207 specimens, without counting the teeth of sharks. Many of these, however, were so fragmentary that we did not collect them. The genera *Portheus* and *Empo* were most abundant.

Several species of marine turtle have been obtained. One described by Cope, *Protostega gigas*, was 15 feet in the expanded flipper. The type is embryonic. This is seen in the structure of the ribs, which are more free and detached from the dermal plates of the carapace than those now living. The other species were much smaller.

Less in number but of more importance are the reptiles of the crocodile and Saurian type. My note-book shows 476 specimens seen by our party in 1875, of which one-half might be called good, and some of

them equal, if not superior, to anything before found in Europe or America. Professor Cope, in the work above quoted, has made a list of all the genera and species now known in the Cretaceous, which shows fifty-one hitherto described, of which Europe furnishes but four, and Kansas twenty-six. To this number must be added six or eight which have been discovered by our party within two years, which are now in possession of Professor Marsh, who will soon publish a technical description of them.

New Jersey comes next, furnishing fifteen species. Although this formation extends quite widely into Nebraska, but few vertebrates have been found within that State. They have been collected most abundantly in the Saline and Smoky Hill Valleys, and nearly all from the Niobrara proper, above the massive limestone of the Fort Hays division. It must be recollected that this deposit is never over 200 feet in thickness.

The Saurians are of all sizes. One from Jewell County was about 70 feet long, while two species were only 6 feet. Most frequently they were from 25 to 40.

The specimens are frequently represented by a few bones washed out and lying exposed. But the best are obtained by finding a projecting fragment, and then following the skeleton into the compact shale or chalk. This sometimes requires much hard labor, but is the most satisfactory, as the fossils are, in such cases, in a better state of preservation. A single specimen has cost us as much as six days' labor. As the bones were sometimes friable, sketches of the best specimens were made before removal. The fossilizing material is lime combined with a little silica.

Coprolites of fish and Saurians are frequently found, containing the remains of the food of the animal. Small fish appeared to be the most common food; but in one instance a rare crustacean was found preserved in this way. The coprolites are not so hard as those of Europe, being little firmer than chalk, and finer-grained.

The following analysis of a Saurian coprolite from Wallace County is by George E. Patrick, professor of chemistry in the University of Kansas:

Moisture	1.22
Organic matter	.42
Oxide of iron and alumina	29.99
Lime	24.31
Alkalies, small amount, undetermined.	
Silica (combined)	.19
Phosphoric acid	34.88
Carbonic acid	7.05
Sulphuric acid	1.92
	99.98

In some cases, the undigested organic matter (bones) was one-fourth of the whole weight.

From this deposit, Professor Marsh has described three species of Pterodactyls, new to science, and Professor Cope one. But as the specimens were not perfect, and two are quite similar, it may be concluded that they are identical. One of a new genus was recently found by me, and is in the hands of Professor Marsh. Those from Kansas vary from the European species in their great size, the largest foreign being but little over 10 feet in extent of wing, while the smallest of those from the Niobrara is 15 feet and the largest are fully 25 feet. Fragments of the bones are frequent, but usually in poor preservation, in strong contrast, in this respect, with the other vertebrate remains. The long bones, being very hollow, were compressed to the thickness of one-tenth of an inch, and exceedingly friable. The articulations, being

thicker, are firm and better preserved. The bones of the head were seldom found. In one instance (of *P. ingens*), I uncovered a hand, with the four long bones of the wing-finger, as they lay in place, and found them measuring respectively 24½ inches, 20¾ inches, 14½ inches, and 9 inches; or 5 feet 8¾ inches in total length. The width of the first, as it lay compressed to one-tenth of an inch, was about 2 inches. My note-book shows seventy-two individual specimens seen in 1875; but little more than half could be saved, much as we valued this rare fossil. In some instances, on opening a piece of chalk, the outline could be distinctly seen, but the bone crumbled to dust.

In Dr. Coues's Key to North American Birds, published in 1873, Professor Marsh has given a list of the fossil birds from the Cretaceous of North America, at which time thirteen species were known, all first described by himself. Of these, five are from the Niobrara beds of Kansas. Only one Cretaceous bird has been found in Europe. Two of ours are aquatic, allied to the cormorant; but the other three are of a new order (*Ichthyornithes*), and are so anomalous as to be provided with jaws and teeth. One, *Hesperornis regalis*, is between 5 and 6 feet high, an aquatic diving-bird, with rudimentary wings, incapable of flight. The others, *Ichthornis* (two species), are small, but with strong wings, of great powers of flight. The latter genus, in addition to its sharp enameled teeth, presented another singular feature in the vertebra, which were biconcave, of the true fish type. The bones of the legs and wings were of the usual bird structure. The first specimen of this was found by the writer, and described by Professor Marsh in the American Journal of Science, vol. iv, p. 314, and illustrated in vol. x, p. 402. Bird-bones being exceedingly difficult in preservation, the number found is very small.

The soil of this division consists of the fine, black loam, so common to the West, and is, on the high prairie, from 1 to 3 feet deep. Were rain more abundant, it would be a rich farming-region. It is a good grazing-country. The following analyses of soils, collected by S. W. Williston from the Smoky Hill Valley, were made by George E. Patrick, professor of chemistry in the University of Kansas. No. 1 is high-prairie loam; No. 2 is from "bottom" lands. Neither soil had ever been cultivated.

	No. 2.	No. 1.
Water	1.895	3.449
Organic matter	3.039	5.224
Soluble in cold hydrochloric acid:		
Oxide of iron	1.503	1.778
Alumina	.557	.721
Lime	4.268	1.618
Magnesia	.422	2.084
Potassa	.214	.202
Soda	.038	.002
Silicic acid	.050	.023
Sulphuric acid	.041	.078
Carbonic acid	3.510	2.567
Phosphoric acid	.173	.118
Sodium chloride	.003	.009
Insoluble in cold hydrochloric acid	84.287	82.127
	100.000	100.000

b.—Fort Hays division.

The massive stratum of limestone above described, together with all the deposits above the sandstones of the Dakota, I shall call the Fort Hays division.

Professor Hayden, in his Final Report of the United States Geological Survey of Nebraska and Adjacent Territories, p. 67, says:

At Wilson's station, I saw the chalky limestone of the Niobrara group filled with *Inoceramus problematicus*. A part of the bed is in slabs or thinnish layers, as it usually appears wherever it occurs south of the Missouri River; but a part also is more arenaceous and rust-colored. Between the two hundred and forty-fifth and two hundred and fiftieth milestone west, the road cuts through No. 3 (Niobrara) very distinctly, the whole country appearing to be underlaid by this rock.

As this deposit thus seen and described by Professor Hayden rests directly on the Dakota, and all those which he supposed might possibly be Benton, are clearly above the strata seen at Wilson's station, the Benton is not seen in Kansas. The lower portion of our Fort Hays may be an equivalent of the upper portion of the Benton, though there does not appear to be any line of demarkation, either by fossils or physical structure.

At Wilson's station and at other places in the same geological horizon, to the thickness of 140 feet, it is composed of shales and thin layers of limestone. The latter are filled quite largely with *Inoceramus* and a few other marine shells, and occasionally with fish-remains. The shales are variable in color, hardness, and composition, lime and clay predominating. This deposit is variable at the same horizon at different points, containing no thick bed of limestone. To make a section at any particular locality would be of little value unless half a dozen others were made for comparison.

The only persistent feature is a thin stratum of buff sandy limestone, in the upper portion, never over 10 inches in thickness. It extends from Smoky Hill Valley northeasterly into Nebraska. It contains *Inoceramus problematicus*, *Gryphea*, *Belemnite*, and an *Ammonite*, all poorly preserved, and, excepting the first, too indistict for specific indentification. It is much used as a building-stone on the whole line named. It is soft, fine-grained, and easily wrought, and its color is pleasing to the eye.

In the Arkansas Valley, west of Fort Dodge, the Fort Hays division is represented by loose sandstone. Next above this is the friable, bluish-black, or slate-colored shade which lies immediately under the massive limestone. It abounds in concretions, or septaria, of all sizes from 1 inch to 6 feet in diameter. The body of the concretions is of hard clay-marl with cracks lined with beautiful crystals of calc-spar. These cracks frequently extend to the outside, and are then filled with a light lime, which gives them fanciful markings, inducing several persons to send small ones to me as "fossil turtles". This stratum is well exposed near the railroad, a few miles west of Fort Hays, and in most places where the massive limestone lies on the high bluffs. It is about 60 feet in thickness, and frequently contains fine clusters of compound crystals of selenite. It affords a few fish and saurian remains. It is more noted, especially in the Saline and Solomon Valleys, for the number and variety of its *Ammonites*, embracing a dozen species, from 1 to 30 inches in diameter. The largest are always in fragments, but some of the smallest are nearly perfect. Usually a portion of the bright pearly shell is still to be seen. A species of *Scaphites* near *larvæformis* is also found in the small concretions; also several *Inocerami*, one near *I. Nebrascencis* of Owen.

The physical features of this stratum, which are very uniform, are similar to the Benton in Northern Nebraska, but its fossils are different.

The total thickness of the Fort Hays group is 260 feet.

The Dakota group includes all the Cretaceous east of the Niobrara. As no fossils of the Triassic or Jurassic have yet been discovered, after ten years' search, we conclude that the Dakota rests directly on the Permian. While the dividing-line has not usually been very well defined, yet in a few instances the fossils of the Permo-Carboniferous and

Dakota groups have been collected within 35 feet vertically and one-half mile horizontally.

The material of this deposit is formed very largely of brown and variegated sandstone, of all degrees of compactness, from that which crumbles in the handling to that which requires a sledge-hammer to break it. This extreme hardness is, in most cases, owing to the presence of iron, in the condition of oxide and silicates. Sometimes poor limonite is seen. In some places, in every county where it abounds, it affords a good building-material. It is frequently interstratified or overlaid by clay-shales, of almost all colors. Many ledges give concretions of fanciful forms, sometimes hollow, or with the center filled with loose sand. Some of the hollow concretions are sufficiently large to be used by the farmers as feeding-troughs for hogs and cattle. In a few localities they assume the form of tubes of various sizes, some being 3 inches in diameter and 3 to 8 feet in length. These concretionary deposits are sometimes glazed and distorted, as if they had been subject to the action of fire; but the cause is the oxidation of iron, and not any application of heat. Such specimens of sandstone frequently inclose well-preserved dicotyledonous leaves.

The fossils of the Dakota are very unequally distributed over its area. In searching for the marine mollusks, we have found but two localities, both in the western part of Saline County, in the vicinity of Bavaria. In one of these spots, covering a few acres, we procured twelve species new to science. These are figured and described in Professor Meek's work on the Invertebrates, now in press. The other locality furnished a less number.

In collecting fossil leaves, we have frequently examined every visible outcrop for fifteen or twenty miles without finding a specimen; then perhaps a single square mile would present several good localities. In this irregular manner we have collected specimens from Washington County to Fort Larned, a distance of one hundred and fifty miles. The fossil plants are usually obtained from thin layers, or strata, extending in a horizontal position along a ravine or around a hill. They may occur at several places in the same vicinity, but usually without any connection. The fossil flora is almost entirely represented by leaves, though a few specimens of fruit, imperfectly preserved, have been collected; also some poor fragments of wood and bark. The leaves, however, are usually in excellent preservation, the veins and veinlets as they lie imprinted on the stone being frequently as clearly visible in all their outlines as those just taken from the living tree.

Professor Lesquereux has recently made a report, issued by the Department of the Interior, on the Fossil Flora of the Cretaceous Dakota Group, which is one of the most valuable monographs published in our country. He describes one hundred and thirty-two species, distributed among seventy-two genera and twenty-three orders, of which one hundred and seven species of nineteen orders and fifty-two genera are dicotyledonous plants. Of these, more than one-half have been collected in Kansas; and about twenty of the new species were described by Professor Lesquereux from specimens discovered by the writer. To these are to be added twenty-six new species described by the same author in a recent bulletin (VII of No. 5, second series) of Hayden's reports. Additions to these are constantly being made. They are found at all depths in the Dakota, from within 35 feet of the Permian to within 40 feet of the Fort Hays limestone.

Although all the species are extinct, yet nearly all the of genera are now existing, and all are of marked modern type. There are eight species of conifers, five of poplar, six of willow, eight of oak, six of platanus or

buttonwood, seven of sassafras, five of magnolia, one fig, one palm, and two of cinnamon. The last four were probably hardy species of their kinds. Still they indicate a warmer climate than now exists. When we recollect that at the period of their growth, this part of the country was nearly on a level with the ocean, and the dry land was comprised principally of a few islands, the variance of the climate is easily explained. These are "the first known of the great modern group of Angiosperms," "and the ordinary fruit-trees of the temperate zones," for leaves of the *Pyrus* and *Prunus*, allied to the pear and plum, have also been found.

The contrast between this fossil flora and the plants of the older formations is very strong, while its resemblance to those now living is equally remarkable. The interest attached to this numerous variety of modern plants is enhanced by the fact that in the earlier formations no dicotyledons are found, the conifers which come down from the Devonian age being the highest type. But in our Dakota and the corresponding age in Europe we have a sudden influx of new types covering nearly all the forms now living. The large proportion of orders and genera to species is very remakable. The numerous indications show that the trees must have grown on islands near the shore-line, and that the leaves were imbedded in the marine sediment immediately after dropping. Worm-borings are also found in the same strata with the leaves. A few fish and one saurian (*Hyposaurus vebbii*) have been found in this group.

In the Dakota group, there are a few veins of brown lignite, which is always an inferior variety of coal. The most important seam extends irregularly, and with frequent omissions, from the State line in Washington and Republic Counties, southwesterly to the Arkansas Valley. It varies in thickness from 10 inches to 40; but usually a portion of this thickness includes seams or layers of clay-shale. This lignite contains a large percentage of ashes; but a more objectionable feature is its tendency to crumble on exposure to frost. This alone renders it almost worthless as a marketable coal. At some localities it has much pyrites, with sulphur so free as to cover the deposit with a yellow coating. This coal sometimes takes fire by spontaneous combustion. Notwithstanding these defects, it becomes of value in sparsely-timbered counties, by furnishing to the settlers a cheap fuel, costing only the time and labor necessary to dig and convey it to their farms. It is usually mined at the surface in the open air, by "stripping," *i. e.* removing the few feet of soil or shale that overlies it. An average outcrop will yield at least a ton for a day's labor. It is found in Washington, Republic, Cloud, Mitchell, Lincoln, Ottawa, Saline, Ellsworth, McPherson, Rice, Barton, and perhaps some adjoining counties. The average width of the Dakota is less than fifty miles, being somewhat less than that in the north part of the State, and more on the Smoky and Arkansas Rivers. The dip is to northwest and very slight. It is difficult to decide the amount, but it does not appear to be on the average more than 5 feet to the mile. It is conformable to the Fort Hays lime formation above it. It corresponds very nearly to the Cretaceous of Swallow's Report, p. 9, and also to Nos. 2 and 3 of his Triassic.* The maximum thickness of this group may be 500 feet. It is difficult to estimate the thickess, as the larger portion of the material consists of sandstone, much of which was originally thrown down in oblique deposits.

The total thickness of the Cretaceous in Kansas we estimate to be 960 feet.

*The other numbers of his Triassic belong to the Permio-Carboniferous.

NOTES IN RELATION TO THE ACCOMPANYING CONTOUR-MAP OF THE UNITED STATES.

By Henry Gannett, M. E.

I have been engaged for several years in collecting elevations in the United States, particularly in that portion west of the Mississippi River. In connection with this work, I have made a quite extensive study of the geography, both horizontal and vertical, of the country, having had access to nearly all sources of such information extant.

By means of the numerous reconnaissances and surveys of different parts of the West, there is scarcely any part of this vast area of which the *general* features at least are not known. The necessity for further reconnaissance, as such, no longer exists, while the need of actual surveys, based on exact methods, increases year by year, as the work of settlement goes on. In the accompanying map, I have sought to embody some of the results of my studies. It represents approximately and as nearly as the information available at present will enable me to do it, the locations of contour-curves over the country.

The vertical distance between the curves is 1,000 feet.

This map is published merely as a beginning in this direction, and as much with a desire of gaining information by criticism as of imparting knowledge on the subject.

The map on which the curves were drawn, and of which this is a photo-lithographic copy, is that used by the Census Bureau for their atlas. It is not all that could be wished for the purpose, as it contains many errors in drainage, geographical positions, &c., due to the fact that the latest geographical work is not represented upon it. In general, I have made the contours conform to the drainage; but in a few cases, where this would necessitate marked errors in the curves, the course of the drainage has been neglected, and the contours have been drawn as I know them to exist, as in the case of Preuss Lake, Utah, which has lately been proven to have no existence, and the mouth and lower course of the Rio Dolores in Eastern Utah, which have been sadly misplaced by map-makers since the time of Captain Gunnison. The scale of the map is smaller than I should wish, and makes it impossible to represent properly many features which could be brought out on a larger map.

Exact measurements of elevation above sea-level are in this country entirely unknown, except near the coast. No leveling for scientific purposes, on any considerable scale, has been done; and the levels of railroad and canal lines, though at first they might seem to be all that is required, on examination are found to be as conflicting as possible. No two lines give the same height for the terminus. The profiles of the railroads, when compared, present a mass of contradictions almost beyond belief. The discrepancies, however, are due, not to the instrumental work, but to the office-work, the computations, the connection of different sections, &c. The matter is greatly complicated by uncertainty concerning the identity of datum-planes, especially when such datum-planes are given as mean, high, or low water in lakes or rivers.

To untangle this mass is an enormous labor, and one perplexing in the extreme. Many have undertaken it, and have given it up in despair. In 1874, Mr. J. T. Gardner, then connected with this Survey, undertook a part of this labor, and succeeded in carrying it through with a considerable degree of success. His problem was, to obtain the true elevation of Denver, Colo., which serves as a hypsometric base for our work in Colorado. To this end, he connected a number of lines from the Atlantic and Gulf coasts, rooted out nearly all the errors, and finally obtained results for the heights of several of the most important railroad-centers, which, from their close agreement, show a strong probability of being correct. Should these results, on the application of further tests, prove trustworthy, they will form a frame-work, by use of which the problem will be simplified very much.

Elevations measured by barometer are liable to large errors, unless the work is done under the very best circumstances. The most potent causes of error are too great distance, horizontal and vertical, from the barometric base. In the earlier days of exploration in the West, it was impossible to obtain even tolerable conditions for the execution of hypsometric work. Hence, naturally, the earlier measurements of elevations in the West are found to present a wide range of error, some being changed scarcely any by later and more reliable measurements, others being several hundreds of feet—indeed, in some cases reaching a thousand feet—from the truth.

In constructing these curves, though I have made use of the many thousands of elevations in my possession, I have borne in mind that elevations of isolated points merely, without a knowledge of the surrounding topography, are of little use. Indeed, in many cases they are worse than useless, as they may tend to mislead.

The *mean* heights of mountain-ranges have been expressed as nearly as possible. They will, no doubt, be subject to much criticism, as many of them are based on insufficient information, and my estimate of the *mean* heights of others, based on the heights of a few peaks, may not be correct.

In the cañons of the Colorado and Green Rivers, I have thought best, owing to the small scale of the map, to run the contours into a single line.

