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TABLE OF CONTENTS.

ART. XXXII.—THE FOSSIL INSECTS OF THE GREEN RIVER SHALES.

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The following descriptions are published to afford some notion of the nature and extent of the insect remains found in the immediate vicinity of Green River Station on the Union Pacific Railroad in Wyoming. Illustrations of all of them have been prepared for a general work on the Tertiary insects of North America, to be published by this Survey.

With a very few exceptions, the specimens were found in a restricted basin, about six kilometres west of the town, exposed by a railway cutting called the "Petrified Fish Cut", from the vast number of fish remains discovered here in building the road. The insects were obtained in the first instance by Dr. Hayden, who brought home a few specimens only; next, Mr. F. C. A. Richardson placed in my hands a considerable collection;* and last summer my untiring friend Mr. F. C. Bowditch and myself spent several days working the shales.

The mass of the specimens from this locality are irrecognizable, and those to the nature of which some clue can be obtained are generally fragmentary; wingless and often legless trunks are very common, and lead to the suggestion that the specimens had undergone long maceration in somewhat turbulent waters before final deposition. The zoological nature of the fauna will be fully considered at another time, and it need only be remarked now that one cannot avoid noticing the tropical aspect of the recognizable forms. More than eighty species are here enumerated. One or two only can be (doubtfully) referred to species described from the White River beds,† referred by Lesquereux to the same horizon.

I must here express my indebtedness to Mr. G. D. Smith of Cambridge, who, with great liberality, has enabled me at all times to use his rich collections of *Coleoptera*, which chance to be specially valuable for my purpose from the intercalation of Mexican forms in the North American series.

HYMENOPTERA.

FORMICIDÆ.

Lasius terreus.—A single specimen (No. 14692) obtained by Dr. Hayden at the "Petrified Fish Cut", Green River (alluded to in his Sun Pictures of Rocky Mountain Scenery, p. 98), is probably to be referred to this

* See American Naturalist, vi, 665–668; Bulletin of this Survey, ii, No. 1, 77–87.

† See Bulletin of this Survey, iii, No. 4, 741–762.

genus, but is in rather a poor state of preservation. The head is small and rounded, with antennæ shaped as in *Lasius*, but of which the number and relative length of the joints cannot be determined, from their obscurity; the long basal joint, however, appears to be comparatively short and uniform in size, being not quite so long as the width of the head, while the rest of the antennæ is more than half as long as the basal joint, and thickens very slightly toward the apex. The thorax, preserved so as to show more of a dorsal than a lateral view, is compact, oval, less than twice as long as broad, with no deep separation visible between the meso- and metathorax, tapering a little posteriorly. The peduncle, as preserved, is a minute, circular joint, but from its discoloration appears to have had a regular, rounded, posterior eminence. The abdomen consists of five joints, is very short-oval, very compact and regular, and of about the size of the thorax, although rounder. The legs are long and slender, the femora of equal size throughout, and all the pairs similar. There is no sign of wings, and the specimen is probably a neuter.

Length of body 7.5^{mm}, of head 1.4^{mm}, of thorax 3.2 ^{mm}, of abdomen 2.9^{mm}; breadth of head 1.1^{mm}, of thorax 1.9^{mm}, of abdomen 2.2^{mm}; diameter of peduncle 0.55^{mm}; length of first joint of antennæ 1^{mm}, of rest of antennæ 1.65^{mm} (?).

MYRMICIDÆ.

Myrmica sp.—A species of this family was found by Mr. Richardson (No. 53), but a specific name is withheld in the hope of finding better material on which to base it. The head is rather small, circular; the thorax very regularly ovate and nearly twice as long as broad; the peduncle small, and composed of two adjoining circular masses, the hinder slightly the larger; the abdomen is much broken, but evidently larger than the thorax and pretty plump; no appendages are preserved.

Length of body 3.3^{mm}; diameter of head 0.4^{mm}; length of thorax 1.2^{mm}; width of same 0.75^{mm}; length of peduncle 0.25^{mm}; diameter of anterior joint of same 0.1^{mm}; width of abdomen 0.85^{mm}, its probable length 1.8^{mm}.

BRACONIDÆ.

Bracon laminarum.—A single specimen and its reverse (Nos. 4196, 4197) show a body without wings or other appendages. The head is quadrate, broader than long, and nearly as broad as the thorax. The thorax is subquadrate, either extremity rounded, about half as long again as broad, the sides nearly parallel, and the surface, like that of the head, minutely granulated; abdomen fusiform, very regular, in the middle as broad as the thorax, as long as the head and thorax together, tapering apically to a point, and composed apparently of six segments.

Length of body 2.8^{mm}, of head 0.6^{mm}, of thorax 0.85^{mm}, of abdomen 1.35^{mm}; breadth of head 1.1^{mm}, of thorax 1.2.

CHALCIDIDÆ.

Decatoma antiqua.—On the same stone (No. 4076) as *Lystra Richardsoni*, but at a slightly higher level, is a minute Chalcid fly. The wings are wanting, but the whole of the body is preserved, together with the antennæ. The head is large, arched, and otherwise well rounded, the face tapering below, the eyes large, deep, with their inner borders nearly parallel, leaving an equal front; the base of the antennæ cannot be made out, but beyond the long basal joint are six nearly equal quadrate joints, increasing very slightly indeed in size away from the head, scarcely so long as broad, the apical joint subconical, scarcely longer than the penultimate. Thorax compact, globose, minutely granulated, like the head; the abdomen also compact, arched, the tip rounded; beyond it, the ovipositor extends very slightly, apparently by pressure.

On a stone collected by Mr. Richardson (No. 86) is pretty certainly another specimen of this species, in which the abdomen is distorted by pressure; the abdomen shows this by the rupture of the integument, and the result is an apparently slenderer abdomen; it is also a female, with exactly the same parts preserved, with the addition of the other antenna; but both antennæ are more obscure than in the other specimen, especially at the apex; they appear, however, to enlarge more rapidly, and may be clavate at the tip, in which case the insect cannot be the same.

Length of body (of No. 4076) 1.85^{mm}, of abdomen 0.95^{mm}, of antennæ beyond basal joint 0.4^{mm}; width of penultimate antennal joint 0.045^{mm}.

DIPTERA.

CHIRONOMIDÆ.

Chironomus sp.—A minute specimen (No. 141), apparently of this family, was taken by Mr. Richardson. Unfortunately, it has no wings, and little can be said of it, more than to record its occurrence; it is 3^{mm} long, has large eyes, a stout thorax, and altogether resembles a *Chironomus;* it is, however, distinct from any found by Mr. Denton in the White River shales.

TIPULIDÆ.

Dicranomyia primitiva Scudd.—A single wingless male (No. 16), taken by Mr. Richardson, can be referred doubtfully to this species, originally described from White River.

About fifteen other specimens of *Tipulidæ* were collected by Mr. Richardson, Mr. Bowditch, and myself at the same spot, but, unfortunately, not one of them presents the vestige of a wing, and seldom anything more than the body; probably some of them also belong to the above-named species; others may with more doubt be referred to *D. stigmosa* Scudd.; but all are valueless for any precise determination, and, indeed, may not belong to *Dicranomyia* at all.

MYCETOPHILIDÆ.

Diadocidia? terricola.—This species is founded upon a single wing (No. 125) found by Mr. Richardson, differing to such a degree from *Diadocidia* that I only place it here because the only other reasonable course would be to refer it to a new genus, which would necessarily be conjectural, from the imperfection of the fragment. If a transverse vein exists in the middle of the wing, it must unite the fourth longitudinal vein with the second, and not, as in *Diadocidia*, with the third. The wing itself is shaped much as in *Diadocidia*, and, at least near its costal border, is covered with fine hairs arranged in rows parallel to the course of the neighboring veins; one of these rows in the costal cell is so distinct as to appear like a vein parallel to and lying within the auxiliary vein. The auxiliary vein terminates in the costal margin far beyond the middle of the wing, a feature apparently unknown in *Mycetophilidæ;* the first longitudinal vein terminates only a little further beyond, and, as in *Diadocidia*, there is no transverse vein connecting them; the second longitudinal vein terminates a little above the apex of the wing, curving downward at its extremity and apparently surpassed a little by the marginal vein; the third longitudinal vein originates from the second at only a short distance before the middle of the wing, and soon forks, or at about the middle of the wing; the fourth longitudinal vein is perhaps connected with the second at the point where it parts with the first by a cross vein perpendicular to the costal margin; at least, it is elbowed at this point, its basal portion running, parallel to the costal margin, to the fifth longitudinal vein, which, beyond this point, has a gently sinuous course, and diverges rather strongly from the fourth; the sixth vein cannot be traced, although the axillary field is broad, very much as in *Diadocidia*, and the inner margin distinct.

Probable length of wing 3.6^{mm}; its breadth 1.45^{mm}.

Sackenia sp.—No. 7 of Mr. Richardson's collection represents a species of *Mycetophilidæ* apparently belonging to this genus, so far as can be determined. It closely resembles *Sackenia arcuata* Scudd. from the White River shales, but differs from it in its smaller size and in possessing a proportionally larger and more arched thorax; the legs also appear to be shorter. Besides the body and (indistinctly) the antennæ and legs, only the upper portion of the wings remain, consisting of the costal margin and first and second longitudinal veins, with the cross vein uniting them; these wholly agree with the same features in *S. arcuata*, excepting that the second longitudinal vein terminates a little higher up.

Length of body 3.75^{mm}, of wings 2.9^{mm}.

Three other species of *Mycetophilidæ* occur among the specimens collected by Mr. Bowditch and myself, but they are indeterminable from their fragmentary condition. One of them, No. 4134, has indeed the remnant of a wing, but the portion of the venation preserved is only sufficiently characteristic to enable us to judge that it belongs in this family. The thorax is strongly arched, and the full and tapering abdomen indicates a female; the head is gone; the thorax and abdomen are 3.5^{mm} long, and the wing probably 3^{mm} long.