The sources of information consulted and made use of in this work are almost numberless. I will enumerate the principal ones. For a knowledge of the Appalachian system and the country adjacent, I am indebted mainly to the article by Professor Guyot on the Appalachian system, published in vol. xxxi (1861) of Silliman's Journal; also, in various State geological and geographical reports, there is much material of value concerning the Eastern States. Information concerning the valley of the Mississippi is scattered far and wide, and to specify authorities would fill a volume. Reports of State and General Government surveys and profiles of railroads have supplied the greater part of this information.

On the slope of the great plains, between longitudes 96° and 104°, the contours are controlled largely by the plotted heights. These heights have been collated from, first, the profiles of the several railroads which cross the plains, the Northern Pacific, Union Pacific, Burlington and Missouri River, Kansas Pacific, Atlantic and Pacific, Arkansas Valley, and others of less importance; and, second, from the profiles of the routes of the numerous expeditions which have crossed the plains in various directions.

The Llano Estacado and the western part of Texas are known mainly

from the reports and maps of Pope,[1] Whipple,[2] and Marcy;[3] the valley of the Canadian, from Whipple;[2] that of the Arkansas, from Emory,[4] Gunnison,[5] and the Arkansas Valley Railroad; the Kansas River and Smoky Hill Fork, from the Kansas Pacific Railroad; the Valley of the Republican, from Frémont[6] and Stansbury;[7] that of the Platte, from the Union Pacific Railroad. Information concerning the Missouri River and the country lying between that river and the Black Hills is derived from the work of Warren,[8] Raynolds,[9] and Ludlow.[10] Stevens[11] gives much information concerning the country east of the Missouri, and the Northern Pacific Railroad furnishes a profile across it. Facts and figures concerning the plains of the Upper Missouri come mainly from Stevens.[11]

The divides between the valleys have been crossed in many places, and profiles made, and in no place do they show much rise above the valleys.

The principal authorities consulted in regard to the Black Hills are the reports of Warren,[8] Raynolds,[9] Ludlow,[10] and Jenney's map.[12]

Proceeding westward and entering the mountains, isolated elevations become of less value, while a knowledge of the general topographic features correspondingly increases in value.

For a knowledge of the topographic features of New Mexico, I have consulted the reports of the United States expeditions which have crossed that Territory; principal among them are Emory,[4] Whipple,[2] Ives,[13] Parke,[14] and Simpson.[15] The mountain and plateau regions of Colorado are from the work, published and unpublished, of this Survey. The plateau country adjacent to the Green and Colorado Rivers is from the published, and, through the courtesy of the geologist-in-charge, the unpublished, work of the survey in charge of Maj. J. W. Powell.[16] The country of the Lower Colorado is known from Ives's[17] report, and the

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[1] Pacific Railroad Reports, vol. ii.

[2] Pacific Railroad Reports, vol. iii and iv.

[3] Exploration of Red River of Louisiana. Thirty-second Congress, second session, Executive Document No. 54.

[4] Notes of a Military Reconnaissance from Fort Leavenworth, Mo., to San Diego, Cal., by Maj. W. H. Emory, 1846–'47. Thirtieth Congress, first session, Executive Document No. 7.

[5] Pacific Railroad Report, vol. ii.

[6] Report of the Exploring Expedition to the Rocky Mountains in the year 1842, and to Oregon and North California in the years 1843–'44, by Brevet Capt. J. C. Frémont.

[7] Exploration and Survey of the Valley of the Great Salt Lake of Utah. Howard Stansbury. Special session, 1851, Senate Executive Document No. 3.

[8] Reconnaissance of the Dakota Country, 1855. Thirty-fourth Congress, first session, Senate Executive Document No. 76.

[9] Exploration of the Yellowstone River, by Brevet Brig. Gen. W. F. Raynolds, and Geological Report, by Dr. F. V. Hayden. Fortieth Congress, first session, Senate Executive Document No. 77.

[10] Report of a Reconnaissance of the Black Hills of Dakota in 1874, by Capt. William Ludlow.

[11] Pacific Railroad Reports, vol. i and Supplement, and vol. xii, part i.

[12] Map of the Black Hills, W. P. Janney, 1875.

[13] Report upon the Colorado River of the West, explored in 1857 and 1858, by Lieut. J. C. Ives. Thirty-sixth Congress, first session, Senate Executive Document.

[14] Pacific Railroad Report, vol. vii.

[15] Report of an Expedition into the Navajo Country, by Lieut. J. H. Simpson, 1849. Thirty-first Congress, first session, Senate Executive Document No. 64.

[16] Exploration of the Colorado River of the West, in 1869–'72, by J. W. Powell.

[17] Report upon the Colorado River of the West, explored in 1857 and 1858, by Lieut. J. C. Ives. Thirty-sixth Congress, first session, Senate Executive Document.

rest of Arizona from Ives,[1] Parke,[2] Whipple,[3] Sitgreaves,[4] Simpson,[5] Mexican Boundary Survey,[6] and the published results of the survey under Lieutenant Wheeler, Corps of Engineers. Southern California has been explored by Parke,[2] Williamson,[7] Whipple,[3] and, in more detail, by the California State survey.[8] The latter has made detailed study, also, of the greater part of the State, notably of the Sierra Nevada and the Coast ranges. Nevada and Western Utah are known principally from the maps of Wheeler's survey. Beckwith[9] also gives some information concerning this region. In the neighborhood of the Union Pacific Railroad, the maps of the "Survey of the Fortieth Parallel"[10] under Mr. Clarence King have, so far as published, furnished valuable information.

Information concerning the country of the Bighorn, Powder, and Tongue Rivers is scanty. The only available source is the report of Raynolds.[11]

The work of this survey in Idaho, Wyoming, and Montana[12] fills out a part of the mountain-region of these Territories. The Wind River Mountains and the adjacent country are described in Jones's report.[13] The contours on the Snake River plateau are located from the work of this Survey and from that of Frémont,[14] Wallen,[15] and Lander.[16] In the Main and Bitterroot ranges, the authorities are mainly Stevens[17] and Mullan.[18] Harney's Lake and the northern part of the Great Basin are known from Wallen.[15] The Blue Mountains of Oregon were traversed by Frémont,[14] Lander,[16] and Wallen.[15] The Cascade Mountains in Oregon and Washington Territory are described by Williamson,[19] Stevens,[17] and the Northern Boundary Commission.[20]

The sources mentioned above are those most fruitful in heights and topographic descriptions. They are, however, but a tithe of the whole number of expeditions which have traversed the West. Many important reconnaissances have been omitted, as their results have been superseded by more accurate and detailed work.

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[1] Report upon the Colorado River of the West, explored in 1857 and 1858, by Lieut. J. C. Ives. Thirty-sixth Congress, first session, Senate Executive Document.

[2] Pacific Railroad Report, vol. vii.

[3] Pacific Railroad Report, vols. iii and iv.

[4] Expedition to the Zuñi and Colorado Rivers, by Capt. L. Sitgreaves. Thirty-second Congress, second session, Senate Executive Document No. 59.

[5] Report of an Expedition into the Navajo Country, by Lieut. J. H. Simpson, 1849. Thirty-first Congress, first session, Senate Executive Document No. 64.

[6] Report on United States and Mexican Boundary Survey, vol. i.

[7] Pacific Railroad Report, vol. v.

[8] Report of Geological Survey of California. Geology. J. D. Whitney.

[9] Pacific Railroad Reports, vol. ii.

[10] Geological Map, No. ii.

[11] Exploration of the Yellowstone River, by Brevet Brig. Gen. W. F. Raynolds, and Geological Report, by Dr. F. V. Hayden. Fortieth Congress, first session, Senate Executive Document No. 77.

[12] United States Geological Survey of Montana and Adjacent Territories, 1871, Hayden. United States Geological Survey of Montana, Idaho, Wyoming, and Utah, 1872, Hayden.

[13] Northwestern Wyoming and Yellowstone National Park, 1873, Capt. Wm. A. Jones.

[14] Report of the Exploring Expedition to the Rocky Mountains in the year 1842, and to Oregon and North California in the years 1843–'44, by Brevet Capt. J. C. Frémont.

[15] Wagon Road Report, by Capt. H. D. Wallen. Thirty-sixth Congress, first session, Senate Executive Document No. 34.

[16] Pacific Railroad Report, vol. ii.

[17] Pacific Railroad Report, vol. i, Supplement; and vol. xii, part i.

[18] Military Road Report, Capt. John Mullan.

[19] Pacific Railroad Report, vol. vi.

[20] Paper by George Gibbs, Journal American Geographical Society, vol. iii.

THE FLORA OF SOUTHWESTERN COLORADO.

By T. S. Brandegee.

Attached to the division of the San Juan as assistant topographer, as much time as possible was given to the botany of the country through which our work obliged us to pass. Under such circumstances, it was impossible to make a complete botanical collection of the district given to our division; therefore no plants were gathered excepting such as seemed to be additions to the flora of Colorado, as published by the Survey in Miscellaneous Publications, No. 4. The collections and notes were almost all made while riding from one topographical station to another.

Early in June we left Pueblo for Southwestern Colorado, via the Mosca Pass, over the Sangre de Cristo. The country was alive with innumerable grasshoppers, busy eating every green thing excepting the leaves of *Juniperus occidentalis* and the cactus-plants. *Opuntia Missouriensis* was in full bloom, and early in the morning, before the grasshoppers had breakfasted upon the newly-opened flowers, presented a magnificent sight. We rode over mile after mile of the Saint Charles and Huerfano Plains, now covered with the red or yellow flowers of *Opuntia Missouriensis*. The mesas, variegated with the different-colored patches of this cactus, presented a striking contrast to their generally dry, barren appearance.

The thickets of *Shepherdia argentea* on the banks of the Huerfano and its tributary streams, and the abundance of *Abronia fragrans* upon the mesas, at once attract the attention of any one familiar with the flora of Northern Colorado. Up the eastern slope of the Sangre de Cristo we meet with *Abies Douglasii*, and at the very summit of the pass find a long-leaved tree of *Abies concolor*. *Pinus flexilis*, scattered here and there by its twisted branches, bears witness to the prevalent direction of the winds. Some fine old trees of *Abies concolor* grow along the little stream which runs down the pass, and near the base of the mountain descend into the habitat of *Pinus edulis*. A camp at the foot of the pass close to the dunes affords an opportunity for examining the vegetation about those mountains of drifting sand. Nothing, not even a blade of grass, grows upon them; but along their base some *Triticum repens*, *Thermopsis*, *Astragalus pictus*, *Psoralea*, have a foothold. The willows continue along the creek until they are almost buried by the sand which has collected about them.

From here to the Rio Grande, the dry level country is very uninteresting botanically. With the exception of the banks and alkaline flats of the lakes, for thirty or forty miles we pass through a Liliputian forest of *Bigelovia*, *Sarcobatus*, and *Atriplex*. Beds of *Heliotropium Curassavicum*, with their pretty white flowers now in full bloom, are scattered over the alkaline flats about the lakes. The sandy beaches of the lakes are the favorite habitat of *Nasturtium sinuatum*. In September, the banks of the streams were yellow with *Bidens chrysanthemoides*, and upon the surrounding plains *Cleome Sonoræ*, with *Aplopappus lanceolatus*, grew in

abundance. These plants, so common about the lakes, were seen in no other place during our summer's explorations.

Up the Rio Grande, as far as to fifteen miles above Del Norte, nothing of interest was noticed; there we first meet with *Berberis Fendleri*, which, after we had crossed the main range, was found quite as plenty upon the western slope.

Wagonwheel Gap, through which the waters of the Rio Grande have barely room to find their way, is a cañon of magnificent beauty, and is very interesting botanically. Although only 8,000 feet above sea-level, *Cryptogramme achrosticoides* flourishes among the loose rock. On the face of the cliffs and among the *débris* at their base, a new *Gilia*, *G. Brandegei*, Gray, was found growing in abundance. But for its yellow flowers, it would have been passed by as *Polemonium confertum*, var. *mellitum*, which it almost exactly imitates in leaves and fragrant viscosity.

At the head of Los Pinos Creek we leave the Rio Grande, cross the Sierra Madre, and come upon the western slope of the Rocky Mountains. The alpine and subalpine floras at this southern latitude are almost exactly the same as those of Northern Colorado. *Pachystima Myrsinites* and *Erythronium grandiflorum* are very common, and *Aquilegia Canadensis* almost entirely takes the place of *A. cærulea*. Among the common species of *Senecio*, *Sedum*, *Pedicularis*, &c., but two additions to the flora of Colorado were noticed: *Arenaria saxosa* of New Mexico and *Corydalis Caseana* of the Sierra Nevada. To find these plants growing with species of so northern a habitat as *Calypso borealis*, *Listera cordata*, and *Aspidium Filix-mas* was very interesting. The *Corydalis* prefers the banks of the little mountain-streams and cold springs in the shade of the forests of *Abies Engelmanni* and *grandis*. Here it reaches a height of 5 feet; the finely-dissected leaves are 2 feet and more long, forming a very handsome foliage-plant, but its blue-tinged flowers lack clearness of color.

In the valleys of the Los Pinos, Florida, and Animas, at about 7,000 feet altitude, the first decided change appears in the flora. Plants not before known to exist in Colorado become common, and in some places form the greater part of the vegetation. Bushes of *Fendlera rupicola* 10 feet high grow upon the bluff-sides; thickets of *Peraphyllum ramosissimum* are very plenty, now full of its long-stemmed fruit called by the few white settlers wild crab-apple. Conspicuous among the plants which mark the change in the flora are *Rhamnus Californicus*, *Hosackia*, *Yucca baccata*.

Southwestern Colorado, an extent of country of very different altitudes, and embracing within its limits various conditions of soil, moisture, &c., of course has a varied flora. The flora of the alpine and subalpine regions of the Sierra La Plata, the only high mountains in our district, like that of the Piedra and Los Pinos Mountains, is similar to that of equal altitudes in Northern Colorado.

To the alpine flora, the only addition is a bright-pink clover, named by Mr. Watson *Trifolium Brandegei*. The subalpine flora compared with that of the eastern slope has a greater abundance of *Rubus Nutkanus*, *Pyrus sambucifolia*, *Prosartes trachycarpa*.

The Mesa Verde, a plain of two hundred square miles, raised nearly 1,000 feet above the surrounding country, is a prominent topographical feature of Southwestern Colorado. Its surface is perfectly dry; the showers from the La Plata Mountains rarely wetting it except upon the northern edge. *Juniperus occidentalis* covers almost the whole mesa, and it is to the abundance of this un-

graceful, bushy tree that the name Green Mesa is due. The piñon is scattered here and there, sometimes covering quite an area, especially where the sandstone does not reach the surface. Very rarely, upon a rocky ledge, is seen a solitary tree of *Juniperus Virginiana*. The trails over the Mesa Verde, some of them evidently very old, generally cross the small parks and follow up openings in the juniper-forest. The sage-bush (*Artemisia tridentata*) covers these parks so thickly that they are almost impassable excepting by the narrow trail, so narrow that as we ride along the encroaching *Artemisia* is continually brushing against us. The yellow flowers of *Helianthus petiolaris* and *lenticularis*, of *Actinella Torreyana* and *Richardsonii*, the delicate pink blossoms of *Mamillaria vivipara*, the light blue of *Pentstemon linaroides*, and the hooked spines of *Echinocactus Whipplei* sometimes are seen; but, after having crossed the Mesa Verde, one has the impression that its vegetation is all *juniper* and *sage-brush*. There is a great difference between the vegetation of the northern slope and cañons (altitude 8,000 feet) and that of the southern edge (altitude 6,000 feet), due mainly to the lower altitude and smaller rain-fall of the southern portion. The northern portion is covered with a luxuriant growth of *Peraphyllum*, *Fendlera*, *Purshia tridentata*, *Cercocarpus parvifolius*, *Amelanchier alnifolia*, *Quercus*, and *Yucca baccata*, while the southern portion has only a growth of *Purshia*, *Cowania*, *Ephedra*, and *Fraxinus anomala*.

The valley of the San Juan really comprises the whole extent of country of the southwest explorations; but as the term is applied to the habitat of plants of the collection, it is limited to a district north of the river about twenty miles wide. The San Juan River was followed from the mouth of the Rio La Plata (5,300 feet altitude) in New Mexico, along its course into Utah, twenty miles from the Colorado line (4,300 feet altitude). All plants of the San Juan Valley of New Mexico come into the limits of Colorado about the mouth of the Mancos, where the San Juan barely touches the corner of Colorado. Some of the species seen only in Utah may not enter the limits of Colorado; but their number is small, less than a dozen. The San Juan Valley is even drier than the Mesa Verde; the soil is perfectly dry close up to the water of the river. The bottom-lands are generally less than one mile wide, and produce quite a growth of plants, which send their roots down in the earth to the level of the water of the river. The course of the Rio San Juan can be distinctly seen long before we reach its banks; it is a line of green a mile wide and many miles in length, winding through the gray desert. Groves of large cottonwood are scattered along its course, and dense thickets of *Shepherdia argentea*, *Cratægus cocciena*, and *Salix longifolia* line its banks. The fragrance of the Bigelovias and other plants is noticeable at a distance of two or three miles; and as we return in the evening after a ride over the dry, barren plains, the delightful odor filling the air announces the proximity of the river long before we reach it. The mesas of the San Juan Valley are very barren of vegetation. The handsome *Eriocoma cuspidata* is sometimes plenty enough to afford a night's pasturage for the mules, and, compared with the general scarcity of growth, *Pleuraphis Jamesii* often seems plenty. There are large areas with absolutely nothing growing upon them, and often, even along the streams, our day's journey would be lengthened four or five miles before grass could be found sufficient for a camping-place. The alkaline flats abound in *Chenopodiaceæ*, mainly *Sarcobatus*, *Atriplex Nuttallii* and *confertifolia*.

Where Mount Elmo and Montezuma Creeks, dry streams from the north, come down to the San Juan, we find many interesting plants.

Symmetrical clumps of *Calamagrostis longifolia* 6 feet high, their large panicles bending gracefully outward, send their roots deep down into the dry sand.

Rings of *Muhlenbergia pungens* are scattered over the flats here and there. This grass spreads by underground stems, which grow continually outward, the older inner part dying and disappearing, leaving the bare sand surrounded by a circumference of living green. These centrifugal circles are sometimes 10 feet in diameter, with the interlaced purple panicles of the ring a foot wide. The rare *Oxytenia acerosa*, with *Bigelovia Wrightii*, *Heliotropium convolvulaceum*, *Dicoria Brandegei*, *Andropogon Torreyana*, are some of the plants common in these dry rivers. When we ride up these rivers of sand, sometimes a bright, green *cottonwood*, or *Negundo*, is met with, showing that water must be down deep somewhere. How they managed to exist before their roots reached moisture is an interesting question. El Late and Cariso, groups of low mountains about 9,000 feet in altitude, produce a flora similar to one another and very different from that of the plains from which they rise. *Pinus edulis* and *Juniperus occidentalis* cover Cariso, and grow nearly upon the summit of El Late. The characteristic vegetation is the same as that of the La Plata and Animas of the same altitude.