Another of them, No. 4114, has a portion of the base of a wing, in which the forking of the fifth and sixth longitudinal veins is very close to the base, as in *Sackenia*, but nothing more can be said concerning it; the thorax is very globular and the abdomen short.

Length of thorax and abdomen 3.65^{mm}.

The third species is represented by two specimens on one stone (No. 4205) which came from the buttes opposite Green River Station, and is the only fly which had the slightest value found in four days' search. One of the specimens is a pupa and the other an imago, apparently of the same species and distinct from either of the preceding, with a longer thorax and slenderer abdomen, provided with large ovate anal lobes.

Length of thorax and abdomen 5^{mm}.

ASILIDÆ.

Stenocinclis (στενός, κιγκλίς), nov. gen.

This genus of *Asilidæ* is founded wholly upon characters drawn from the neuration of the wing, the only portion of the insect preserved. It falls into the group of *Dasypogonina*, in which the second longitudinal vein terminates in the margin apart from the first longitudinal vein, instead of uniting with it just before the margin. It is not very far removed from *Dioctria*, but differs from it and from all *Asilidæ* I have examined in that the third longitudinal vein arises from the first before the middle of the wing, instead of from the second longitudinal vein after its emission from the first; the first longitudinal vein has therefore two inferior shoots, giving the wing a very peculiar aspect, and causing it to differ radically from all other *Asilidæ;* indeed, it would be hard to know where to look for a similar feature among allied *Diptera*, unless it be in the anomalous group of *Cyrtidæ.* The wing is very slender, and all the cells unusually elongated, which also gives it a unique appearance.

Stenocinclis anomala.—This species is represented by a single fragment of a wing (No. 4143), which I found in the Green River shales. Nearly all the neuration is preserved; but the posterior margin is absent, and the length of the cells which border upon it cannot be accurately determined. The insect was evidently small, with a long and slender wing. The auxiliary vein terminates slightly beyond the middle of the costal margin; the first longitudinal vein runs up toward the margin where the auxiliary vein terminates, and follows along next the edge far toward the tip, as usual in this group; the second longitudinal vein originates from the first a little way before the middle of the wing, and with an exceedingly gentle sinuous curve, turning upward apically, terminates a little way beyond the first longitudinal vein; the third longitudinal vein originates from the first as far before the origin of the second longitudinal vein as the distance apart of the tips of the first and second longitudinal veins, and running at first parallel and almost as close to it as the first longitudinal vein to the apical half of the costal margin, but distinctly separate throughout, it diverges slightly from it at the middle of the wing and terminates at the lower part of the apex of the wing, curving downward more strongly toward the margin; at the middle of the divergent part of its course, which is very regular, it emits abruptly a superior branch, which afterward curves outward and runs in a very slightly sinuous course to the margin, curving upward as it approaches it. The fourth longitudinal vein is seen to start from the root of the wing, and runs in a straight course until it reaches a point just below the origin of the second longitudinal vein, where it is connected with the vein below by the anterior basal transverse vein, and then bends a little downward, running nearly parallel to the third longitudinal vein, but continuing in a straighter course, terminates on the margin at nearly the same point; these two veins are connected by the small transverse vein midway between the anterior basal transverse vein and the forking of the third longitudinal vein; the fourth longitudinal vein is connected by the posterior transverse vein (which is scarcely as long as the small transverse vein) with the upper apical branch of the fifth longitudinal vein just beyond its forking, or opposite the forking of the third longitudinal vein; the fifth longitudinal vein forks previously to this, emitting a branch barely before the point where the anterior basal transverse vein strikes it, so that the branch almost appears to be a continuation of the transverse vein; and previous to this it has a distinct angle, where another vein is thrown off at right angles, directly opposite the upper extremity of the anterior basal transverse vein, and beyond the origin of the third longitudinal vein; the basal half only of the sixth longitudinal vein can be seen, but its direction shows that it unites with the lowest branch of the fifth at its apex, as in *Dasypogon*. All the cells throughout the wing are exceedingly narrow.

Length of wing 6.75^{mm}; probable breadth 1.6^{mm}.

SYRPHIDÆ.

Milesia quadrata.—A specimen (No. 14691) in a fine state of preservation, although not perfect, and with most of the neuration of the wing concealed under hard flakes of stone which cannot be wholly removed, was found by Dr. Hayden at the "Petrified Fish Cut", Green River. It is the larger fly alluded to in Dr. Hayden's Sun Pictures of Rocky Mountain Scenery, p. 98. The head and thorax are black, the head large, nearly as broad as the thorax, the eyes large, globose, as broad as the summit of the head between them, the front very large, prominent, half as broad as the head, and half as long as broad. Thorax globose, a little longer than broad, largest in the middle. Wings surpassing slightly the abdomen; the third longitudinal vein originates from the second in the middle of the wing, is very gently arcuate (the convexity backward) in its outer half, and appears to terminate just above the tip of the wing; the fourth longitudinal vein is united by an oblique cross-vein to the third very near the origin of the latter, and the spurious longitudinal vein cannot be made out, from poor preservation; the marginal vein between these two appears to be very simple, the fourth longitudinal vein bending downward at its tip to meet it. The abdomen is as broad as the thorax, fully as long as the rest of the body, broad-ovate, tapering slightly at the base and rapidly beyond the middle, broadest at the second segment; the first segment is longest, and half as long as broad, the second and third slightly shorter, the fourth still shorter, and the fifth minute; the abdomen is light-colored, probably yellow in life, and the first three segments are rather narrowly margined posteriorly with black; the first segment is also similarly margined in front, and besides has a median black stripe of similar width, which divides the segments into equal lateral quadrate halves,—whence the specific name; the whole abdomen is rather profusely covered with very brief, black, microscopic hairs, which are thickest in the black bands bordering the segments, and next the hind edge of the fourth and fifth segments, producing a dusky posterior margin, similar to but narrower than the dark belts of the preceding segments, and of course very inconspicuous.

Length of body 18^{mm}, of head 2.85^{mm}, of thorax 5.65^{mm}, of abdomen 9.5^{mm}; breadth of front 2.4^{mm}, of head 4.5^{mm}, of thorax 6^{mm}, of abdomen 6^{mm}; probable length of wing 14.5^{mm}; length of hairs on abdomen 0.04^{mm}; width of dark abdominal bands 0.5^{mm}.

Cheilosia ampla.—This species is primarily founded on a single specimen (No. 4112) which Mr. Bowditch and I found in the Richardson shales at Green River, and which preserves nearly all parts of the insect. There is also a specimen with its reverse (Nos. 4135, 4141) which we obtained at the same place, and another (No. 40) which Mr. Richardson sent me from these beds, agreeing with the first-mentioned specimen, but a little larger. As only the bodies are preserved, they are temporarily placed in this connection, until other material is at hand, while the species is described wholly from the more perfect individual. This has a body more nearly of the shape of an *Orthoneura*, the abdomen being broader and stouter than is usual in *Cheilosia;* but the wings are much longer than in the species of *Orthoneura* I have seen, and both the shape of the wing and its neuration agree well with *Cheilosia.* The head is round and moderately large, the thorax stout and rounded ovate, the scutellum large, semilunar, twice as broad as long; all these parts are dark brown. The wings are very long and narrow, extending much beyond the tip of the abdomen, the costal edge very straight until shortly before the tip, where it curves rapidly; all the veins are very straight, especially those of the upper half of the wing; the auxiliary vein terminates in the middle of the costal border, the first longitudinal at the extremity of the straight part of the costa, beyond the middle of the outer half of the wing, the third at the tip of the wing, and the second midway between the first and third; the third is united to the fourth by a straight cross-vein in the middle of the wing, directly beneath the tip of the auxiliary vein, and about its own length beyond the extremity of the long second basal cell; the extremity of the third basal cell is very oblique and reaches the tip of the lower branch of the fifth longitudinal vein; the marginal vein, uniting the third and fourth veins, strikes the former just before the tip, while that uniting the fourth and fifth, toward which the fourth bends to receive it, is removed further from the margin by about half the width of the first posterior cell. The legs are slender, scantily clothed with short, fine hairs. The abdomen is broad, oblong ovate, fully as broad as the thorax, broadly rounded at the apex, no longer than the rest of the body, of a light color, with darker incisures, and scantily covered with delicate hairs; it is composed of five segments, of which the second, third, and fourth are of equal length, the first shorter and suddenly contracted, the apical minute.

Length of body 7^{mm}; diameter of head 1.35^{mm}; length of thorax 2.5^{mm}; breadth of same 2^{mm}; length of abdomen 3.5^{mm}; breadth of same 2.2^{mm}; length of wing 6.4^{mm}; breadth of same 1.8^{mm}; length of hind femora 1.25^{mm}, of hind tibiæ 1.25^{mm}, of hind tarsi 1.25^{mm}.

Cheilosia sp.—Two specimens (Nos. 4113, 4150) of a smaller species of *Syrphidæ*, preserving the bodies, agree so completely with the last-mentioned species, excepting in their much smaller size, that they are referred to the same genus; but as the wings are almost entirely lost, the reference is only made to indicate the approximate place of the species, which need not be described until better material is at hand. The length of the body is 4.25^{mm}.

Syrphus sp.—A fourth species of this family, and second only to the *Milesia* in size, is represented by two specimens, reverse and obverse (Nos. 4110, 4132), which are too imperfect for description, only the body being preserved; the form and size of this agree best with the genus *Syrphus*. The length of the body is 10^{mm}.

MYOPIDÆ.

Poliomyia (πολιός, μυῖα), nov. gen.