Upon the eastern slope of the Rocky Mountains, in the valley of the Arkansas, the *Cactaceæ*, on account of their abundance and size, are a prominent part of the vegetation. It was expected that the southern latitude, low altitude, and dryness of Southwestern Colorado, with its proximity to the cactus region of Arizona, would be favorable to the growth of *Cactaceæ*, but the number of species is less than in the Arkansas Valley, and the number of plants is very small. Only two species to be added to the flora of Colorado make their appearance: an *Echinocactus* and a *Cylindropuntia*. The *Cylindropuntia* is found at altitudes between 7,000 and 8,000 feet, and *Echinocactus Whipplei* generally does not grow in the lowest altitudes, so that the country along the San Juan River has not a single additional species of cactus, and lacks very nearly all the species of the eastern slope. The great beds of *Opuntia Missouriensis* which cover the plains and parks of the eastern slope are not found in Southwestern Colorado; neither *Opuntia arborescens* nor *Cereus viridiflorus* was seen, and no species is common.

The genus *Astragalus* is represented by few species, and these are not very abundant. They grow almost wholly above 6,000 feet altitude. None of the species of *Astragalus* of Southwestern Colorado, with the exception of *A. lonchocarpus*, appear upon the eastern slope. Twelve leguminous plants were found which grow in Eastern Colorado, while not more than eight species common to the plains of both eastern and western slopes were seen. Few of the *Leguminosæ* are very abundant.

The shrubby *Rosaceæ* are in strong force and characteristic of the flora of Southwestern Colorado from high to low altitudes. The species common to both eastern and western slopes, the abundance of some which rarely grow upon the eastern slope, together with those species which here enter the limits of Colorado, give great prominence to the rosaceous shrubs.

The genus *Eriogonum* is well represented in species, and the plants are very abundant, especially those of the annuals. Nine annual species grow in the San Juan Valley; in the Arkansas Valley but three are found, and in Northern Colorado but one.

At about 8,000 feet altitude, the common oak of Colorado is very abundant, growing upon the bluff-sides and becoming a small tree in moist locations. At lower altitudes, it is rarely seen, and is a small bush

about two feet high, with small, somewhat sharply-lobed, leaves. The forms so common in the Greenhorn range, bearing small, nearly evergreen leaves, do not grow in Southwestern Colorado.

The subalpine *Coniferæ* of the southwestern slope are mainly *Abies Engelmanni* and *grandis*. These two species, either together or in forests of one alone, cover the western slope down to the altitude of *Pinus ponderosa*, 9,000 feet. Both species become large, magnificent trees. *Abies Engelmanni* is the only conifer found at timber-line, but *A. grandis* reaches very nearly to as high an altitude. *Abies Menziesii* is confined mainly to the vicinity of the water-courses between altitudes of 10,000 and 8,000 feet *Abies Douglasii* is not very common, and grows between altitudes of 9,000 and 7,000 feet, descending into the region of *Pinus edulis* and *Juniperus occidentalis*. *Abies concolor* was not seen upon the western slope, and not a tree of *A. grandis* could be found upon the eastern slope. The range of *Abies concolor* in Colorado is southward from the Ute Pass and Manitou (6,000 to 7,000 feet altitude); in the cañons of the Greenhorn range, to the summit of Lucille Hill, Rosita, 1,000 feet, along the Sangre de Cristo and Raton Mountains to New Mexico. *Pinus ponderosa* in Southwestern Colorado is abundant at 8,000 feet altitude, and its large trees will furnish a great amount of lumber. *Pinus flexilis* is not common; it grows at an altitude of 8,500 feet with *Pinus ponderosa*, *Abies grandis*, *Menziesii*, *Engelmanni*, and *Douglasii*, all associated at this altitude. *Pinus edulis* and *Juniperus occidentalis* cover the mesas and mountains below 7,500 feet altitude. The piñon often grows in company with *Pinus ponderosa* and *Abies Douglasii*, and in the Arkansas Valley grows above the lower altitudes of *Abies concolor* and *Menziesii*. Last year *Juniperus occidentalis* and *Virginiana*, *Abies concolor*, and *Pinus ponderosa* matured quantities of fruit, and probably the other *Coniferæ* also did; but this year, wishing to collect seeds, I was unable to find any, and am sure that the *Coniferæ* of Southern Colorado matured no fruit. *Pinus edulis* is said to fruit once in seven years, and it certainly sometimes fruits in such abundance that the nuts are collected by the Mexicans in quantity.

Southwestern Colorado having never been the residence of the white man, those plants which become introduced with eastern seeds have not yet made their appearance. *Xanthium strumarium* has been probably introduced upon both eastern and western slopes. Upon the eastern slope it is said to have come from Texas with the importation of cattle, the burrs clinging to their hair and becoming everywhere distributed. Upon the western slope it perhaps was introduced from the south by the cattle, sheep, and goats of the Indians. It is not as common as upon the eastern slope, but will become so when farmers, like those of the eastern slope, begin to irrigate the land. *Xanthium* must have a location where its roots can reach wet ground, and prefers the banks of irrigation-ditches, where, in company with other troublesome plants, it is permitted to grow to perfection, and its seeds spread over the cultivated fields. The corn-fields of the band of Utes about El Late are not irrigated and are free from introduced weeds, having very few of any sort. The corn is planted in hills without any regularity; the roots striking down to moisture soon, they are but slightly dependent upon showers from El Late. The most noticeable plants growing among the corn were *Nicotiana attenuata* and *Convolvulus sepium*. The edges of the field produced a fine growth of those species of *Helianthus* which so rapidly increase in number with the irrigation and cultivation of the soil. *Helianthus petiolaris* and *lenticularis* are now sparingly found in Southwestern

Colorado, but, when the valleys of the streams are cultivated, will become as plenty and as troublesome as upon the eastern slope. The vegetation of the valleys of Southwestern Colorado was free from the effects of irrigation, cultivation, and large herds of cattle and sheep, all of which rapidly produce great changes.

As before mentioned, the flora of Southern and Southwestern Colorado above timber-line is nearly the same as the alpine floras of Central and Northern Colorado. From timber-line (11,000 to 12,000 feet altitude) down to 8,000 feet altitude, the effects of latitude and longitude are barely noticeable upon the flora. As we approach New Mexico, but very few plants of a more southern habitat appear, and very few of those common in Northern Colorado are absent. The western slope produces very few plants of a more western habitat until altitudes below 8,000 feet have been reached. Below this altitude are found the somewhat distinct floras of the different parts of Colorado. The flora below 8,000 feet, north of the divide between the Platte and Arkansas Rivers, is in greater part found southward in the parks and valleys along the base of the mountains. It contains the greater number of species of *Astragalus*, thirty species growing, where, upon an equal area southward and westward, not more than half a dozen can be found. As we cross the divide and come into the valley of the Arkansas, a difference in the aspect of the vegetation is at once noticed. This is the cactus-center of Colorado. *Mentzelia* is magnificently represented by seven species. The *Nyctaginaceæ* are nearly as well developed as in Southwestern Colorado, while *Solanaceæ* and *Euphorbiaceæ* are much better represented. Many plants of southern habitat, as *Zinnia*, *Melampodium*, *Ximenesia*, *Tricuspis*, &c., become quite conspicuous, and many stragglers of the south here grow in their most northern location. San Luis Valley, an elevated plain (7,000 to 9,000 feet altitude), does not possess the different conditions necessary to the growth of an extensive flora. The alkaline flats produce an abundance of *Chenopodiaceæ*.

Many interesting plants undoubtedly grow along the boundaries of the park and the edges of the mountains. Its southern portion on the Rio Grande (altitude 7,000) has, in a very limited degree, the appearance of a New Mexican flora. The number of the phænogamous plants growing in Southwestern Colorado will not equal the 900 species that can be found upon any similar area upon the eastern slope. The impressions received by any one who has noticed the flora of the eastern slope, riding rapidly over Southwestern Colorado, below 8,000 feet altitude, are, the great scarcity of all vegetation; the comparative abundance of rosaceous shrubs, and *Artemisia tridentata;* the great number of the annual species of *Eriogonum;* the showy blossoms of *Malvaceæ;* the few species of *Astragalus* and *Pentstemon.*

LIST OF PLANTS OF COLORADO NOT MENTIONED IN THE SYNOPSIS OF THE FLORA OF COLORADO, MISCELLANEOUS PUBLICATIONS, No. 4.

Thanks are due to Dr. Asa Gray for descriptions of new species and determinations of many plants of the collection; to Dr. George Engelmann for his descriptions of new species and determinations of *Cactaceæ*, *Loranthaceæ*, and species of other orders; to Mr. S. Watson for determinations; to Prof. Thomas C. Porter for determinations of plants from the vicinity of Cañon City; and to Prof. D. C. Eaton for herbarium facilities and assistance; to Mr. Eugene A. Rau for the list of *Musci* and *Hepaticæ;* and to Mr. J. H. Redfield for much assistance.

RANUNCULUS RHOMBOIDEUS, Goldie.

Sierra La Plata, 10,000 feet altitude.

BERBERIS FENDLERI, Gray, Plant. Fendl., p. 5.

Valleys of the Rio Grande, Animas, and Mancos.

CORYDALIS CASEANA, Gray, Proc. Am. Ac., x, 69.

Piedra Mountains, 10,000 feet altitude.

NASTURTIUM TRACHYCARPUM, new species.

E radice annua? erectum (pedale), ramosum, fere glabrum; foliis lyrato-sub-pinnatifidis; racemis laxis; floribus albidis; petalis spathulatis sepala antherasque oblongo-sagittatas parvum superantibus; siliquis oblongo-linearibus (lin. 4–5 longis) papilloso-asperatis in pedicello rigido mox recurvato adscentibus stylo longo subulato superatis.

The rhachis and stout pedicels are studded with the small and rough papillæ which abound on the pod, and suggest the name of this very distinct species.—ASA GRAY. Southwestern Colorado.

STREPTANTHUS CORDATUS, Nutt.

Mesa Verde, growing under *Juniperus occidentalis*, 6,500 feet.

THELYPODIUM INTEGRIFOLIUM, Endl. var.?

Flowers white; racemes much longer and pod more stipitate. Common in the San Juan Valley.

DRABA AUREA, var. *stylosa*, Gray.

Wagonwheel Gap, on the Rio Grande.

BRASSICA.

San Juan Pass, 10,000 feet, introduced.

BISCUTILLA (DITHYREA) WISLIZENI, Englm.

Valley of the San Juan, 4,500 to 6,000 feet altitude.

CLEOME AUREA, Nutt.

Valleys of the San Juan and Mancos, 5,500 feet altitude.

CLEOME SONORÆ, Gray, Pl. Wright, p. 16.

San Luis Valley.

CLEOMELLA OÖCARPA, Gray, new species, Proc. Am. Acad., xi, 72.

Diffusa, spithamæa ad sub-pedalem; foliolis oblongo-linearibus; racemo sæpissime densifloro; bracteis inferioribus foliis conformibus, superioribus simplicibus; setulis stipularibus manifestis; staminibus petala superantibus; ovario apice 3-ovulato; capsula ovata lineam longa stylo breviusculo superata stipite (pedicellum subæquante) triplo breviore; seminibus 1–2 lævibus.

Very abundant on the adobe hillsides and alkaline flats on the borders of the Mesa Verde about the Rio Mancos. Collected also in Nevada by Drs. Torrey and Gray.

SILENE ANTIRRHINA, L.

Mountains about Cañon City, 6,000 feet altitude.

ARENARIA SAXOSA, Gray, Pl. Fendl., p. 13.

Piedra and Los Pinos Mountains, 10,000 feet; Parrott City and banks of the La Plata to 6,000 feet altitude.

PORTULACA RETUSA, Englm., Pl. Lindn., 2, p. 154.

Arkansas Valley and Southwestern Colorado.

MALVASTRUM LEPTOPHYLLUM, Gray, Pl. Wright, p. 17.
Valleys of the San Juan and La Plata.

SPHÆRALCEA EMORYI, Torrey, Pl. Wright, 1, 21.
Valleys of the San Juan, La Plata, and Mancos.

THAMNOSMA TEXANUM, Gray.
Soda Spring Ledge, Cañon City, 5,400 feet altitude.

GLOSSOPETALON SPINESCENS, Gray, Pl. Wright, ii, 29.
Near Hovenweep Castle, 5,250 feet altitude.

RHAMNUS (FRANGULA) CALIFORNICUS, Esch.
Valley of the Animas, 6,500 feet altitude.

POLYGALA ACANTHOCLADA, Gray, new species, Proc. Am. Acad., xi, p. 73.
Fruticulosa, bipedalis, ramosissima, subcinereo-pubescens, spinis gracilibus armata; foliis lineari-spathulatis rigidulis (lin. 3–4 longis); floribus subaxillaribus sparsis albidis lin. 2 longis pedicello basi bibracteato parum brevioribus; alis obovatis sepalis cæteris duplo majoribus corollam adæquantibus; carina breviter cymbiformi nuda dorso umbonata.
Growing upon a bluff side near the San Juan River in Utah, not far from the Colorado boundary.

LUPINUS SILERI, Watson.
Trail between Parrott City and the Mancos, 7,500 feet altitude.

LUPINUS SITGREAVII, Watson, Proc. Am. Ac., viii, 527.
Common in Southwestern Colorado, 7,000 feet altitude.

TRIFOLIUM ERIOCEPHALUM, Nutt.
Lost Cañon and Parrott City, 8,600 feet altitude.

TRIFOLIUM BRANDEGEI, Watson, new species, Proc. Am. Ac., xi, p. 130.
Dwarf, perennial, cespitose, and acaulescent, glabrous, the inflorescence slightly villous; stipules scarious; leaflets elliptic-oblong, thin, acutish, entire, a half to an inch long; peduncles about equaling the leaves; flowers spicate in a loose naked head, purplish, seven lines long; calyx-teeth lanceolate, acuminate, a little longer than the campanulate tube; ovary stipitate, 7-ovuled.
A very showy species, common in the Sierra La Plata.

HOSACKIA WRIGHTII, Gray, Plant. Wright, p. 42.
Southwestern Colorado, 8,000 feet altitude.

DALEA LANATA, Spreng.
Valley of the San Juan, 6,000 to 4,000 feet.

PETERIA SCOPARIA, Gray, Pl. Wright, p. 50.
La Plata Valley.

ASTRAGALUS DIPHYSUS, Gray.
Southwestern Colorado, 6,000 feet.

ASTRAGALUS BIGELOVII, Gray.
Valley of the Mancos, 5,000 to 6,000 feet.

ASTRAGALUS SUBCOMPRESSUS, new species.
A. racemoso sect. *Galegiformium* admodum similis; dentibus calycis brevioribus; corolla ochroleuca; legumine falcato lateraliter compresso

intus septo completo bilocellato, sulco dorsali angusto subclauso, stipite e calycis tubo haud exserto.

Legumes an inch and a quarter or shorter in length, 2½ to 3 lines wide, the well-developed ones decidedly falcate; the partition about twice the length of the depth of the groove, which in the cross-section before dehiscence is oval and almost closed.—ASA GRAY.

Animas Valley, 7,000 feet altitude.

ASTRAGALUS ROBBINSII, Gray, var. (?) *occidentalis*, Watson.

Animas Valley, 9,000 feet.

ASTRAGALUS HUMILLIMUS, new species.

Cæspitoso-depressus, condensatus; caudice lignescente; caulibus vix pollicaribus stipulis scariosis coalitis imbricato-tectis, petiolis persistentibus hystricosis; foliolis 3–5 jugis oblongis canescentibus margine revolutis (lineam longis) demum deciduis; pedunculis brevibus 1–3 floris; calycis dentibus subulatis tubo oblongo-campanulato dimidio brevioribus; corolla pallida; legumine ovato-coriaceo albo-pubescente parvo (lin. 2 longo) uniloculari 9-ovulato fere monospermo, suturis extus prominulis.

Habit of *A. jejunus*, Watson, but much more dwarf and condensed; petioles and rhachis more spinescent and persistent; pod decidedly different.—ASA GRAY.

Growing upon sandstone-rock of the Mesa Verde, near the edge of the Mancos Cañon.

ASTRAGALUS HAYDENIANUS, new species.

A. bisulcato affinis, minor, pube magis cinerea; spica elongata virgata; floribus multo minoribus (lin. 3–4 longis); calycis dentibus subulatis tubo multo brevioribus; corolla alba, carina tantum apice purpureo-tincta; legumine ovali utrinque obtusissimo venis transversis ruguloso 6–7-ovulato 2–4-spermo, facie ventrali late profundeque impressa sutura costæformi valde prominente percussa, stipite calycem haud superante.

Also collected on Grand River, Middle Park, by H. N. Patterson. A striking species, with slender stems 2 or 3 feet high; dedicated to the director of the Survey, and one of the oldest, most indefatigable, and distinguished explorers of the whole Rocky Mountain region.—ASA GRAY.

The flowers of this species have the peculiar disagreeable odor of those of *A. bisulcatus*.

Southwestern Colorado, between Parrott City and the Mancos, 8,000 feet.

ASTRAGALUS PATTERSONI, new species.

Scytocarpi, robustus, 1–2-pedalis, adpresso-puberulus, nunc glabellus; foliolis 5–10-jugis oblongis crassiusculis (semipoll. ad pollicem longis); pedunculis racemoso-plurifloris folium æquantibus vel superantibus; floribus ultra semipollicaribus mox pendulis; calycis dentibus setaceo-subulatis tubo cylindraceo dimidio brevioribus; corolla alba, carina apice nunc purpurascente; legumine ovali crasso-coriaceo inflato glabro (sæpius pollicari) polyspermo, basi intra calycem abrupte contracta substipitiformi, suturis nec intrusis nec extus prominulis.

The only flowering specimens seen were collected by Mr. H. N. Patterson, for whom it is named, in the foot-hills of Gore Mountains, Colorado.

Fruiting specimens were also abundantly collected by L. H. Ward in Powell's exploration.—ASA GRAY.

Fruiting specimens only; collected in McElmo Valley, 5,500 feet altitude.

ASTRAGALUS ———.

An interesting species, collected in fruiting specimens only, grows about Navajo Springs, near Cariso Mountains, Arizona. Another uncertain species, growing upon the alkaline flats of the La Plata, was almost out of fruit in June.

OXYTROPIS PODOCARPA, Gray.

Sierra Sangre de Cristo, 12,000 feet altitude, and alpine summits of the mountains near Breckenridge.

PRUNUS DEMISSA, Walp.

Common upon both eastern and western slopes at 8,000 feet elevation.

COWANIA MEXICANA, Don.

Mesa Verde and its cañons; El Late, 6,000 feet.

COLEOGYNE RAMOSISSIMA, Nutt.

Near Hovenweep Castle, 5,250 feet altitude.

PERAPHYLLUM RAMOSISSIMUM, Nutt.

Valleys of the Animas, La Plata, and Mancos, 6,000 to 8,000 feet altitude.

CRATÆGUS COCCINEA, L.

Greenhorn Range of the Arkansas Valley and along the banks of all the streams and rivers of Southwestern Colorado.

CRATÆGUS RIVULARIS, Nutt (?).

Texas Creek, near the Sangre de Cristo, 8,000 feet.

POTENTILLA CRINITA, Gray, Pl. Fend., 41.

Thompson's Park, 7,500 feet.

HEUCHERA RUBESCENS, Torr.

El Late, 9,000 feet.

FENDLERA RUPICOLA, Eng. & Gray, Pl. Wright, 77.

Valleys of the Animas, La Plata, and Mancos, Mesa Verde and Cariso Mountains.

TILLAEA DÆRUMMONDII, T. & G.

Rio Grande Valley.

CALLITRICHE VERNA, L.

Rio Grande Valley.

ŒNOTHERA BREVIPES, Gray, var. *parviflora*, Watson.

Sand-bar of the Rio Mancos, 5,000 feet.

ŒNOTHERA SCAPOIDEA, Nutt.

Alkaline flats, Cañon City Park, 5,500 feet.

MENTZELIA ORNATA, T. & G.

Common throughout the Arkansas Valley, from 4,000 to 6,000 feet altitude. The flowers are more than 6 inches in diameter, opening at twilight, about two hours later than those of *M. nuda*. When opening, they fill the surrounding air for some distance with fragrance. *M. multiflora*

also gives out the same delicious odor when the flowers at first open. It is often noticeable 100 feet from the plants.

MENTZELIA CHRYSANTHA, new species.

Biennis, ramosissima, caule albido asperuto; foliis ovato-lanceolatis sinuato-dentatis, inferioribus versus basin angustatis, superioribus sæpius basi lata sessilibus; floribus subsessilibus bractealatis oppositifoliis; pomeridianis aureis, calycis laciniis lanceolato-subulatis tubo longioribus; petalis sub-10 lanceolatis acutis longe unguiculatis interioribus in stamina latiora abeuntibus; capsula cylindrica seu ovata; seminibus ovatis compressis anguste marginatis nec alatis.

Barren clayey limestone hills on the Arkansas, near Cañon City, with *Frankenia*, several shrubby *Atriplex*, *Juniperus occidentalis*, etc., where I discovered it in September, 1874; also in Southern Utah, Dr. Parry, 1874, No. 78, doubtfully referred to *M. multiflora*.

From the large, fleshy, branching, not fusiform root rise branching stems 1–2 feet high; leaves 1–3 inches long, ¼–1½ inches wide, more or less coarsely dentate, upper ones often entire; flowers 15–20 lines in diameter, open in the afternoon (and evening?); petals 6–9 lines long, 2–3 lines wide, often less than 10 in number, the innermost smaller and antheriferous; ovary with three placentæ, each bearing two series of ovules; capsule 3 lines wide, in some ½, in others fully 1 inch long; seeds very narrowly margined, similar to those of *M. lævicaulis*, but much smaller and not winged, surface facetted. Apparently near *M. pumila*, as described in Torr. & Gr. Fl. N. A., 1, 535, but that species is said to have small terminal flowers and winged seeds. Name from the golden-yellow color of the flowers, by which it is easily distinguished from the different cream-white species which grow in the same region. This color, however, gradually fades in drying, or becomes brown; this is also the case in the yellow flowers of *M. lævicaulis*, while the flowers of *M. oligosperma* retain their color much better.—GEO. ENGELMANN.

ECHINOCACTUS WHIPPLEI, E. & B.

La Plata Valley and mesa Verde, 5,000 to 8,000 feet.

CEREUS CÆSPITOSUS; Eng., var. *castaneus*, Eng.

South of Pueblo, mesas of the Saint Charles.

OPUNTIA (CYLINDRO-PUNTIA)———?

Spreading over the ground; sometimes the small joints ascending to a height of 1 foot; flowers small, yellow; fruit yellow and unarmed. In flower about the 1st of July. Not determinable on account of the lack of mature seeds. La Plata Valley, Mancos, and McElmo, 6,500 feet.

ARALIA NUDICAULIS, L.

Ute Pass and Greenhorn Range.

SYMPHORICARPUS OREOPHILUS, Gray.

Mountains near Cañon City.

GALIUM ANGUSTIFOLIUM, Nutt.

Mancos Cañon and Cariso, 5,500 feet.

GALIUM BRANDEGEI, new species.

Cæspitoso-depressum, parvum, glabrum; radicibus fibrosis; foliis quarternis obovatis vel spathulatis fere eveniis, lin. 1–3 longis; pedunculis unifloris solitariis geministe nudis; flore albido semilineam longo; fructu lævi glabro.

A diminutive species, hardly to be compared with any other of this country.—ASA GRAY.

Near the banks of the Rio Grande, where the Los Pinos trail begins to ascend the Sierra Madre. September.

BRICKELLIA LINIFOLIA, D. C. Eaton, King's Rep., p. 137.

Common in Southwestern Colorado.

BRICKELLIA MICROPHYLLA, var. *scabra*, Gray, Proc. Am. Ac., xi, 74.

Foliis parvulis rigidioribus papilloso- vel hirtello-scabris; pappo tantum 16–20-chæto.

Very common upon the sandstone-rocks of the Mesa Verde. Also collected by Dr. Parry.

ASTER NOVÆ-ANGLIÆ, L.

Cañon City.

ASTER PAUCIFLORUS, Nutt.

Growing about a warm soda-spring in the Animas Valley. In this species, the pappus separates readily from the achenium, with the bristles slightly connected at their base.

ASTER COLORADOENSIS, Gray, new species, Proc. Am. Acad., xi, 76.

MACHÆRANTHERA sed perennis, nanus, tomentuloso-canescens; caulibus in caudice lignescente confertis plurimis monocephalis; foliis imis spathulatis, summis fere linearibus, omnibus argute dentatis, dentibus spinuloso-setiferis; involucri hemisphærici squamis pluriserialibus subulatis laxiusculis; ligulis 35–40-linearibus purpureis elongatis; acheniis brevibus turbinatis creberrime cano-villosis.

Found in the mountains of Northern Colorado by nearly all collectors, and passed over as a form of a species of *Machæranthera*.

Southwestern Colorado, San Juan Pass, 12,000 feet altitude.

ERIGERON STENOPHYLLUM, var. *tetrapleurum*, Gray.

In rocky localities of the Mancos Cañon and Mesa Verde, 5,500 feet.

ERIGERON FLAGELLARE, Gray.

Cañon City and Southwestern Colorado.

ERIGERON BIGELOVII, Gray, Bot. Mex. Bound., 78.

Flats of the San Juan Valley, 5,200 feet.

TOWNSENDIA FENDLERI, Gray.

Wet Mountain Valley and Huerfano Creek.

TOWNSENDIA INCANA, Nutt.

Mesas of Southwestern Colorado.

TOWNSENDIA STRIGOSA, Nutt.

Flats of the San Juan Valley, 5,000 feet.

BIGELOVIA WRIGHTII, Gray.

San Juan Valley, 5,000 to 4,000 feet.

GRINDELIA MICROCEPHALA, DC.

Mancos Valley, 7,500 feet altitude.

APLOPAPPUS NUTTALLII, T. & G.

Mesas near Rio Mancos, 7,000 feet altitude.

APLOPAPPUS LANCEOLATUS, T. & G.

Near lake of San Luis Valley.

APLOPAPPUS ARMERIOIDES, Nutt.
Mesas of Southwestern Colorado, 7,000 feet.

APLOPAPPUS GRACILIS, Gray, Plant. Fend., 76.
Mancos Plains, 7,500 feet altitude.

BACCHARIS WRIGHTII, Gray, Plant. Wright, 101.
Soda Spring Ledge, Cañon City.

DICORIA BRANDEGEI, Gray, Proc. Am. Ac., xi, 76, new species.
Diffusa, pube substrigulosa cinerea; foliis lanceolatis obtusis subintegerrimis; capitulis laxe racemoso-paniculatis parvis; involucri squama interna florem fœmineum fulcrante unica cæteris haud longiore achenio oblongo turgido margine calloso-dentato subdimidio breviore.
An interesting accession to the genus, requiring considerable modification of the character.
Common along the San Juan, between McElmo and Recapture Creeks.

OXYTENIA ACEROSA, Nutt., Pl. Gambell, 172.
Very abundant in the dry gulches running into the San Juan at about 4,500 feet altitude.

ENCELIA FRUTESCENS, Gray, Proc. Am. Ac., viii, 657.
Rocky edges of mesas, Southwestern Colorado.

ENCELIA MICROCEPHALA, Gray, Proc. Am. Ac., viii, 657.
San Juan Valley, 4,500 feet.

HYMENANTHERUM (LOWELLIA) AUREUM, Gray, Plant. Fend., 89.
Cañon City, Colorado Springs, Pueblo, and on the Huerfano.

WYETHIA SCABRA, Hook., Proc. Am. Ac., viii, 655.
La Plata Valley, 5,000 feet; base of Cariso.

WYETHIA ANGUSTIFOLIA, Nutt.
Valley of Los Pinos Creek, 8,000 feet.

BALSAMORHIZA SAGITTATA, Nutt.
Mesas of La Plata and Los Pinos Creeks, 8,000 feet.

ACTINELLA TORREYANA, Gray.
Mesas of Southwestern Colorado—common.

HYMENOPAPPUS FLAVESCENS, Gray, Plant. Fend., 97.
San Juan Valley, 4,500 feet altitude.

HYMENOPAPPUS LUTEUS, Nutt.
San Luis Valley.

SCHKUHRIA INTEGRIFOLIA, var. *oblongifolia*, Gray, Proc. Am. Ac., ix, 199.
Hovenweep, McElmo—common—4,500 to 6,000 feet.

SCHKUHRIA NEO-MEXICANA, Gray, Pl. Fend., 96.
Rio Grande Valley, near Del Norte—plants small, not 2 inches high.

ARTEMISIA BIENNIS, Willd.
Near Cañon City and Parrott City.

ARTEMISIA BIGELOVII, Gray.
Abundant in the Arkansas Valley.

ANAPHALIS MARGARITACEA, R. Br.
La Plata Valley, near Parrott City.

GNAPHALIUM PALUSTRE, Nutt.
Parrott City and San Luis Valley.

MADIA GLOMERATA, Hook., Proc. Am. Ac., ix, 189.
Near Parrott City, 8,700 feet.

CNICUS PARRYI, Gray, Proc. Am. Acad., x, 47.
Parrott City, 8,400 feet.

STEPHANOMERIA EXIGUA, Nutt.
San Juan Valley, 5,000 feet altitude.

LACTUCA CANADENSIS, L.
Greenhorn range and mountains near Canon City.

PLANTAGO MAJOR, L.
Sandflats of the Mancos and Dolores, 7,000 feet—apparently indigenous.

PENTSTEMON BARBATUS, Nutt, var. *trichander*, Gray, Proc. Am. Acad., xi, 94.
Humilior e caudice lignescente; antheris longe parceque lanoso-barbatis!
A new variety of this handsome *Pentstemon*—Southwestern Colorado.

PENTSTEMON LINARIOIDES, Gray.
Southwestern Colorado, 6,000 to 7,000 feet.

PENTSTEMON BRIDGESII, Gray, Proc. Am. Ac., vii, 379.
El Late, 6,000 to 8,000 feet altitude.

ORTHOCARPUS PURPUREO-ALBUS, Gray.
Valleys of the La Plata and Mancos.

CORDYLANTHUS KINGII, Watson, King's Rep., 233.
San Juan Valley, 5,500 feet.

PEDICULARIS———.
A species common upon the Mesa Verde, growing under *Juniperus occidentalis*. Flowers and fruit not seen.

POLIOMINTHA INCANA, Gray, Proc. Am. Ac., 1870, 295.
San Juan Valley, 4,500 feet.

MARTYNIA PROBOSCIDEA, Glox.
Cañon City, 5,300 feet altitude.

ERITRICHIUM CALIFORNICUM, DC.
Rio Grande Valley.

PHACELIA CRENULATA, Torr., Proc. Am. Ac., x, 318.
Rio Mancos, 5,300 feet altitude.

NAMA HISPIDA, Gray.
San Juan Valley, 5,000 feet.

GILIA (IPOMOPSIS) HAYDENI, Gray, new species, Proc. Am. Acad., xi, 85.
Fere glabra, e basi indurata perenni vel bienni paniculato-ramosissima, pedalis; foliis linearibus, imis vix spathulatis parce pinnatilobatis

dentatisve, ramealibus plerisque minimis subulatis integerrimis; paniculis subthyrsoideis floribundis calycibusque parum glandulosis; corolla cæruleo-purpurea gracili infundibulari-tubulosa (ultra, semipollicari), tubo lobis suis ovatis calyceque 3–4-plo longiore; antheris oblongo-sagittatis subsessilibus fauci insertis; ovarii loculis 8–9-ovulatis; seminibus paucis oblongis, tegumento humectato nec spirillifero nec mucilaginoso!

A handsome species common upon the mesas of the Mancos, the western slope of the Mesa Verde, and about El Late, 5,000 to 7,000 feet altitude.

GILIA CONGESTA, Hook., var. *crebrifolia*, Gray.

McElmo Creek, 6,000 feet.

GILIA GUNNISONI, T. & G.

San Juan Valley, common.

GILIA BRANDEGEI, Gray, new species, Proc. Am. Acad., xi., 85.

EUGILIA, perennis, pube glandulosa fragrante viscosissima; caulibus erectis spithamæis vel subpedalibus thyrsifloris; foliis circumscriptione linearibus pinnatisectis, segmentis plurimis sessilibus parvis aut oblongo-linearibus rarius ovalibus integerrimis aut bipartitis verticillos 3–4-foliolatos simulantibus; corolla aurea infundibuliformi-tubulosa calyce cylindraceo semiquinquefido 2–3-plo longiore, fauce parum ampliata, lobis ovalibus brevibus; ovulis in loculis paucis.

A showy species, very common at Wagonwheel Gap on the Rio Grande, and also seen near the base of the Sierra Madre on the Los Pinos trail, eastern slope.

DATURA METELOIDES, DC.

Hovenweep Cañon, 5 miles above Hovenweep Castle. The large white flowers seemed wonderfully beautiful contrasted with the surrounding "greasewood and sage-brush".

LYCIUM PALLIDUM, Miers.

San Juan Valley—common.

CUSCUTA UMBELLATA, Kunth.

Hovenweep Cañon—parasitic upon *Portulaca retusa*.

ERYTHRÆA CHIRONIOIDES, Torrey.

Base of Cariso, Arizona.

FRASERA ALBOMARGINATA, Watson, King's Rep., 280.

Mesa Verde and San Juan Valley, 6,000 to 4,500 feet.

FRAXINUS ANOMALA, Torrey.

Mesa Verde, 5,700 feet; Hovenweep, 5,200 feet.

FORESTIERA ACUMINATA, Poir.

Banks of the San Juan.

ATRIPLEX POWELLII, Watson, Proc. Am. Ac., ix, 114.

Alkaline flats of the San Juan and Mancos.

ATRIPLEX NUTTALLII, Watson.

Southwestern Colorado.

ATRIPLEX CONFERTIFOLIA, Watson.

Cañon City and Southwestern Colorado.

GRAYIA BRANDEGEI, Gray, new species, Proc. Am. Acad., xi, 101.

Inermis, sesquipedalis, leviter furfuraceo-cinerea; foliis spathulato-linearibus; thecis minoribus flavidulis oblato-orbiculatis quandoque trialatis basi latissime retusis, alis subundulatis; ovario basilari papuloso.

Found only at the most western topographical station, San Juan Valley, 3,200 feet.

ALTERNANTHERA LANUGINOSA, Torrey.

Pueblo and San Juan Valley.

AMBLOGYNE TORREYI, Gray, Proc. Am. Acad., 5, 169.

Cañon City.

ASCLEPIAS INCARNATA, L.

Cañon City.

POLYGONUM CONVOLVULUS, L.

Colorado Springs—introduced.

POLYGONUM HARTWRIGHTII, Gray, Proc. Am. Acad., 1870, 249.

Cañon City.

POLYGONUM COARCTATUM, Dougl.

Parrott City.

ERIOGONUM INFLATUM, Torrey.

San Juan Valley—common.

ERIOGONUM SALSUGINOSUM, Hook.

San Juan Valley—common.

ERIOGONUM DIVARICATUM, Hook.

San Juan and Mancos Valleys.

ERIOGONUM THOMASII, Torrey.

Southwestern Colorado.

ERIOGONUM RENIFORME, Torrey.

Southwestern Colorado.

ERIOGONUM ACAULE, Nutt.

San Juan Valley.

ERIOGONUM RACEMOSUM, Nutt.

Common at 8,000 feet in Southwestern Colorado.

ERIOGONUM CORYMBOSUM, Benth.

Slopes of the Mesa Verde.

ERIOGONUM CORYMBOSUM, var. *divaricatum*, T. & G.

Slopes of the Mesa Verde.

ERIOGONUM MICROTHECUM, Nutt., var. *confertifolium*, Benth.

Southwestern Colorado.

ERIOGONUM MICROTHECUM, var. *leptophyllum*, T. & G.

Southwestern Colorado—common.

ARCEUTHOBIUM DIVARICATUM, Englm.

Cariso and Mancos Mesas, 6,000 feet—parasitic upon *Pinus edulis*.

PHORADENDRON JUNIPERINUM, Englm.

Cariso Mountains—parasitic upon *Juniperus occidentalis*—6,000 feet altitude.

EUPHORBIA DENTATA, Mx.

Cañon City.

EUPHORBIA SERPYLLIFOLIA, Pers.

Wet Mountain Valley.

EUPHORBIA STICTOSPORA, Engelm. in Bot. Mx. Bound., p. 187; Boiss. in DC. Prod., 15, 2, p. 41.

Abundant on the saline flats about Cañon City (Brandegee).—This common New Mexican species is thus shown to extend into Southern Colorado. It is a prostrate annual, readily known by its pubescence, which extends to the sharp angled capsule. It has rounded, subcordate, sharply serrate leaves; lateral, leafy, crowded racemes, with very small and *slender long-peduncled* involucres and *slender sharply 4-angled rugose-dotted* seeds, which are about as long as the involucre itself (about 0.6 lines long). The styles are short and undivided.—GEO. ENGELMANN.

EUPHORBIA FLAGELLIFORMIS, new species.

Annua, glaberrima; caulibus e basi pluribus ramosissimis declinatis seu decumbentibus; foliis breviter petiolatis e basi subinæquali linearibus subacutis mucronulatis integris; stipulis triangulari-lanceolatis inferioribus connatis superioribus distinctis; involucris solitariis pedicello æquilongo fultis late campanulatis intus hirtulis polyandris, lobis triangularibus glandulas 2–4 parvas concavas angustissime appendiculatas æquantibus; stylis brevibus erectis bifidis; capsula depressa trisulca; seminibus lævibus cinereis trigonis acutis. *E. petaloidea, δ. flagelliformis*, Englm. Bot. Mex. Bound., p. 185. *E. zygophylloides, γ. flagelliformis*, Englm. in Boiss. Euph. DC. Prod., 15, 2, p. 29.

Originally sparingly collected without fruit on the Rio Grande, near El Paso, by Charles Wright.

This species, as it now proves to be, was abundantly seen on the sandy flats of the San Juan River, in Southwestern Colorado, by Mr. Brandegee, where it occurs with the allied *E. petaloidea*, but unfortunately it seemed to be too common to make specimens of!