This genus of *Myopidæ*, most nearly allied to *Myopa*, appears in the neuration of the wings to resemble closely some genera of *Syrphidæ*, especially *Xylota* and *Milesia*, but it altogether lacks the spurious longitudinal vein, and the third, fourth, and fifth longitudinal veins are not united at their extremities by marginal veins; indeed, they run, without swerving, and subparallel to one another, to the margin. In this respect, the genus differs also from other *Myopidæ*, as it does also in the extreme length of the third basal cell, which is as long as in *Syrphidæ*. In these points of neuration, it would seem to agree better with the *Pipunculidæ*, which family, however, is entirely composed of very small flies, so that it seems better with our imperfect knowledge of the fossil to refer it to the *Myopidæ*. The body resembles that of *Syrphus* in general form. The wings are as long as the body, and slender, with very straight veins; the auxiliary and first to fourth longitudinal veins are almost perfectly straight, the third originating from the second longitudinal vein at some distance before the middle of the wing; the auxiliary vein terminates beyond the middle of the costal margin; directly beneath its extremity is the small transverse vein, and about midway between the latter and the margin the large transverse vein uniting the fourth and fifth veins; the extremity of the second basal cell is further from the base than the origin of the third longitudinal vein, and the third basal cell reaches very acutely almost to the margin of the wing.

Poliomyia recta.—The single specimen (No. 14696) referable to this species was obtained by Dr. Hayden at the "Petrified Fish Cut", and represents a dorsal view of the insect with the wings partly overlapping on the back. It is the smaller fly referred to in Dr. Hayden's Sun Pictures of Rocky Mountain Scenery, p. 98. The head is broken; the thorax is stout, rounded-ovate, and blackish; the scutellum large, semilunar, and nearly twice as broad as long, with long black bristles along either lateral edge and along the sides of the thorax posteriorly. The wings are long and narrow; the auxiliary vein runs into the margin just beyond the middle of the wing; the first longitudinal vein runs into the margin at about two-thirds the distance from the tip of the auxiliary vein to that of the second longitudinal vein, and scarcely turns upward even at the tip; the straight second and third longitudinal veins diverge from each other at the extreme tip after running almost parallel throughout the length of the latter, which originates from the second some distance before the middle of the wing; the small tranverse vein between the third and fourth longitudinal veins lies just beyond the middle of the wing and perpendicular to the costal border, while the large transverse vein between the fourth and fifth longitudinal veins is perpendicular to the latter, and renders the discal and second posterior cells of about equal length. The abdomen is apparently lighter-colored than the thorax, regularly obovate, as broad as the thorax, and longer than it, its terminal (fifth) segment small, the others large and subequal.

Length of thorax and scutellum 4^{mm}; breadth of same 2.75^{mm}; length of abdomen 4.5^{mm}; breadth of same 2.75^{mm}; length of wing 6.5^{mm}; breadth of same 2.25^{mm}.

I am indebted to Mr. Edward Burgess for some critical remarks upon the affinities of this fly, and for a careful sketch of the neuration, which is very difficult to trace in certain places.

DOLICHOPIDÆ.

Dolichopus sp.—A specimen and its reverse (Nos. 4124, 4148) is to be referred to this family by the structure of the abdomen and its general aspect. The wings and head, however, are wanting. The thorax is globose, well arched, and, like the abdomen, of a light brown color, and ornamented with scattered, bristly, black hairs. The tip of the abdomen is recurved beneath. The length of the fragment is 3.65^{mm}.

TACHINIDÆ.

Tachina sp.—To this is referred provisionally a small but stout and densely hairy fly (No. 48^{b}, obtained by Mr. Richardson), with thick, slightly tapering abdomen, broadly rounded at the tip, long wings with heavily ciliated costal margin, the auxiliary vein terminating a little before the middle, and the first longitudinal vein not very far before the tip; the other veins of the wing cannot be determined. The legs are pretty stout and densely haired. About the fly are scattered many arcuate, tapering, spinous hairs 0.7^{mm} long, evidently the clothing of the thorax.

Length of body 4^{mm}; breadth of thorax 1.25^{mm}; length of wings 4^{mm} (?), of hind femora 0.6^{mm}; hind tibiæ 1.25^{mm}; hind tarsi 1.25^{mm} (?).

SCIOMYZIDÆ.