Stems 6–12 inches long; leaves 6–9 lines long, ½ to 1 line wide; involucres about ⅔ line wide; seeds of same length.—Readily distinguished from the allied *E. petaloidea* by the smaller involucre bearing very small and almost naked glands, often less than four in number, the more numerous stamens (often up to 25) with much smaller anthers, and by the smaller, more angular and more pointed, grayish seeds, while those of the allied species are larger, thicker, with rounded angles, and of a more reddish color.—GEO. ENGELMANN.

EPHEDRA ANTISYPHILITICA, C. A. Meyer.

La Plata Valley, 5,500 feet.

EPHEDRA TRIFURCA, Torrey.

Mesa Verde and Animas Valley.

ABIES CONCOLOR, Lindl.

JUNIPERUS OCCIDENTALIS, Hook.

ZANNICHELLIA PALUSTRIS, L.

Cañon City—a very troublesome plant, growing in the irrigation-ditches.

EPIPACTIS GIGANTEA, Dougl.
San Juan Valley.

PROSARTES TRACHYCARPA, Watson, King's Rep., 344.
Sierra Sangre de Cristo and abundant in the La Plata Mountains.

ALLIUM ACUMINATUM, Hook.
La Plata and Animas Valleys, 8,000 feet.

YUCCA BACCATA, Torrey.
Southwestern Colorado—common at 8,000 feet altitude; growing at a higher altitude than *Y. angustifolia.*

FESTUCA TENELLA, Willd.
Cañon City.

STIPA PENNATA, L.
Cañon City.

ORYZOPIS ASPERIFOLIA, Mx.
Piedra Mountains, 9,000 feet.

GLYCERIA NERVATA, Trin.
Wet Mountain Valley.

AIRA FLEXUOSA, L.
Alpine—Sierra Sangre de Cristo.

EATONIA OBTUSATA, Gray.
Near Cañon City.

SETARIA CAUDATA, Roem. & Schultz.
Cañon City.

BOUTELOUA ERIOPODA, Torrey.
San Juan Valley.

BOUTELOUA POLYSTACHYA, Torrey.
San Juan and Mancos Valleys.

MELICA STRICTA, Boland.
Parrott City, 8,500 feet.

ERAGROSTIS POÆOIDES, Beauv., var. *megastachya*, Gray.
Cañon City—introduced.

TRICUSPIS PULCHELLA, Torrey.
San Juan Valley.

CALAMAGROSTIS LANGSDORFFII, Trin.
Parrott City.

ANDROPOGON JAMESII, Torr.
San Juan Valley.

The following is a list of plants seen growing in Southwestern Colorado on the plains of the western slope below an altitude of 8,000 feet. As those of the higher altitudes are generally found throughout the

mountain-regions of the State, they are omitted, as are also those mentioned in the preceding list. It is of interest as a means of comparison with the flora of the eastern slope of the same altitude.

Clematis ligusticifolia, Nutt.
Vesicaria stenophylla, Gray.
Stanleya pinnatifida, Nutt.
Erysimum cheiranthoides, L.
Lepidium alyssoides, Gr.
Cleome integrifolia, T. & G.
Frankenia Jamesii, Torr.
Silene Menziesii, Hook.
Arenaria congesta, Nutt.
Malvastrum coccineum, Gr.
Sphæralcea angustifolia, Spach.
Linum rigidum, Pursh.
Geranium Fremontii, Torr.
Pachystima myrsinites, Raf.
Ceanothus Fendleri, Gr.
Negundo aceroides, Mœnch.
Rhus glabra, L.
Rhus toxicodendron, L.
Trifolium longipes, Nutt.
Psoralea lanceolata, Pursh.
Petalostemon candidus, Mx.
Astragalus lonchocarpus, T. & G.
Glycyrrhiza lepidota, Nutt.
Hedysarum Mackenzii, Richards.
Lathyrus palustris, L.
Spirea dumosa, Nutt.
Rubus Nutkanus, Moç.
Rubus strigosus, Michx.
Purshia tridentata, DC.
Cercocarpus parvifolius, Nutt.
Geum Rossii, Seringe, alpine, flowers double.
Potentilla Anserina, L.
Rosa blanda, Ait.
Pyrus sambucifolia, Cham. & Schlecht.
Amelanchier alnifolia, T. & G.
Philadelphus microphyllus, Gr.
Œnothera biennis, L.
Œnothera albicaulis, Nutt.
Œnothera triloba, Nutt.
Œnothera Hartwegii, Benth., var.
Mentzelia nuda, T. & G.
Mentzelia multiflora, Nutt.
Mamillaria vivipara, Haw.
Echinocactus Simpsoni, Eng.
Cereus Fendleri, Eng.
Cereus phœniceus, Eng.
Opuntia Camanchica, Eng. & Big.
Opuntia Rafinesquii, Eng.
Cucurbita perennis, Gr.
Kuhnia eupatorioides, L., var.
Brickellia Californica, Gr.
Diplopappus ericoides, T. & G.
Erigeron armeriæfolium, Turcz.
Erigeron Bellidiastrum, Nutt.
Solidago pumila, T. & G.
Bigelovia Howardii, Gr.
Bigelovia Parryi, Gr.
Bigelovia depressa, Gr.
Bigelovia Douglasii, Gr.
Aplopappus spinulosus, DC.
Aplopappus croceus, Gr.
Grindelia squarrosa, Dunal.
Chrysopsis villosa, Nutt.
Iva xanthiifolia, Gr.
Helianthus petiolaris, Nutt.
Helianthus lenticularis, Dougl.
Thelesperma gracile, Gr.
Ximenesia encelioides, Cav.
Gaillardia pinnatifida, Torr.
Actinella scaposa, Nutt.
Actinella Richardsonii, Nutt.
Achillea Millefolium, L.
Artemisia filifolia, Torr.
Artemisia tridentata, Pursh.
Artemisia Ludoviciana, Nutt.
Senecio aureus, L.
Tetradymia canescens, DC., var.
Stephanomeria minor, Nutt.
Pterospora Andromedea, Nutt.
Phelipæa Ludoviciana, Don.
Pentstemon glaber, Pursh.
Castilleia linariæfolia, Benth.
Orthocarpus luteus, Nutt.
Hedeoma Drummondii, Benth.
Monarda fistulosa, L.
Monardella odoratissima, Benth.
Dracocephalum parviflorum, Benth.
Echinospermum deflexum, Lehm., var.
Echinospermum Redowskii, Lehm.
Heliotropium convolvulaceum, Gr.
Collomia longiflora, Gr.
Gilia pungens, Benth.
Calystegia sepium, R. Br.
Saracha Coronopus, Gr.
Nicotiana attenuata, Torr.
Apocynum cannabinum, L.
Asclepias speciosa, Torr.
Mirabilis oxybaphoides, Gr.
Mirabilis multiflora, Gr.
Alliona incarnata, L.
Abronia fragrans, Nutt.

Abronia cycloptera, Gr.
Cycloloma platyphyllum, Moq.
Atriplex patula, L.
Eurotia lanata, Moq.
Sarcobatus vermiculatus, Torr.
Eriogonum alatum, Torr.
Eriogonum Jamesii, Benth.
Eriogonum umbellatum, Torr.
Eriogonum cernuum, Nutt.
Shepherdia argentea, Nutt.
Euphorbia petaloidea, Englm.
Euphorbia Fendleri, T. & G.
Euphorbia montana, Englm.
Celtis occidentalis, L.
Quercus alba, L., var. Gunnisoni, Torr.
Salix longifolia, Muhl., var.
Populus angulata, Ait.
Populus balsamifera, L., vars.
Corallorhiza multiflora, Nutt.
Cypripedium parviflorum, Salisb.
Yucca angustifolia, Pursh.
Scirpus validus, Vahl.
Muhlenbergia pungens, Thurber.
Calamagrostis longifolia, Hook.
Eriocoma cuspidata, Nutt.
Pleuraphis Jamesii, Torr.
Phragmites communis, L.
Triticum repens, L.
Pteris aquilina, L.
Pellæa gracilis, Hook, La Plata Mountains.
Cheilanthes lanuginosa, Nutt.
Woodsia Oregana, Eaton.

LIST OF MUSCI AND HEPATICÆ COLLECTED IN SOUTHERN COLORADO, MOSTLY BETWEEN 5,000 AND 9,000 FEET ALTITUDE, DETERMINED BY E. A. RAU, WITH THE ASSISTANCE OF C. F. AUSTIN AND T. P. JAMES.

Weissia viridula, Brid.
Weissia cirrhata, Hedw.
Weissia crispula, Hedw.
Weissia crispula, var.—Plants much smaller than in usual forms; leaves dark green, with much closer areolation.—Sierra Madre of Southwestern Colorado.
Gymnostomum rupestre, Schwaegr.—Mancos Valley.
Gymnostomum Brandegei, Austin, new species, Bulletin Torrey Botanical Club, vol. vi, p. 46.—Cañon City.
Dicranum scoparium, L.—Southwestern Colorado.
Dicranum rhabdocarpum, Sulliv.
Dicranum (Campylopus) Rauei, nov. sp., C. F. Austin.

Caule brevi compacte cæspitoso inferne dense tomentoso-radiculoso; foliis erectiusculis, subtortuosis, lineali-lanceolatis, semel tortis valde convoluto-concavis, dorso indistincte papillosis margine ad apicem subserratis; costa angusta, excurrente; reti minuto cellulis angularibus perpaucis paulum inflatis; capsula subcylindrica, erecto-incurva pallida laeviuscula, seta brevi tenui flexuosa, operculo longe rostrato; annulo angusto, calyptra solum, operculi rostrum obtegente: color læte fulvo-virens. Colorado—1875—T. S. Brandegee (Rau). About the size of D. flagellare. Leaves shaped about as in D. flagellare (costa more solid, otherwise similar); once twisted as in D. Schraderi, convolute-concave much as in D. Muhlenbeckii; reticulation much as in D. fulvum. Color, shape, and texture of the capsule also much as in D. Schraderi, but that has a straight and longer pedicel, much larger calyptra, lighter costa, and cells at the base of the leaf more lax, those above more granulose, margins more decidedly serrate, &c., besides it is a much larger species.

Fissidens exiguus, Sulliv.
Desmatodon cernuus, Br. Eu.
Desmatodon latifolius, Br. Eu., var. β. glacialis.
Didymodon rubellus, Br. Eu.

Distichium capillaceum, Br. Eu.
Barbula ruralis, Hedw.
Trichostomum tophaceum, Brid.
Ceratodon purpureus, Brid.
Ceratodon purpureus, var. xanthopus.
Encalypta vulgaris, Hedw.
Encalypta vulgaris, var. obtusa.
Encalypta vulgaris, var. with leaves very obtuse, obovate oblong; costa shorter than in the preceding; peristome pale and fugacious. A fine variety, very distinct from the former, both in shape of the leaves and in the presence of a fine peristome.
Encalypta ciliata, Hedw.
Orthotrichum anomalum, Hedw.
Orthotrichum cupulatum, Hoffm., var. minus.
Orthotrichum Sturmii, H. & H.
Orthotrichum Kingianum, Lesq.
Orthotrichum Watsoni, James.
Coscinodon Wrightii, Sulliv.—Cañon City.
Coscinodon Rauei, Austin, new species, Bulletin Torrey Botanical Club, vol. vi, p. 46.—Cañon City.
Grimmia Brandegei, Austin, new species, Bulletin Torrey Club, vol. vi, p. 47.—Cañon City.
Grimmia obtusa, Schwaegr.
Grimmia calyptrata, Hook.
Grimmia anodon, B. & S.
Grimmia apocarpa, Hedw.
Grimmia apocarpa, var. leaves broader and shorter; peristome paler; teeth narrower.
Grimmia plagiopodia, Hedw.
Grimmia ovata, W. & M.
Tayloria serrata, B. & S.
Funaria hygrometrica, Hedw.
Funaria hygrometrica, var. patula.
Bryum pyriforme, Hedw.
cruduum, Schreb.
nutans, Schreb.
cernuum, Hedw.
intermedium, Brid.
cirrhatum, H. & H.
bimum, Schreb.
pallescens, Schwaegr.
cæspiticium, Linn.
argenteum, Linn.
obconicum, Hornsch.
pseudotriquetrum, Hedw.
turbinatum, Hedw.
turbinatum, var. latifolium.
Mnium cuspidatum, Hedw.
affine, Bland.
serratum, Schrad.
Timmia megapolitana, Hedw.
Polytrichum juniperinum, Hedw.
Fabronia Wrightii, Sulliv.—Cañon City.
Wrightii, var. of a larger growth; leaves less strongly serrate.
Leskea polycarpa, Hedw.

Pseudoleskea atrovirens, Schwaegr., var. brachycladus.
Brachythecium denticulatum, Linn.
rivulare, Br.
collinum, Schp.
collinum, var.
Utahense, James.—Cañon City.
Fendleri, Sulliv.—Cañon City.
Eurynchium strigosum, Hoffm.
diversifolium, Br. Eu.
Amblystegium confervoides, Schwaegr.
minutissimum, S. & L.
serpens, Linn.
orthocladon, Beauv.
radicale, Brid.
compactum, C. Mull.
Stereodon plicatile, Mitt.
Limnobium palustre, Br. Eu.
Hypnum filicinum, Linn.
uncinatum, Hedw.
reptile, Michx, var.
curvifolium, Hedw.

HEPATICÆ.

Marchantia polymorpha, Linn.
Jungermannia pumila, With.
trichophylla, Linn.
Scapania compacta, L.
Reboulia hemisphærica, Rad.

BRIEF SYNOPSIS OF NORTH AMERICAN EARWIGS, WITH AN APPENDIX ON THE FOSSIL SPECIES.

By Samuel H. Scudder.

The following synopsis includes all the species of *Forficulariæ* (thirty-eight in number) known to me from North America and the West Indies. Only fourteen of them occur within the limits of the United States, and of these one (*Forf. Percheroni*) is doubtful, and but nine are indigenous. The introduced species are *Labidura riparia*, *Anisolabis maritima*,* *Forficula Percheroni*, *F. auricularia*, and *Labia minor*. Those which I have not seen, and which are consequently described from the writings of others, with more or less inaccuracy on my part, are preceded by a dagger. Doubtless some of them, and especially those of Fabricius, may be entirely misplaced, or even synonymous with others, as they have not since been recognized, and few if any points of structure enter into the brief descriptions of the older authors. One is necessarily omitted. The descriptions have been made as brief as possible, and no synonymy is given; for the latter the student is referred to my list of described *Forficulariæ* of the whole world, now printing in the eighteenth volume of Proceedings of the Boston Society of Natural History. The length of the body is exclusive of the forceps; and where the colors and length of the wings are mentioned, reference is made only to the portion of the wings which is exposed when the insect is at rest.

I. *Sixth antennal joint much shorter than the first.*

A. *Sixth antennal joint no longer than broad.*

THERMASTRIS. Whole body, but especially the anterior half, much flattened; antennæ very long, composed of more than 30 joints; prosternum pointed anteriorly; tegmina and wings present; first and third tarsal joints equal; second very small, simple; third joint furnished with a pad; second and third abdominal segments without lateral plications; forceps moderately stout, straight, either distant, incurved at tip (♂), or attingent (♀).

Posterior edge of penultimate ventral segment rounded and entire ..... 1. *Chontalia.*

Posterior edge of same rounded, but excised in the middle ..... 2. *Saussurei.*

1. *Chontalia* Scudd. Dull castaneous, the head, thorax, tegmina, and wings uniform black or blackish-brown, Body 18.5mm; forceps ♀ 6.25mm. Nicaragua.

†2. *Saussurei* Dohrn. Rufo-piceous, the elytra and wings rufo-fuscous, but the latter yellow on inner half; base of femora, apex of tibiæ, and whole of tarsi yellow. Body 19mm; forceps ♂ 5mm. Mexico.

* This may be indigenous, but it occurs over nearly the whole world.

I. *Sixth antennal joint much shorter than the first.*

B. *Sixth antennal joint nearly or quite twice as long as broad.*

1. First antennal joint as long as the fourth to the sixth joints inclusive.

a. Furnished with both tegmina and wings.

* Antennæ with more than twenty joints.

LABIDURA. Body flattened only in front, the abdomen tumid, especially above. Antennæ a little more than half as long as the body, the first joint enlarging much toward the tip; prosternum of equal width in front and behind. Tegmina and wings present; first tarsal joint equal to the other two, the second simple, third with no pad; second and third abdominal segments without lateral plications; forceps moderately stout, rather simple, slightly arcuate, distant at base (♂), or straight, incurved at tip, approximate (♀).

1. *riparia* Pall. A very variable species, but usually with the head dark castaneous; pronotum and tegmina dark fuscous, with an inner pale band; wings fuscous, pale interiorly; abdomen blackish above, castaneous on sides and also on dorsum of last segment; the legs luteous; antennæ with 27–30 joints; forceps of male with a slight tooth beyond middle of inner edge. Length 20mm; forceps: ♂ generally about half the length of body, but sometimes much more; ♀ 5mm. Texas, Florida, Cuba, Mexico, (and nearly the whole world).

[*Labidura advena* Mein. from Jamaica is unknown to me, and the description inaccessible.]

** Antennæ with less than twenty joints.

PSALIS. Body stout, the abdomen rather tumid; antennæ less than half as long as the body, the first joint long and increasing but little in size apically; prosternum broadening anteriorly. Tegmina and wings present; first tarsal joint equal to the other two, the second simple, the third padless; no lateral plications on abdomen; forceps slender, cylindrical, arcuate, widely distant (♂), or stout, trigonate at base, attingent, straight, and incurved at tip (♀).

a. Wings extending conspicuously beyond the tegmina..*b.*
Wings extending but slightly beyond the tegmina, 1. *gagatina.*

b. Tegmina with a light-colored spot on darker ground, 2. *procera.*
Tegmina unicolorous..... 3. *americana.*

†1. *gagatina* Klug. Shining piceous, the thirteenth and fourteenth and sometimes the adjoining joints of antennæ pale; tarsi and tibiæ rufous at the tip. Tegmina short; abdomen punctulate. Length 19mm; forceps 4–5mm. Porto Rico.

I. *Sixth antennal joint much shorter than the first.*

2. *procera* Burm. Shining castaneo-piceous, the mouth-parts castaneo-luteous, the antennæ brown, paler toward the tip, the legs luteous, the tegmina with a large rufo-luteous spot. Length 22mm; forceps, ♂ 9mm, ♀ 6mm. West Indies and Central America (as well as northern parts of South America).

†3. *americana* Pal. Castaneous; mouth-parts and legs fulvous; antennæ 18-jointed; tegmina uniform in coloring throughout; forceps of female strongly incurved at the tip, denticulate on the basal half of inner margin. Body 21mm; forceps ♀ 9mm. St. Domingo and other parts of the West Indies and Central America.

b. Possessed of neither tegmina nor wings.

ANISOLABIS. Body long and slender, wholly apterous, of nearly equal width throughout; antennæ scarcely half as long as the body, with about 20 joints; first and last tarsal joints of about equal length, the second small, simple; second and third abdominal segments with very slight lateral plications; forceps short, rather stout, arcuate, similar in the two sexes, except in being much more arcuate in the male and generally a little asymmetrical.

{ Femora broadly annulated with fuscous..... 1. *azteca.*
{ Femora unicolorous .....2. *maritima*

†1. *azteca* Dohrn. Piceous, very delicately punctulate; tibiæ and tarsi testaceous; femora broadly annulate in the middle with fuscous, the ninth joint of the antennæ pale, the rest rufo-testaceous, like the mouth-parts. Body 9mm; forceps 1mm. Mexico.