Sciomyza? manca.—This fly, extremely abundant in the Green River shales—in fact, outnumbering all the other *Diptera* together—is temporarily placed in this genus, because its characters seem to agree better with those of the family *Sciomyzidæ* than of any other; yet it cannot properly be placed in any of the genera known to me. I should be inclined to place it near *Blepharoptera* in the *Helomyzidæ*, but all the tibiæ are bristled throughout. Its general appearance is that of the *Ephydrinidæ*, but the bristly surface of the middle tibiæ would allow us to place it only in the *Notiphilina*, from which it is excluded by the want of pectinations on the upper side of the antennal bristle. The want of complete neuration prevents me from designating it at present by a new generic name, which it can hardly fail to require as soon as that is known; only two or three of the three score specimens before me have any important part of the wings, and this constant fragmentary condition of the fossils has suggested the specific name. The genus in which it would fall may be partially characterized as follows:—Body compact, stout; the head comparatively small, perhaps one-third the bulk of the thorax, about three-fourths its width, with large, naked eyes, the front between them nearly equal and pretty broad, obliquely sloped and slightly tumid on a side view, so as to project considerably below; a few curved bristles project from its summit. Antennæ with the flagellum subglobose, scarcely longer than broad, much larger than the joints of the scape, and bearing at its tip above a curved, rather short, naked, tapering style, *scarcely longer than the flagellum* proper and bluntly pointed; in several specimens in which this part is pretty well preserved, this is invariably its character, and no terminal thread can be seen in any of them, nor any indication of joints in the style; this brevity of the style seems to be peculiar. As far as the neuration of the wing can be made out (there must remain some doubt upon this point until better examples are discovered), the course of the auxiliary vein cannot be determined; the first longitudinal vein appears to end before the middle of the costal border; the second originates abruptly from the middle of the first longitudinal vein, and terminates (certainly) only a little way before the tip of the wing; the third runs very nearly parallel to the second longitudinal vein, terminates at the tip of the wing, and is perhaps connected by a cross-vein with the fourth longitudinal vein scarcely within the extremity of the first longitudinal vein; the fourth longitudinal vein originates from the fifth or sixth a little before the origin of the second longitudinal vein, diverges rapidly from the third beyond this connection, and is arcuate, curving upward again before reaching the posterior border and running outward to the outer border; the fifth longitudinal vein curves still more strongly from the fourth, until it reaches the middle of the posterior border, to which it suddenly drops, and scarcely above which it is united with the fourth longitudinal vein by a long, oblique cross-vein. The femora are stout, the front pair largest at the base and tapering, the other pairs subequal throughout, all armed externally above and below with a row of very delicate, nearly straight spines, the upper row perhaps wanting on the middle femora, and the lower row developing into longer and stiffer bristles on the apical half of the fore femora. The tibiæ are equal, a little longer than the femora, considerably slenderer, but still rather stout, furnished alike with several straight, longitudinal rows of minute spines, and on the outer side with three or four distant, moderately stout, longer spines (less prominent on the fore tibiæ than on the other legs), and at the tip with a cluster or several similar spines or spurs. The tarsi are very much slenderer than the tibiæ, longer than they, the other joints slenderer than the metatarsus, all profusely armed with exceedingly delicate spines or spinous hairs, arranged regularly in longitudinal rows; at tip is a pair of very slender, pretty long, strongly curved claws, and apparently a pretty large pulvillus.

The brevity of the antennal style, the length of the first longitudinal vein of the wing, the approximation of the middle transverse vein to the base, the strong arcuation of the fourth longitudinal vein, the obliquity of the posterior, large, transverse vein, and its approach to the posterior margin, the bristly nature of the legs, and the length and comparative slenderness of the tarsi—all, excepting parts of the neuration, characters open to little question—render this fly peculiar and its exact location somewhat dubious. When, however, the neuration of the wing is sufficiently well known to enable us to understand more definitely the character of the basal cells, and other parts of the base of the wing, the relation of the auxiliary to the first longitudinal vein, and to map unquestionably the whole course of the fourth longitudinal vein, we shall probably be able to arrive at very precise conclusions.

In addition to the features above mentioned, it may be added that the thorax is subquadrate, scarcely longer than broad, furnished with distant, long, curving bristles disposed in rows, but in no individual well enough preserved to give further details of distribution. The abdomen is composed of five visible, subequal joints; its mass compact, scarcely constricted at the base, regularly and pretty strongly arched on a side view, tapering rapidly on the apical half to a bluntly rounded apex, the surface abundantly clothed with rather delicate spinous hairs, those at the posterior edge of the segments longer, and forming a regular transverse row. The metatarsus of the middle leg is proportionally longer than in the others, where it is about half as long as the other joints combined.

Measurement of average individuals:—Length of body as curved 4.25^{mm}, of head 0.65^{mm}, of thorax 1.7^{mm}, of abdomen 2.2^{mm}; breadth of head 0.85^{mm}, of thorax 1.25^{mm}, of abdomen 1.4^{mm}; length of flagellum of antennæ 0.16^{mm}, of style 0.19^{mm}, of wing 3.4^{mm}?; breadth of same 1.2^{mm}; length of femora 0.75^{mm}, of tibiæ 0.95^{mm}, of fore tarsi 0.85^{mm}, of middle tarsi 1.5^{mm}, of hind tarsi 1.6^{mm}, of fore metatarsi 0.4^{mm}, of middle metatarsi 0.64^{mm}, of hind metatarsi 0.48^{mm}; breadth of femora 0.28^{mm}, of tibiæ 0.12^{mm}, of metatarsus 0.08^{mm}, of tip of tarsi 0.05^{mm}; length of claws 0.09^{mm}.