2. *maritima* Bon. Blackish mahogany-brown; mouth-parts and legs luteous; antennæ luteous, more or less infuscated, the ninth joint of the same color as the rest. Body 18mm; forceps 3mm. North Carolina, South Carolina, Key West, Bermuda, Nicaragua (and nearly the whole temperate and subtropical world).

2. First antennal joint no longer than the fourth and fifth joints together.

SPONGOPHORA. Whole body flattened, long, and slender, the sides of the abdomen straight; antennæ more than half the length of the abdomen, 15–20-jointed, the joints rather long; tegmina and wings present; first tarsal joint longer than the other two together, the third scarcely longer than the simple second joint; pad minute; second and third abdominal segments with lateral plications; forceps very long, generally nearly straight, and either separated with a few teeth on inner edge (♂), or attingent and nearly or quite unarmed (♀).

I. *Sixth antennal joint much shorter than the first.*

a. Forceps longer than pronotum, tegmina, and wings together ..... b.
Forceps shorter than pronotum, tegmina, and wings together ..... 1. *brunneipennis.*

b. Exposed part of wings unicolorous ..... c.
Exposed part of wings black, with a colored spot on them ..... 2. *prolixa.*

c. Hind border of abdominal segments 3–5 beaded with a row of tubercles above ..... 3. *parallela.*
Hind border of abdominal segments 3–5 longitudinally and profusely striate above ..... 4. *forfex.*

1. *brunneipennis* Serv. Head, thorax, and tegmina blackish-castaneous; abdomen dark rich castaneous; wings yellow, edged within, and at apex with dark castaneous; palpi luteous; antennæ 14–15-jointed, brownish-luteous; legs honey-yellow; forceps half as long as abdomen, simple, straight, incurved at tip with a quadrate basal tooth within (♀), or two-thirds as long as abdomen, straight, incurved at extreme tip with a more or less prominent inner tooth before the middle or in middle of basal half. Body 9mm; forceps, ♂ 4mm, ♀ 3mm. Pennsylvania and Kentucky to Florida, Texas, Arizona, and Mexico.
2. *prolixa* Scudd. Blackish, the abdomen more or less tinged with castaneous; wings with a conspicuous fulvous spot; palpi, antennæ, and legs brownish-luteous, the latter more or less obscured with fuscous, and tinged with castaneous; forceps (♂) very variable and slender, either nearly as long as the body, straight and slender, incurved at tip with a minute tooth before the middle of basal half, or not much longer than the abdomen, straight to beyond the middle, beyond bent abruptly inward, still straight but sinuous, the inner edge with a median spinous tooth. Body 23mm. Mexico.
3. *parallela* Westw. Blackish-castaneous; tegmina reddish-brown; wings uniform tawny; palpi and antennæ brownish-fuscous; legs infuscated reddish-brown; forceps (♂) as long as the body, very slender, straight, but incurved at extreme tip with a minute tooth at or before the middle of basal half. Length 17mm. Mexico, Nicaragua.
4. *forfex* Scudd. Dark castaneous-brown; mouth-parts scarcely paler; antennæ castaneous, infuscated beyond the base; legs luteo-castaneous, the front of femora blackish-fuscous; wings pale mahogany-brown. Forceps (♂) nearly as long as the body, very slender, straight but incurved at extreme tip, with a minute tooth just before the middle of the inner edge. Length 22mm. Locality unknown; probably Central America.

II. *Sixth antennal joint as long, or very nearly as long, as the first.*

A. *Sixth antennal joint cylindrical, many times longer than broad.*

1. A minute scutellum exposed.

NEOLOBOPHORA. Head and thorax depressed; abdomen unusually tumid, subcylindrical, the sides full; antennæ more than half as long as the body, with less than twelve joints, mostly long and cylindrical; tegmina present; wings absent; first tarsal joint but little longer than the third, the second minute but produced below the third and bilobate; third joint without pad; second and third abdominal segments with distinct lateral plications; forceps long, slender, simple, nearly or quite attingent, unarmed, nearly or quite straight, and longer in the male than in the female.

1. *volsella* Scudd. Head reddish; rest of body black; mouth-parts and antennæ blackish, tinged with red, the latter growing paler toward tip; tegmina nearly square; legs luteous, with the apical half of the femora black; forceps reddish (♀), or black, reddish at base (♂), with a slight tooth in the middle of inner edge in male. Body 12mm; forceps, ♂ 10.5mm, ♀ 5mm. Mexico.

2. No scutellum exposed between base of closed tegmina.

a. Abdomen greatly expanded in middle; penultimate and antepenultimate dorsal segments in male very short.

ANCISTROGASTER. Body depressed, but abdomen somewhat tumid as well as broadly expanded in the middle; antennæ nearly as long as the body, 12-jointed, the joints unusually long; tegmina and wings present; legs long and slender, first and last tarsal joint nearly of the same length, the second short but produced far below the third and bilobed; third joint without pad; second and third abdominal joints with lateral plications, and fourth and fifth joints with extreme lateral posterior prolongations; forceps not so long as abdomen, subcylindrical, either straight, attingent, simple (♀), or strongly bowed, the tip expanded and toothed, the extreme base with an inner tooth (♂).

Sides of fourth and fifth abdominal segments slightly and sharply produced posteriorly ..... 1. *gulosa.*
Sides of third, fourth, and fifth abdominal segments greatly and sharply produced posteriorly ..... 2. *spinax.*

1. *gulosa* Scudd. Very dark brown; palpi and antennæ pale brown; wings pale dull luteous; posterior prolongations of fourth and fifth segments inconspicuous; legs dull luteous, more or less infuscated; forceps of the male with the tip depressed laminate, either extremity of it produced to a fine point, the middle of inner border smooth. Body 11mm; forceps, ♂ 4mm, ♀ 3mm. Mexico.

II. *Sixth antennal joint as long, or very nearly as long, as the first.*

† 2. *spinax* Dohrn. Blackish; eighth segment of antennæ pale at tip; base and extreme tip of wings and whole of tarsi pale yellow; third, fourth, and fifth dorsal segments of abdomen conspicuously prolonged laterally in a backward curve, tapering and pointed; forceps of male with the tip bearing a backward-directed hook, and the middle of inner border denticulate. Body 11mm; forceps 4mm. Mexico.

b. Abdomen but little or not at all expanded in the middle; all the dorsal segments before the last of nearly equal length in both sexes.

FORFICULA. Whole body more or less flattened, generally long and slender; antennæ usually a little more than half as long as the body, 10–14-jointed, the joints cylindrical, scarcely larger at the apex than at the base, seldom as little as four times as long as broad; tegmina present; wings usually present; first tarsal joint a little longer than the third, the second short, but dilated apically and lobate, passing beneath the third joint; second and third abdominal segments with lateral plications; forceps of varied construction.

a. Wings protruding beyond the tips of the tegmina....*b.*
Wings wanting, or shorter than the tegmina.....*k.*

b. A large pale spot at base of tegmina.....*c.*
Tegmina concolorous or vittate.....*d.*

c. Wings unicolorous; forceps slender.....2. *bimaculata.*
Wings bicolorous; forceps stout.....3. *Percheroni.*

d. Male forceps with an inward and upward directed basal lamella.....4. *lugubris.*
Male forceps with no such lamella.....*e.*

e. Middle legs very much nearer the fore legs than the hind legs.....*f.*
Middle legs only a little nearer the fore legs than the hind legs.....*h.*

f. Male forceps attingent at extreme base..5. *auricularia.*
Male forceps widely separated at extreme base.....*g.*

g. Tegmina longitudinally vittate.....6. *tæniata.*
Tegmina concolorous.....7. *tolteca.*

h. Inner edge of male forceps with a post-median tooth, 8. *exilis.*
Inner edge of male forceps with no distinct post-median tooth.....*i.*

i. Inner edge of male forceps sharply and profusely denticulate.....9. *californica.*
Inner edge of male forceps with a single sharp basal tooth.....10. *pulchella.*

k. Forceps of male long, but shorter than abdomen, only a little curved.....11. *aculeata.*
Forceps of male longer than abdomen, but little curved.....12. *ruficeps.*
Forceps of male short, strongly bowed.....13. *vara.*

II. *Sixth antennal joint as long, or very nearly as long, as the first.*

(*F. albipes* and *F. elongata*, known only from the short descriptions of Fabricius, are not inserted in this table, and the descriptions of them below are but adapted translations from Fabricius's Entomologia Systematica.)

† 1. *albipes* Fabr. Black; mouth-parts pale; antennæ fuscous; posterior border of thorax, base of tegmina, wings and legs whitish; abdomen shining, the borders of the segments reddish; forceps small, black; of medium size. West Indies.

† 2. *bimaculata* Pal. Dark ferruginous; sides of prothorax pale; base of tegmina with a large, oval, pale yellow spot; wings wholly pale yellow; antennæ, palpi, and legs brown; forceps of ♀ small, simple, slender, incurved at tip. Body 12mm; forceps 2.5mm. St. Domingo.

3. *Percheroni* Guer. Head, thorax, and legs tawny; antennæ brownish, with two middle joints tawny; tegmina and abdomen black, the former with a large, basal, yellow spot, not reaching the suture; wings yellow at base, black at tip; forceps rather stout, simple, incurved. Body 18.5mm; forceps 4mm. Described from Cayenne, but is presumed to have been found in Massachusetts in a single instance, since there is a specimen in the Harris collection (described by me as *Spongophora bipunctata*), catalogued "May 20, 1827, from Z. Cook, esq."

† 4. *lugubris* Dohrn. Shining piceous; palpi and antennæ reddish-brown; prothorax narrower than the head, yellow on the sides and at extreme hind border; tegmina a little longer than the prothorax; wings with a yellow dot at end of inner margin; legs ferruginous; forceps of male about half as long as the body, slender, bent a little inward next the base, then strongly outward and incurved at tip, subcristate on basal third. Body 10mm; forceps 4–6mm. Mexico.

5. *auricularia* Linn. Fusco-ferruginous; antennæ 14–15-jointed; basal joint, sides of pronotum, and legs testaceous; tegmina and wings dull luteous, the former half as long again as the pronotum; forceps of male usually as long as the abdomen, horizontal, depressed, and dilated at the base, and beyond rather strongly arcuate, tapering to a point, the extreme base of inner edge tuberculato-denticulate, with a distinct inner tooth at base of arcuate portion. Body (average) 11mm; forceps, ♂ 4–8mm, ♀ 3mm. New York, Cuba (Para, Europe, Northern Africa, Western Asia, Madeira). The only New York male I have seen has short forceps. It is undoubtedly an introduced insect.

6. *tæniata* Dohrn. Piceous; head rufous; antennæ 12-jointed, rufous; mouth-parts and sides of prothorax testaceous; tegmina and wings luteo-testaceous, their inner margin rather broadly edged with black;

II. *Sixth antennal joint as long, c. very nearly as long, as the first.*

legs luteo-testaceous; forceps of male more than half as long as the abdomen, gently arcuate, the inner edge slightly angulated at end of basal third, the whole tuberculate, with a pre-apical slightly inferior tooth. Body 11–15^{mm}; forceps, ♂ 4.5–5.5^{mm}, ♀ 3–3.5^{mm}. Cuba, Arizona, Texas, Mexico, Guatemala, Panama (Brazil).

7. *tolteca* Scudd. Head rufous; palpi and base of antennæ as well as prothorax luteous, rest of antennæ light brown, the tenth joint pale; tegmina dark brown, twice as long as pronotum; wings and legs luteous; abdomen dark castaneous; whole body sparsely pilose; forceps of female more than half as long as abdomen, simple. Body 8^{mm}; forceps 2.4^{mm}. Mexico.

8. *exilis* Scudd. Mahogany-brown, the pronotum rufo-luteous; palpi brownish-luteous; antennæ reddish-brown; tegmina nearly twice as long as pronotum, and with the wings and legs luteous; forceps of male very slender, more than half as long as the abdomen, gently arcuate, slightly expanded interiorly at the base, the basal half of inner edge denticulato-tuberculate, the middle of apical half with a slight tooth. Body 10.5^{mm}; forceps 3.75^{mm}. Texas.

†9. *californica* Dohrn. Castaneo-fuscous; pronotum rather narrower than the head, longer than broad, the sides testaceous; tegmina twice as long as pronotum and like the wings testaceous, the suture broadly fuscous; legs testaceous; forceps of male less than half as long as the body, rather broad at the base, gently arcuate, the inner margin sharply and profusely denticulate, smooth beyond the middle. Body 10^{mm}; forceps 3^{mm}. California.

†10. *pulchella* Serv. Head blackish; antennæ 11-jointed (?), brownish, paler at the base; pronotum brown, the sides and posterior margin paler; tegmina brown; wings yellow, edged with brown; abdomen reddish-brown; forceps of male arcuate in the middle, pointed, with an inner tooth near the base. Body 8; forceps, ♂ 5^{mm}, ♀ 2.5^{mm}. Niagara, N. Y.

11. *aculeata* Scudd. Dark castaneous; palpi luteous; antennæ 12-jointed, dark brown; pronotum longer than broad, narrower than the head, the sides pale luteous; tegmina nearly twice as long as the pronotum, luteous, broadly margined with fuscous interiorly; legs luteous; forceps of male three-fourths as long as the abdomen, slender, arcuate, bent downward a little beyond the base, and again horizontal a little before the tip, with a slight pointed tooth at end of descending portion; pygidium aculeate. Body 11^{mm}; forceps, ♂ 5^{mm}, ♀ 3.5^{mm}. New York, Northern Illinois, Southern Michigan.

†12. *ruficeps* Burm. Black, the head and antennæ reddish-brown; prothorax as broad as the head; tegmina somewhat longer than the pronotum; femora black,

II. *Sixth antennal joint as long, or very nearly as long, as the first.*

griseous at base; tibiæ reddish-brown; tarsi yellow; forceps of male nearly as long as the body, nearly straight, incurved at tip, with a median inner tooth. Body 14mm; forceps, ♂ 11mm, ♀ 5mm. Mexico.

13. *vara* Scudd. Dark maghogany-brown, the prothorax a little lighter; palpi and antennæ dark luteous, the latter 11–12-jointed; pronotum scarcely as long as broad, as broad as the head, the sides dull luteous; tegmina a little longer than the pronotum, dark brown; legs luteous; forceps of male less than half as long as abdomen, strongly arcuate, and also sinuate when viewed laterally; inner edge minutely denticulate at base, beyond crenulate. Body 8mm; forceps, ♂ 3mm, ♀ 2.6mm. Mexico.

†14. *elongata* Fabr. Dark fuscous; head ferruginous; antennæ yellowish; margin of prothorax pale; tegmina and legs uniform pale; abdomen dull ferruginous in the middle, darker at the end; forceps long, arcuate, pale at base, fuscous at tip, with a single basal inner tooth of medium size. West Indies.

B. *Sixth antennal joint plainly obconic.*

LABIA. Of small size. Whole body flattened, long, and slender; the abdomen occasionally a very little tumid; antennæ about half as long as the body, 10–13-jointed, the joints moniliform or obconico-fusiform, seldom more than three times as long as broad; tegmina present; wings present or absent; first and third tarsal joints equal, the second minute, perfectly simple, compressed; second and third abdominal segments with lateral plications; forceps seldom more than half as long as the abdomen, in the male generally simple, arcuate, horizontal; in the female simple, straight, incurved at tip, unarmed.

a. Wings wanting, or shorter than the tegmina.....*b.*
Wings protruding beyond the tips of the tegmina....*c.*

b. Last ventral segment of male very broadly rounded posteriorly, half as long as broad.....1. *Burgessi.*
Last ventral segment of male one-third as long as broad, the posterior border very convex.....2. *brunnea.*

c. Forceps of female flattened beneath, with sharp lateral edges.....*d.*
Forceps of female scarcely flattened beneath, with rounded lateral edges.....*e.*

d. Exposed part of wings, with a distinct yellow spot, 3. *guttata.*
Exposed part of wings unicolorous.....4. *melancholica.*

e. Last ventral segment of male with a long apical tubercle.....5. *minor.*
Last ventral segment of male (probably always) entire, *f.*

f. Lateral tubercle of third abdominal segment prominent, rounded.....6. *unidentata.*
Lateral tubercle of third abdominal segment scarcely more prominent than that of the second, 7. *rotundata.*

(*L. annulata*, known only by the description of Fabricius, is not included in this table.)

II. *Sixth antennal joint as long, or very nearly as long, as the first.*

1. *Burgessi* Scudd. Dark castaneous, the pronotum fusco-luteous; antennæ 13-jointed, the basal joints and the palpi luteous, darker beyond; tegmina fusco-luteous, but little longer than the pronotum; legs pale luteous; forceps of male about half as long as abdomen, slender, gently arcuate, with a large sub-basal and smaller postmedian tooth, the former depressed laminate. Body, ♂ 7–8mm, ♀ 8–9mm; forceps, ♂ 3mm, ♀ 2.5mm. Northern Florida.
2. *brunnea* Scudd. Dark castaneous; mouth-parts and antennæ somewhat luteous, the latter 11-jointed; pronotum nearly as broad as the head, of equal length and breadth, paler at the sides; tegmina castaneo-fuscous, fully half as long as the pronotum; legs castaneo-luteous; forceps of male a little more than half as long as the abdomen, simple, very gently arcuate, with a slight basal and pre-apical tooth on inner edge. Body 6.5mm; forceps, ♂ 2.25mm. Cuba.
3. *guttata* Scudd. Blackish-castaneous, the pronotum, tegmina, and especially the apical third of abdomen a little lighter; antennæ 12–13-jointed, at base luteous, like the palpi, beyond duskier; pronotum slightly narrower than the head in front, equal to it behind; edges fusco-luteous; tegmina half as long again as the pronotum; wings half as long as tegmina, brownish-fuscous, with a luteous spot in middle of base; legs bright luteous; forceps of male rather slender, rather more than half as long as the abdomen, shaped as in *L. Burgessi;* last ventral segment of male with an apical tubercle, long, equal, and very slender. Body 6mm; forceps 2.5mm. Texas.
4. *melancholica* Scudd. Blackish-castaneous, shining; antennæ 13-jointed, bright luteous at base, like the palpi, beyond infuscated, the tip dusky; pronotum as broad as the head posteriorly, a little longer than broad, the sides and hind border dark luteous; tegmina nearly twice as long as pronotum; wings nearly two-thirds as long as tegmina; legs luteous; forceps of male unknown, of female longer than usual, moderately stout, simple, straight, incurved at tip. Body 8.25mm; forceps 2mm. Texas.
5. *minor* Linn. Testaceous, pubescent. Head blackish; antennæ 10–12-jointed, fuscous; mouth-parts pale; pronotum narrower than the head, behind, as well as in front, scarcely longer than broad; tegmina nearly twice as long as the pronotum, the wings as long as the pronotum; legs pale luteous; abdomen rufo-testaceous in the middle above; forceps of male considerably more than half as long as the abdomen, rather heavy, distantly serrulate on inner edge; last ventral segment of male with an apical, compressed, upcurved, long, and slender tubercle. Body 3.75–6mm; forceps, ♂ 1.25–2mm, ♀ slightly less. Maine, New Hampshire, Massachusetts, Maryland, Virginia, Texas (Europe, Siberia, Madeira).