Sciomyza ? disjecta.—A second species, apparently of the same genus as the last mentioned, but smaller, is found in considerable numbers in the same bed, although in far less abundance than the last, a dozen specimens having been found by Mr. Richardson, Mr. Bowditch, and myself. The wings appear to be proportionally shorter than in the last species, with a rather broader space between the veins in the upper half of the wing, indicating perhaps a broader wing. The legs are slenderer, the disparity in the stoutness of the tibiæ and tarsi is not so great, and the tarsi are proportionally shorter; the legs are also as densely, though less coarsely, spined, and a similar delicacy is observable in the hairiness of the body. All the specimens are preserved on a side view, and the last species are in a like fragmentary condition.

Length of body of an average individual 3.2^{mm}, of head 0.55^{mm}, of thorax 1.2^{mm}, of abdomen 1.8^{mm}, of wing 2.4^{mm}?, of hind femora 1.2^{mm}, of hind tibiæ 1.4^{mm}, of middle and hind tarsi 1^{mm}.

COLEOPTERA.

CARABIDÆ.

Cychrus testeus.—A single specimen (No. 4059) with its broken reverse (No. 4100) shows a pair of elytra slightly misplaced. They appear to represent a small species of *Cychrus* allied to *C. angusticollis* Fisch., but without the irregularities which mark the furrow formed by the marginate outer edge in this species and its near allies. The elytra are almost precisely similar in form to those of *C. angusticollis*, but they are slightly broader at the base; they are covered with rather inconspicuous, closely crowded striæ, almost exactly as in the recent species mentioned, but even more closely crowded, numbering about twenty-five, including the frequent lines bordering the margin, which is simple and striate to the very edge, or, possibly, faintly marginate, as in some *Carabi*, but differing conspicuously from the species of *Cychrus* to which I have compared it. The form of the tip of the elytra is also exactly as in this species. The interspaces of the elytra do not exhibit the imbricated appearance common to most of the *Carabini*, but the surface has more of the nearly imperceptible waviness seen in *C. angusticollis*, although, if anything, the surface is less broken.

Length of elytron 7.5^{mm}; greatest breadth (behind the middle) 2.6^{mm}.

Platynus senex.—This species is represented by a single specimen and its reverse (Nos. 3998, 3992). The upper surface is shown with none of the slenderer appendages. The true form of the head cannot be determined, as the edges are not preserved. The prothorax is unusually square for a Carabid, resembling only certain forms of *Bembidium* and *Platynus*, and especially *P. variolatus* LeC. It is, however, still more quadrate than in that species, and differs from it in shape, being a little broader than long, broadest just behind the middle, tapering but little anteriorly, and scarcely more rapidily at the extreme apex; the elytra are together only about half as broad again at base as the thorax, and are furnished with eight very faint and feeble striæ, apparently unpunctured, the one next the margin interrupted by four or five foveæ on the posterior half of the elytra; the humeral region is too poorly preserved to determine the striæ at that point; the form of the elytra is as in *P. variolatus*.

Length of body 6.1^{mm}; breadth of thorax 1.5^{mm}, of base of elytra together 2.3^{mm}; length of elytra 4.1^{mm}.

HYDROPHILIDÆ.

Tropisternus saxialis.—One specimen and its reverse (Nos. 4023, 4027), found by me in the Green River shales, represent a species of *Tropisternus* nearly as large as *T. binotatus* Walk. from Mexico. The large size of the head and the shortness of the prothorax are doubtless due to the mode of perservation, the whole of the head, deflected in life, being shown, while the thorax is in some way foreshortened. In all other respects, it agrees with the *Hydrophilidæ*, and especially with *Tropisternus*, having the form of the species mentioned. The head is broad and well rounded, with small, lateral, posterior eyes. The thorax is much broader and much more than twice as broad as long, with rounded sides, tapering anteriorly, the front margin broadly and rather deeply concave, the hind border gently convex; the scutellum is large, triangular, a little longer than broad. The surface of the thorax and elytra is apparently smooth; at least, no markings are discoverable, excepting the line of the inner edge of the inferior margination of the sides of the elytra, which appears through the latter, as do also the abdominal incisures and the hind femora and tibiæ. These legs are longer and slenderer than in *T. binotatus*, the femora extending beyond the sides of the abdomen, and the tibiæ are armed beneath at tip with a pair of slender spines, which together with the tibiæ are about as long as the femora.

Length of body 6.65^{mm}, of elytra 4.45^{mm}; breadth of middle of body 3.25^{mm}; length of hind femora 2^{mm}, of hind tibiæ 1.25^{mm}.

Tropisternus sculptilis.—In a specimen (No. 3989) of which only the abdomen and elytra are preserved, we have a well-marked species of *Tropisternus* of about the size and shape of *T. mexicanus* Castln., but with rather frequent striæ, more distinct than in that species, and composed, not, as there, of rows of impressed points, but of continuous, faintly impressed lines; the lines are apparently eight in number and uniform in delicacy and distance apart; the base of the elytra, however, is poorly preserved; the elytra are rather slenderer than in the recent species mentioned, and the extreme tip is rounded and not acutely pointed. Distinct striation of the elytra is rare in *Tropisternus*, but it scarcely seems possible to refer this species elsewhere.