II. *Sixth antennal joint as long, or very nearly as long, as the first.*

† 6. *unidentata* Pal. Ferruginous; antennæ paler, 11-jointed; pronotum also paler, no longer than broad, scarcely narrower than the head; tegmina twice as long as the pronotum; wings pale yellowish, as long as the pronotum; legs pale ferruginous; forceps (of female?) nearly straight, scarcely bent inward, with a small postmedian inner tooth, the apex blunt, incurved. Body 7mm; forceps 2mm. St. Domingo.

7. *rotundata* Scudd. Dark mahogany-brown; antennæ 10-jointed, the basal joint, like the palpi, reddish-brown, beyond duskier; pronotum nearly as broad as the head, scarcely longer than broad, reddish-luteous, paler on sides; tegmina about half as long again as the pronotum, brownish luteous; wings blackish; legs luteous; abdomen broad, blackish toward the base; forceps of male unknown, of female scarcely one-third as long as the abdomen, simple, separated, straight, incurved at tip. Body 6mm; forceps 1.5mm. Mexico.

† 8. *annulata* Fabr. Black; antennæ 13-jointed, the first and penultimate joints with the mouth-parts pale; pronotum flat, the margin pale; legs pale, the femora with a fuscous annulation; forceps short, unarmed. Of small size. West Indies.

Index of species.

Note on the fossil species.

In this bulletin (II, 447–448), to which the reader is referred for full particulars, I described *Labidura tertiaria* from the Tertiary beds near Castello's ranch, South Park, Colo. By some accident, I described the single specimen known as a female; it is a male. A second specimen of this species, too broken to determine the sex, from near Florissant, Colo. (perhaps the same locality as the preceding), has been kindly placed in my hands by Prof. A. E. Foote. It shows that the species should hardly be referred to *Labidura*, but it seems to agree quite as little with any other living genus. Both the specimens, however, are too imperfect in the parts necessary to be studied in determining genera in this group, and especially in the tarsal and antennal joints, to warrant any change, and I await more material to determine the precise relationship of the animal.

Another specimen from near Florissant (Prof. A. E. Foote) evidently belongs to the same genus as the preceding, but differs specifically, and may be called *Labidura lithophila*. It is a female; the body is much flatter than that of *Labidura tertiaria*, the abdomen being equal on a side-view, and the whole surface appears to be minutely punctulate; the

form of the head cannot be determined; the antennæ approach in length the body, the first joint nearly cylindrical, scarcely enlarging at the tip, about four times as long as broad; the comparative or actual length of the succeeding joints cannot be determined; the prothorax has its hinder margin entire and flat; the tegmina are a little longer than the prothorax, their hinder edge straight and apparently oblique; the wings appear to have surpassed the tegmina; the legs are very short (especially the femora) and not stout; the abdominal joints are of equal length; the forceps are peculiar, having the appearance of being strongly bowed, although the specimen is a female; they are very stout at the base, rapidly and regularly diminish in size on the basal half (which is about equal in length to two-thirds the last abdominal joint), beyond which they are equal, about half as stout as the base, bent apparently rather strongly inward, and very broadly rounded at the tip, a form of forceps I have never seen in any living earwig. Length of body, including forceps, 14.5^{mm}; of antennæ, 11^{mm}; of pronotum, 1.85^{mm}; of tegmina, 2.5^{mm}; of hind femora, 1.8^{mm}; of forceps, 2.25^{mm}.

LIST OF THE ORTHOPTERA COLLECTED BY DR. A. S. PACKARD IN COLORADO AND THE NEIGHBORING TERRITORIES, DURING THE SUMMER OF 1875.

By Samuel H. Scudder.

1. A species of Locustarian, belonging near *Epphippiger*, is represented in the collection by a larva and two pupæ, taken on the foot-hills at the entrance to Clear Creek Cañon, July 3. It differs structurally from anything with which I am familiar.

2. *Scudderia* sp. Two pupæ, probably belonging to *S. curvicauda* (DeG.) Stål, were taken at Manitou, Colo., July 14.

3. *Xiphidium* sp. A single pupa, probably belonging to *X. saltans* Scudd. or perhaps to *X. ensiforme* Scudd., was taken in gardens at Salt Lake City, July 2.

4. *Ceuthophilus pallidus* Thom. A number of specimens, both ♂ and ♀, which I refer with some doubt to this species, were taken under rotten pine logs in Idaho, Colo., July 5. A single specimen, very young, was taken at Williams Cañon, Manitou, Colo., July 15.

5. *Stenopelmatus oculatus* nov. sp. This insect is closely allied to the typical *S. talpa* Burm., but differs from it conspicuously in the great prominence of the eyes, which are subpedunculated, being, with their base, as high as broad; the head is immense, globose, the prothorax narrows rapidly behind, the legs are exceedingly stout, with spines arranged as in *S. fasciatus* Thom. Length, 30^{mm}; breadth of head, 12^{mm}; length of hind femora, 13^{mm}; of cerci, 3.5^{mm}. 1 ♂. Utah.

6. *Caloptenus bivittatus* (Say). 3 ♂, Salt Lake City, gardens, July 21, where it was more common than *C. spretus*; 1 ♀, foot-hills, at entrance to Clear Creek Cañon, July 3.

7. *Caloptenus fasciatus* Scudd. 1 ♂, Golden, Colo., July 3; 2 ♀ and pupæ, on foot-hills at entrance of Clear Creek Cañon, July 3; 1 ♀, Garden of the Gods, Colo., July 13; 2 ♂, Lake Point, Salt Lake, July 26, when *C. spretus* was not seen.

8. *Caloptenus occidentalis* Thom. I refer a single male taken at Lake Point, Salt Lake, July 27, to this species; but it has reddish hind tibiæ, and may be distinct.

9. *Caloptenus spretus* Uhl. In abundance (pupa aud imago) at Warrensburgh, Mo., June 5; 1 ♂, 2 ♀, Boulder, Colo., June 28; 1 ♂, 6 pupæ, Blackhawk, Colo., July 2; 4 pupæ, on foot-hills at entrance Clear Creek Cañon, July 3; 2 ♀, summit of Pike's Peak, July 4; young, Williams Cañon, Manitou, Colo., July 15. Those taken on Pike's Peak had slightly shorter wings than the others.

10. *Caloptenus minor* Scudd. A single female, apparently of this species, but having reddish hind tibiæ, was taken at Salt Lake City July 21. It was not common in the imago-state; but pupæ, supposed to belong to this species, were seen.

11. *Pezotettix Dodgei* Thom. A pair of specimens taken in American Fork Cañon, Utah, are provisionally referred to this species, the descrip-

tion of which is insufficient. They differ from the description in the comparative length of the tegmina and hind femora, and in the color of the latter. In these specimens, they measure as follows: tegmina, ♂ 3.5mm; ♀ 4.5mm; hind femora, ♂ ♀ 10mm.

HESPEROTETTIX *nov. gen.* (ἕσπερος, τέττιξ).

Allied to *Pezotettix* and *Caloptenus*. Head not very prominent; vertex very narrow between the eyes, with a slight median pit; the fastigium broadening considerably in front, declivant, shallowly sulcate in the middle, the sides rounded; front straight, a little (♀) or considerably (♂) oblique; the frontal costa equal, scarcely contracted at the extreme summit; antennæ slightly longer than the head and prothorax together; eyes slightly prominent, a little more so in the male than in the female. Pronotum rather long, nearly equal, broadening a very little posteriorly, transversely arched, with a scarcely perceptible median tectiform carina and well-rounded lateral margins; the hind scarcely longer than the front lobe; the hind border delicately marginate, obtuse-angled; prosternal thorn rather long, conical, compressed, bluntly pointed; meso- and metastethia together much longer than broad. Tegmina and wings reaching the tip of the abdomen. Femora as long as the abdomen, the superior carina slight, unarmed; hind tibiæ slender, the spines of either side of equal length, scarcely diverging, the upper lateral margins smooth and rounded; first joint of hind tarsi scarcely longer than the third, the second small, with a large inferior apical lobe; pulvillus large, nearly twice as long as broad.

12. *Hesperotettix viridis* (*Ommatolampis viridis* Thom.). 1 ♂, Lake Point, Salt Lake, July 26.

13. *Mermiria neomexicana* (*Opomola* (sic!) *neomexicana* Thom.). Two pupæ were brought home, one from the foot-hills at the entrance to Clear Creek Cañon, July 3, the other from Williams Cañon, Manitou, Colo., July 15.

14. *Chrysochraon deorum* nov. sp. Head large, prominent; fastigium of vertex broad, scarcely acute-angled in front; lateral foveolæ scarcely depressed, subquadrate, nearly twice as long as broad, the inner angle rounded, the edges shining; frontal costa with straight edges, scarcely broadening below, flat, distantly punctate in two rows, below the ocellus vanishing; whole front faintly and very sparsely punctate, the cheeks smooth. Pronotum gently constricted in the middle, the front border a little full, the hind border very obtusely angled; median carina equal, slight. The general color is brown, the face and antennæ with a reddish tinge, the cheeks a little ashen, the vertex pallid, with a pair of narrow, blackish stripes next the upper edge of the eyes, which follow along and are intenser upon the lateral edges of the fastigium, and extend backward to the pronotum. There is a broad dusky band behind the middle of the eyes, which extends over the lateral margin of the pronotal disk, broken by a slender, oblique, yellowish-brown line, which extends forward from the base of the tegmina, and, having divided this belt, faintly follows its upper margin to the eye. The tegmina are shorter than the abdomen, pallid, brown on the basal third of the upper area, the basal two-thirds of the median area, and the upper edge of the lower area; beyond, a few coarse brownish flecks. Wings scarcely shorter than the tegmina, pellucid, the upper veins dusky, the middle ones bluish. Hind femora reddish-brown, more or less infuscated along the upper margin, the apex black; hind tibiæ red, black at extreme base, the spines red at base, black at tip; abdomen yellowish, tinged

above with orange. Length of body, 15mm; of antennæ, 8.25mm; of tegmina, 8.25mm; of hind femora, 10mm. A single male was taken in the Garden of the Gods, Colo., July 13.

15. *Scyllina delicatula* nov. sp. Fastigium of vertex moderately broad, with prominent margins, slightly approaching each other in a curve posteriorly, acute-angled in front; lateral foveolæ rather large, rhomboidal, closely approximate; frontal costa with straight sides, regularly divergent, rather deeply sulcate, sparsely punctate, like the rest of the face; cheeks smooth; antennæ about as long as the head and pronotum together. Pronotum obtuse-angled posteriorly, the median carina equal, moderately prominent, severed scarcely in advance of the middle; the lateral lobes with a secondary, blunt, irregular, rugulose carina, extending from a little above the middle of the front border to the posterior extremity of the lateral carinæ. Color dusky-brown above, ashen or yellowish brown below, the front pallid brownish, the cheeks and vertex livid, the latter with a pair of dusky streaks extending backward from the lateral carinæ of the fastigium. Pronotum enlivened above with a reddish tinge, the lateral lobes more or less marked with blackish above, the lower third pale yellowish, with a yellowish longitudinal ruga on the middle of the posterior half. Tegmina surpassing the femora, fuliginopellucid, flecked with small, quadrate, more or less distinct, blackish spots along the median area, the base of upper area and the veins brown; wings scarcely shorter than the tegmina, pellucid, with a slight fuliginous stigma next the extremity of the front margin, the veins of the upper half of the wing blackish. Hind femora extending much beyond the abdomen, bluish livid, with a basal dash, and an oblique premedian streak of black on the outer side and above, and a slight infuscation along the upper margin; hind tibiæ pale reddish, the color fading toward the base; spines tipped with black. Length of body, 12.5mm; of antennæ, 5mm; of tegmina, 13mm; of hind femora, 8.5mm. 2 ♂, Garden of the Gods, Colo., July 13.

16. *Arphia luteola* Scudd. 1 ♂, Denver, Colo.; 1 ♀, Utah.

17. *Arphia arcta* nov. sp. Head grayish-brown above, yellowish elsewhere, the median carina of vertex broken at the posterior limit of the fastigium by the deeply-impressed, arcuate, transverse furrow, which marks the same, extending through the frontal costa nearly to the ocellus, expanding and forming an oval loop at the extremity; lateral foveolæ strongly depressed, narrowing interiorly. Pronotum grayish-brown, the upper surface unusually flat for an *Arphia*, rugulose, the median carina but little elevated, not laterally pinched in the middle, regularly, though but slightly, diminishing in height posteriorly. Tegmina profusely sprinkled with very small grayish-fuscous spots, less abundant apically, where it is pellucid. Wings yellow at the base, pellucid to an unusual extent at the tip (nearly one-third of the anteanal field is included in the pellucid area), making the transverse dusky band narrower than in any species of *Arphia* known to me; the radial shoot toward the base is, however, unusually broad and long, equaling at its origin the entire breadth of that part of the wing, and scarcely stopping short of the base. Hind femora brownish-yellow externally, with two broad, a little oblique, dusky, transverse bands; hind tibiæ pale yellow, with a broad fuscous cloud at the tip and just before the middle. Length of body, 21mm; of antennæ, 8.5mm; of tegmina, 22.5mm; of hind femora, 11.5mm. 1 ♂, Denver, Colo.

This species is more closely allied to the preceding than to any described species, but is smaller and differs from it in the narrowness of

the band on the wings, and in the structure of the upper surface of the pronotum.

18. *Hippiscus neglectus* (*Œdipoda neglecta* Thom.). 1 ♂, 1 ♀, Blackhawk, Colo., July 2; Manitou, Colo., July 14. I place this species temporarily in this group, to which it is somewhat closely allied, but from which it should doubtless be separated.

19. *Hippiscus Haldemanni* (*Œdipoda Haldemanni* Scudd.). 2 ♀, Garden of the Gods, Colo., July 13.

20. *Hippiscus corallipes* (*Œdipoda corallipes* Hald.). 1 ♂, 1 ♀, Boulder, Colo., June 29.

MESTOBREGMA (μεστός, βρέγμα) *nov. gen.*

Somewhat allied to *Psinidia* Stål. Head large; face horizontal; vertex tumid, but not so elevated as in *Psinidia*, broad between the eyes, the fastigium quadrate, depressed, with very high and abrupt lateral and frontal carinæ, which form the continuation of the sides of the equal, completely sulcate frontal costa; lateral foveolæ small, depressed, rudely semicircular, the ocelli situated beneath their outer extremity; eyes small, moderately prominent, but little longer and not so broad as the space between them; antenna (♀) about as long as the hind femora. Pronotum posteriorly as broad as the head, somewhat constricted in the middle, the hind lobe scarcely longer than the front, the posterior border rectangular; median carina moderately conspicuous, slightly higher on the front than on the hind lobe, twice deeply cleft, the transverse sulcations extending into the lateral lobes; lateral carinæ of posterior lobe prominent; surface of hind lobe nearly flat, pretty smooth; front lobe with a few oblique rugæ and small tubercles. Tegmina and wings surpassing the abdomen, the axillary vein of the former free; hind femora as long as the abdomen.

21. *Mestobregma Plattei* (*Œdipoda Plattei* Thom.). 1 ♀, Boulder, Colo., June 29.

CIRCOTETTIX (κίρκος, τέττιξ) *nov. gen.*

Somewhat closely allied to *Ctyphippus* Fieb., but differing considerably from it in general aspect. Head closely resembling that of *Trimerotropis* Stål; eyes rather smaller, somewhat prominent, separated above by a space about equal to their width; antennæ but little longer than the head and prothorax combined. Pronotum with the front lobe slightly narrower than the head, severed behind the middle; the hind lobe, which is about twice as long as the front lobe, broadening rapidly and greatly, slightly gibbous; the median carina distinct on the anterior portion of the front lobe, obsolete on the posterior portion, and inconspicuous on the hind lobe; front margin scarcely angulate; hind margin rectangulate; lateral carinæ distinct on posterior lobe, but not prominent; surface slightly rugulose. Tegmina and wings much longer than the body, the former with the intercalary vein approximating the radial at its tip, the axillary vein free; wings peculiar, being falcate (Thomas calls it papilio[ni]form), with more or less undulate margin; the falcation arises from the prolongation of the pre-anal area and the fullness of the middle of the anal area; the principal veins of the latter are supported on either side by spurious veins, running very close beside and parallel to them, to which the transverse veins are attached, while the spurious veins are themselves united to the principal nervures by other cross-veins, forming a more or less regular net-work on either

side of the principal veins; with this exception, the neuration of the wing is unusually regular and scalariform, the veins of the apex resembling somewhat their disposition in *Ctyphippus*.

The type of this genus is *Œdipoda undulata* Thomas. *Œdipoda sparsa* Thom. also belongs here, and I have a third undescribed species of the genus from Nevada, sent me by Mr. H. Edwards.

22. *Circotettix undulata* (*Œdipoda undulata* Thom.). 1 ♂, Manitou, Colo., July 14.

23. *Trimerotropis citrina* nov. sp. Ash-gray, blotched with dark fuscous; foveolæ of the head moderately distinct, a slight, lozenge-shaped, flat depression at the tip of the fastigium; antennæ yellowish-brown, obscurely annulated with fuscous. Median carina of pronotum distinct only on front lobe, and on its anterior part somewhat elevated, deeply cleft by the transverse sulcations, and sometimes depressed below the general level of the surface at the hindmost sulcation; front lobe corrugate, hind lobe nearly flat, granulose, with a few small, scattered tubercles, the posterior margin rectangular. Tegmina and wings extending far beyond the abdomen, the former as in *T. vinculata* Scudd., but much more uniform, the transverse ashen bands being more infuscated, and very rarely so distinct as in that species; wings rather pale lemon-yellow at base, pellucid, with black nervules at apex, and near the middle furnished with a broad, blackish, or very dark fuliginous band, shaped as in *T. vinculata*, but a little broader; beyond it, half-way to the apex of the wing, the space between the anterior two veins is more or less distinctly castaneous. Hind femora as in *T. vinculata*, hind tibia rather pale coral-red, becoming very pale at the base, the spines black-tipped. Length (of average specimens), ♂ 0.23^{mm}; ♀ 28.5^{mm}; of antennæ, ♂ 12, ♀ 10.5^{mm}; of tegmina, ♂ 27.5^{mm}, ♀ 31.5^{mm}; of hind femora, ♂ 12.5, ♀ 15^{mm}. A single male was taken at Denver, Colo., July 10. I have also specimens from the Red River of the North (Kennicott) to Texas (Belfrage, Boll). Boll's specimens were taken in Dallas County, June 6. Belfrage found the species "common in sandy places" in October and November, and a few also in June and July in the same State. The species seems to vary somewhat, northern specimens differing from the southern in having a paler band on the wings, the tegmina more distinctly fasciate, and the disk of the pronotum more depressed at the posterior sulcation. It is closely allied to *T. vinculata*, but the color at the base of the wings is deeper, the black band is broader, the tegmina are rarely so distinctly fasciate, and the hind tibiæ are red instead of yellow.

24. *Trimerotropis suffusa* nov. sp. Color varying from blackish-brown to very dark olive-brown above, the sides, and of the head the face, changing from livid below to brown above, all flecked heavily with black dots and blotches, the general effect being a speckled gray; antennæ very dark brown, faintly annulate with fuscous. Tegmina dark brown, suffused with blackish clouds on the basal half, heavily flecked with moderately large, quadrate, blackish-brown spots on the outer half, the cross-veins here and there brownish-yellow. Wings pale-citron on the basal half, separated from the outer half by a nearly straight line parallel to the body (when the wing is completely extended); outer half blackish fuliginous, deepest at apex and next the middle of the wing, and emitting a broad tapering shoot next the ulnar vein half-way from the middle of the wing toward the base; occasionally, the middle of the fuliginous area is semi-pellucid; the middle half of the apical four-fifths of the costal margin is blackish, sometimes as far as the radial vein; hind legs as in *T. verruculata*. Length (Utah specimen) of body, 27^{mm}; of antennæ, 11^{mm}; of tegmina, 29^{mm}; of hind femora, 13.5^{mm}.

1 ♀, American Fork Cañon, Utah. I have also received specimens from Mr. Henry Edwards from California and Vancouver's Island (No. 2), which are a little larger; the above description is in fact based upon them, as Dr. Packard's specimen was collected in alcohol.

This species is closely allied to *T. verruculata* (Kirb.) Scudd., which Mr. Edwards has also sent me from Vancouver's Island (No. 4), but differs from it in the more uniform distribution of the spots on the tegmina (*T. verruculata* always showing a couple of distinct, median, transverse, grayish bars), and in the extent of the fuliginous area of the wings, which in *T. verruculata* is confined to the extreme apex and to a narrow median band, sometimes so narrow as to be nearly broken in the middle.

AULOCARA (*αὐλών, κάρα*) *nov. gen.*

Not very distant from *Acrotylus* Fieb. Head large, tumid, the fastigium of the vertex pretty strongly declivant, scarcely depressed, its rounded lateral carinæ convergent to a blunt apex, by which it is separated from the frontal costa; lateral foveolæ distinct, pretty large, triangular, longer than broad, the lower edge horizontal; frontal costa narrow above, regularly broadening, fading out midway between the ocellus and the clypeus, sulcate throughout; eyes rather small, scarcely longer than broad, slightly shorter than the anterior part of the cheek, rather prominent, above nearly as distant as their breadth; antennæ very long and slender, scarcely depressed, fully as long as the hind femora. Pronotum very short, no longer than the head, constricted in the middle, the lobes equal in length; median carina very slight, equal, the front lobe twice distinctly severed in its posterior half, all the sulcations running distinctly a little way into the lateral lobes; lateral carinæ slight but distinct, excepting between the sulcations; lateral lobes scarcely narrowing below. Tegmina and wings reaching or surpassing the tip of the abdomen, the former with free, short, axillary vein, no intercalary vein and very few spurious veins. Hind femora rather stout and broad, with rather prominent carinæ; first hind tarsal joint longer than the third; arolium minute. The insects of this group have much the aspect of *Stenobothri*. The type of the genus is the species *cæruleipes*, now to be described.

25. *Aulocara cæruleipes* nov. sp. Head brown, heavily obscured above with broad longitudinal dark-brown or blackish stripes, made up of transverse bars; the face and cheeks more or less blotched with livid, becoming pale dull blue in front; clypeus and labrum pale brown, the edge of the latter pallid, like the palpi; antennæ brownish-yellow at base, beyond black or blackish. Pronotum brown, darkest above, the median carina darker; lateral lobes, with the upper border, blackish, and a pair of attingent, transverse, quadrate, black patches, the hinder a little the higher, in the middle. Tegmina surpassing the abdomen, brownish-fuscous, the posterior margin narrowly and the outer two-thirds of the anterior margin more broadly pallid, the middle area sparsely sprinkled with small, quadrate, fuscous spots, more abundant apically; wings pellucid, with a scarcely perceptible bluish tinge, the veins bluish, excepting the outer half of the upper portion, where they are black, or, at the extreme apex above, brownish. Outside of hind femora yellowish-brown, their upper half with a median and pre-apical, oblique, black patch, the latter tinging also the inferior surface; inside of femora blue, with a transverse, pre-apical, black patch; the whole apex bluish-black; hind tibiæ deep blue, the base yellowish-brown on the sides, spines black-tipped; hind tarsi pale yellowish-brown. Abdo-

men dull yellow, the upper surface marked transversely with brown. Length of body, 18.75mm; of antennæ, 12.5mm; of tegmina, 15mm; of hind femora, 12mm. 4 ♂. Garden of the Gods, Colorado, July 13.

26. *Aulocara decens* nov. sp. This species differs but little from the preceding, and may possibly belong with it, but it is paler-colored, less variegated, and has shorter tegmina and wings. The head, excepting the dark-brown vertex, is uniform very pale yellowish-brown; the clypeus and labrum very pale dull straw-yellow, almost white; more than a third of the antennæ is pale at the base. The tegmina are scarcely as long as the abdomen, light brown on the basal half of the middle area and basal third of the front area, the rest pallid or very pale brown, sparsely sprinkled with brownish dots. Hind tibiæ pale blue, with a broad, pallid, basal annulus. Abdomen yellow throughout. Length of body, 17.5mm; of antennæ, 11.75mm; of tegmina, 11.75mm; of hind tibiæ, 11mm. 1 ♂. Lake Point, Salt Lake, July 26, where they were common.

27. *Acrolophitus hirtipes* (Say) Thom. 2 ♀. Golden, Colo., and foothills at entrance to Clear Creek Cañon, July 3.

28. *Brachystola magna* (*Brachypeplus magnus* Girard). A single pupa was taken at the Garden of the Gods, Colo., July 13. This generic name, derived from βραχύς and στλοή, is proposed in place of *Brachypeplus* Charp. (*B. virescens* Charp. is the type), which is pre-occupied in Coleoptera (Erichs., 1842).

29. *Platamodes pennsylvanica* (De G.) Scudd. 1 ♂. Salina, Kans., in a house.

Stenopelmatus oculatus and *Cratypedes lineata* are described from specimens dried after immersion in alcohol; the remaining species from ordinary cabinet-specimens.

NOTICE OF A SMALL COLLECTION OF BUTTERFLIES, MADE BY DR. A. S. PACKARD, IN COLORADO AND UTAH, IN 1875.

By Samuel H. Scudder.

The collection has some interest, as it contains several rare forms, and extends our knowledge of the geographical distribution of many of the species. Thirty-three species in all were obtained, and of these eight have not been previously known in the Territory in which they were taken.

1. *Œneis Semidea* (Say). A single specimen was taken, July 14, on Pike's Peak, at an elevation of 13,000 feet. Although this has previously been reported from the Rocky Mountains of Colorado, it has always seemed questionable to me whether the allied form *Œ. Œno* was not meant. A careful study of a number of specimens, and a comparison of the abdominal appendages, leave no reasonable doubt that *Semidea* is an inhabitant of the Rocky Mountain summits, as well as of those of the White Mountains, New Hampshire.

2. *Erebia Epipsodea* Butl. Pike's Peak, just above timber-line, July 14.

3. *Cœnonympha ochracea* Edw. Pike's Peak, 8,000 feet, July 14.

4. *Danaida Plexippus* (Linn.). Pike's Peak, 8,000 feet, July 14.

5. *Chlorippe Lycaon* (Fabr.). Golden, Colo., July 3. I am not aware that this has ever before been found west of the great plains.

6. *Polygonia Satyrus* (Edw.). Salt Lake City, July 21.

7. *Polygonia Zephyrus* (Edw.). Georgetown, Colo., July 8.

8. *Papilio Antiopa* Linn. Salt Lake City, July 21.

9. *Vanessa cardui* (Linn.). Boulder City, June 29; Denver, July 10; Pike's Peak, from 8,000 feet to summit, July 14; Arapahoe Peak, 11,000 to 12,000 feet.

10. *Euptoieta Claudia* (Cram.). Manitou and Garden of the Gods, Colo., July 13; Pike's Peak, 8,000 to 9,000 feet, July 14.

11. *Argynnis Meadii* Edw. American Fork Cañon, Utah, July 22. I formerly questioned whether this were distinct from *A. Edwardsii*, but it now seems to me to be so. It has not been hitherto reported out of Colorado.

12. *Argynnis Hesperis* Edw. American Fork Cañon, Utah, July 22; also known hitherto only from Colorado. A single specimen was taken with the colors as in Edwards's figures, but with the marking of both the upper and under surfaces heavier, almost exactly as in *A. monticola*.

13. *Brenthis Helena* (Edw.). Pike's Peak, from timber-line upward, July 14.

14. *Lemonias Anicia* (Doubl.-Hewits.). The alpine form *nubigena* was taken at Pike's Peak, from the timber-line upward, July 14.

15. *Phyciodes pratensis* (Behr.). The form *campestris* was taken at Denver, June 27, Georgetown, July 8, and Manitou, July 16.

16. *Thecla Edwardsii* Saund. A very worn specimen, but unquestionably of this species, was taken at Manitou, Colo., July 16. It has never before been reported west of Iówa.

17. *Thecla Liparops* Lec. Taken with the preceding, and similarly worn. Kansas has hitherto been its westernmost known limit.

18. *Hypaurotis Chrysalus* (Edw.). A fine specimen of this rare and beautiful species was taken in the Garden of the Gods, Colo., July 13.

19. *Cupido Pembina* (Edw.). Golden, Colo., July 3.

20. *Cupido heteronea* (Boisd.). American Fork Cañon, Utah, July 22. It has not before been found east of the Sierra Nevada.

21. *Agriades Podarce* (Feld.). Georgetown, Colo., July 8.

22. *Rusticus Anna* (Edw.). A very poor specimen, but pretty certainly belonging to this species, was taken in American Fork Cañon, Utah, July 22.

23. *Hemiargus Isola* (Reak.). Manitou, Colo., July 15. The only United States localities previously known for this species were Texas and Kansas.

24. *Eurymus Eurytheme* (Boisd.). Denver, Colo., June 27, July 10; Garden of the Gods, July 13; Manitou, July 15–16; Farmington, Utah, July 23; Arapahoe Peak, between 11,000 and 12,000 feet. Very com, mon.

25. *Pontia Protodice* (Boisd.-LeC.). Denver, June 27; Golden, July 3; Georgetown, July 8, abundant; Garden of the Gods, July 13; Salt Lake City, July 21.

26. *Pieris oleracea* (Harr.). This was found very common at Salt Lake City, July 21. The specimens were very clear, with but little dusting of the nervules on the under side.

27. *Jasoniades Daunus* (Boisd.). This was common in Clear Creek Cañon, near Golden, Colo., July 13, at the Garden of the Gods and Manitou, July 16.

28. *Parnassius Smintheus* Doubl.-Hew. Pike's Peak, 8,000 to 9,000 feet, July 14; Manitou, July 16.

29. *Thanaos Persius* Scudd. Georgetown, Colo., July 8. A poor male.

30. *Hesperia tessellata* Scudd. Manitou, July 12–16; Garden of the Gods, July 13.

31. *Pamphila Juba* Scudd. Manitou, July 16. This has not before been found so far east.

32. *Euphyes Metacomet* (Harr.). Manitou, July 16. Previously known from the Rocky Mountains under the name of *Garita* Reak.

33. *Oarisma Hylax* (Edw.). Manitou, July 16.

NOTES ON THE GRAMMAR OF THE NEZ PERCÉS LANGUAGE.

BY REV. GEORGE AINSLIE.

The language spoken by the Nez Percés tribe of Indians is expressed by twenty-five elementary sounds, viz: Eight vowel, four diphthongal, and thirteen consonantal. These are written by twenty-five characters and combinations, as follows:

Alphabet of the Nez Percés language.

VOWELS.

A, a,	as in	all,	hama,	named	awe.
A, *a*,	"	man,	w*a*tu,	"	*a*h.
E, e,	"	prey,	tsekin,	"	aye.
E, *e*,	"	met,	k*e*h,	"	*e*h.
I, i,	"	marine,	im,	"	ee.
O, o,	"	note	tota,	"	owe.
U, u,	"	full,	hu,	"	oo.
U, *u*,	"	tub,	k*u*la,	"	*u*h.
W, w,	"	wine,	wah,	"	we.
Y, y,	"	you,	yoh,	"	ye.

DIPHTHONGS.

Ai, ai,	"	aisle,	aishin,	"	eye.
Au, au,	"	mound,	hautnin,	"	ou.
Ei, ei,	"	*wanting*,	pel*ei*pel*ei*,	"	*ei*.
Oi, oi,	"	voice,	liloinin,	"	oi.

CONSONANTS.

H, h,	"	home,	hama,	"	he.
K, k,	"	king,	kaua,	"	ke.
L, l,	"	low,	lawit,	"	le.
M, m,	"	mate,	m*a*tu,	"	me.
N, n,	"	not,	nih,	"	ne.
P, p,	"	pear,	pana,	"	pe.
S, s,	"	sun,	silu,	"	see.
T, t,	"	time,	tats,	"	te.
Sh, sh,	"	shine,	ipsush,	"	she.

H, *h*, guttural.
K, *k*, guttural.

The language contains eight parts of speech, viz: Nouns, pronouns, adjectives, verbs, adverbs, conjunctions, prepositions, and interjections.

Nouns may be classed as common and proper, as in other languages

Proper nouns usually express some sentiment; as—

La-la-kol-so-te (the bat that flies by day), Indian name of Lawyer, late head-chief.

Objects as the sun and moon are not designated by different names, the word hisamtuks being applied to both, showing that the language is not affluent in nouns.

Gender.

Only to a very limited extent is distinction of gender expressed as—

hama	man	hatswul	boy
aiot	woman	pitin	girl
pisht	father	askap	brother
pika	mother	kauis	sister

But boar is hama hokhok, man swine; sow is aiot hokhok, woman swine, and so with most of the inferior animals.

Number.

Only a few nouns form the plural.

Some form the plural by repeating the first syllable: as, hama, man; haham, men; hatswul, boy; hahatswul, boys; pitin, girl; pipitin, girls.

Other nouns from the plural by prefixing ha; as, aiot, woman; haiot, women; askap, brother; haaskama, brethren.

The plural of names of inferior animals or inanimate objects is expressed by the use of numerals, or the indefinite words tatash, some; ilani, many.

Declension.

Nouns are thus declined:

Nom. hama (man)	Nom. watash (earth)	Nom. John
Poss. hamanim	Poss. watashnim	Poss. Johnnim
Ac. hamana	Ac. watāshna	Ac. Johnna

NOTE.—Whenever the thing possessed is in the accusative—as, He teaches John's sons—then the possessive takes the sign of the accusative. Also the nominative often has the termination of the possessive. The vocative case is indicated by the words *a* and kam. The nominative is sometimes written after its verb, and the objective before the verb governing it, but usually the order is otherwise. In this it differs from other Indian languages, as the Choctaw, where both the subject and the object are always before the verb.

Remarks.

Nouns are formed from adjectives; as—

kapskaps	strong	komaits	sick
kapskapsnawit	strength	komaiitswit	sickness

Nouns are formed from verbs; as—

himtaksha	to teach	hipinwash	kitchen
himtakawat	a teacher	tamiasha	to trade
hitaminwash	a school	tamiawat	trader
hipsha	to eat	tamiawash	trading-post
hipt	food		

PRONOUNS.

Pronouns have no gender, only person, number, and case. The third person, *ipi*, is used for he, she, and it. They are declined as follows:

Singular.

I.	THOU.
Nom. in	Nom. im
Poss. inim or innih	Poss. imim or imnih
Obj. inna	Obj. imana

HE, SHE, or IT.

Nom. ipi Poss. ipnim or ipnimnih Obj. ipna

Plural.

WE.	YE.	THEY.
Nom. nun	Nom. ima	Nom. ima
Poss. nunim	Poss. imamnim	Poss. imamnim
Obj. nuna	Obj. imamna	Obj. imuna

The forms innih, imnih, and ipnimnih are always strictly possessive, representing, respectively, mine, thine, his. But the other form given for the possessive is sometimes found in the nominative; and, as in nouns, the objective form is at times used in the possessive.

RELATIVE PRONOUNS.

WHO.	THAT or WHICH.
Nom. ishi	Nom. kapam
Poss. ishinim	Poss. kapamnim
Obj. ishina	Obj. kapamna
WHO?	THOSE.
Nom. Ishi?	Nom. yokomam
Poss. Ishinim	Obj. yokomuna

ADJECTIVES.

The Nez Percés language differs from other Indian languages, as the Choctaw, &c., the adjective being always placed before the noun; as—

Nez Percés: tats hama (good man).

Choctaw: hatak chukma (man good).

Adjectives do not regularly take degrees of comparison, except that they may be intensified; as—

kapsish, bad; kapsishnihnih, &c.

Adjectives of number are:

naks, 1	winapt, 7	ilaptit, 20
lapit, 2	wimutut, 8	mitaptit, 30
mitat, 3	kuis, 9	wilaksaptit, 60
pilapt, 4	putimt, 10	putaptit, 100
pahat, 5	putimt wah naks, 11	putumisus, 1000
wilaks, 6	putimt wah lapit, 12	

Compare construction with the Choctaw:

NEZ PERCÉS.	CHOCTAW.
1, naks	1, achupa
2, lapit	2, tuklo
3, mitat	3, tuchina
4, pilapt	4, ushta
5, pahat	5, tahlapi
6, wilaks	6, hanali
7, winapt	7, untuklo
8, wimutut	8, untuchina
9, kuis	9, chakali
10, putimt	10, pokoli

As in Nez Percés, *l* and *n* are interchangeable.

NEZ PERCÉS.	CHOCTAW.
6 is winaks, or wi 1	
7 is wilapit, or wi 2	untuklo un, 2
8 is wimitat, or wi 3	untuchina un, 3

Note.

Does it not indicate that five was the original basis of numbers, as ten now is, and that counting was done on the fingers of one hand only?

NOTE.—Many adjectives are double words; as—

kuts-kuts	little	kaih-kaih	white
pilei-pilei	foolish	ilp-ilp	red
tsimuh-tsimuh	black		

NOTE.—The language is not affluent in adjectives, as, for instance, bitter or sour, they use the same word they do for sweet.

VERBS.

Verbs usually end in *sha* or *tsa*, having the corresponding plurals ending in *shih* or *tsih*. The verb to be is an exception to this rule; as—

wash	I am	hiushih	they were
imwash	thou art	witsatatasha	I shall be
hiwash	he she or it is	hiwitsatatasha	he shall be
num washi	we are	hiwitsatatashih	they shall be
ima washi	ye are	witsatatashaka	I should have been
ima hiwashih	they are	keh waku	if I am
waka	I was	keh huitsaya	if he is
hiwaka	he was		

kusha, to go, is thus conjugated:

kusha	I go	hikushina	they have gone
hikusha	he goes	kutatasha	I will go
kushih	we go	hikutatasha	he will go
hikushih	they go	kutatashih	we will go
hushaka	I went	hikutatashih	they will go
hikushaka	he went	kutatashaka	I would have gone
kushiaka	we went	hikutatashaka	he would have gone
hikushiaka	they went	kutatashiaka	we would have gone
kushana	I have gone	hikutatashiaka	they would have gone
hikushana	he has gone		
kushina	we have gone		