Length of elytra 6.5^{mm}; breadth of combined elytra 5^{mm}.

Berosus tenuis.—The single specimen (No. 4002) representing this species is preserved on a dorsal view, and is unusually slender for a *Berosus*, but seems to fall here rather than in any other of the Hydrophilid genera. It is of about the size of *B. cuspidatus* Chevr. from Mexico, and agrees generally in appearance with it, but is slenderer, and the tip of the elytra is simple; the punctured striæ are exactly as in that species, as far as they can be made out. The head is large and well rounded, with large, round eyes. The pronotum, the posterior edge of which is partly concealed by the overlapping base of the elytra, pushed a little out of place, is shorter than in *B. cuspidatus*, with rounded sides, broadly and shallowly concave front, and apparently smooth surface. The elytra are long and slender, with entire, bluntly pointed tips, and very delicate, finely impunctured striæ. The whole body is regularly obovate, broadest in the middle.

Length of body 5.65^{mm}, of elytra 4.15^{mm}; breadth of body 2.75^{mm}.

Berosus sexstriatus.—A single well-preserved elytron (No. 4079) represents a species scarcely smaller than *B. punctipennis* Chevr. (undescr.) from Mexico, with the elytra of which it also agrees in the character of the tip and in the shape of the whole, unless in the fossil it tapers more toward the base; the latter is also remarkable for the absence of the two lateral striæ, the others retaining their normal position; for the delicacy of the striæ themselves, which are even more faintly impressed than in

B. cuspidatus Chevr., and, unlike all *Berosi* I have seen, are nearly devoid of any sign of punctuation; faint traces only can be seen when magnified twenty-five diameters. As not unfrequently happens in *Hydrophilidæ*, although I have not noticed it in *Berosus*, a short supplementary stria originates near the base of the second stria, pushing it a little to one side, and runs into the first stria a short distance from the base of the elytra.

Length of elytron 4.5^{mm}; breadth 1.4^{mm}.

Laccobius elongatus.—A single specimen and its reverse (Nos. 81^{a}, 136^{g}), collected by Mr. Richardson, but overlooked in my former paper on the Coleoptera of the Rocky Mountain Tertiaries,* exhibit the elytron of a slender species of *Laccobius*. It is more than two and a half times longer than broad, and is furnished with thirteen equidistant, delicately punctured, faintly impressed striæ, the punctures of which are more apparent on the basal than on the apical half; the inner stria is as distant from the sutural border as from the neighboring stria, while the outer is scarcely separate from the outer margin. The species is very large, and also very slender, for a *Laccobius*, in which genus, however, I am inclined to place it, from the large number of punctured striæ. The elytron has much the general appearance of that of a *Lebia*, but the number of striæ, of course, forbids such a reference.

Length of elytron 2.9^{mm}; breadth 1.1^{mm}.

Philhydrus primævus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 78.—A single specimen, found by Mr. Richardson.

Philhydrus spp.—Two specimens (Nos. 4033, 4042) of a second species of *Philhydrus* were found by Mr. Bowditch and myself, but neither of them very perfect, representing little else than elytra, and these rather obscurely preserved. The larger species has smooth elytra; the elytra of the other have eight delicate striæ, which apparently are not punctured. Possibly one or both should be referred to *Hydrobius*.

Length of elytra of larger species (No. 4033) 4^{mm}; breadth of body 3.2^{mm}.

Length of elytra of smaller species (No. 4042) 3.75^{mm}; breadth of body 3^{mm}.

Hydrobius decineratus.—A single specimen (No. 4007) exhibits the dorsal surface, but with part of the thorax gone. It represents a species a very little larger than *H. fuscipes* Curt. of California, and is apparently allied to it, though slenderer; the head and eyes are as in that species; the thorax shorter and the elytra longer, and more tapering at the tips, the extremities of which, however, are not preserved; they are furnished with eight delicate striæ, in which the punctures are scarcely perceptible, even when magnified; the surface otherwise appears to be smooth, but is not well preserved. The scutellum is as in the recent species mentioned.

Length of body 7.5^{mm}, of elytra 4.75^{mm}; breadth of body 3.6^{mm}.

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*Bulletin of this Survey, ii, No. 1, 77-87.

STAPHYLINIDÆ.

Lathrobium abscessum Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 79.—Two specimens were found by Mr. Richardson, and since the description of the species three others by myself at the same locality.

Bledius adamus.—A rather poorly preserved specimen (No. 4081) shows the dorsal view of the body without the legs or antennæ. It is of about the size of *B. annularis* LeC., and resembles it in general appearance, but seems to have shorter tegmina, although these are obscure; it is also a rather slenderer species. The head is large, as broad as the thorax, with rather large eyes. The thorax is quadrate, and the elytra together quadrate, and of the same size as the thorax. The abdomen beyond the elytra is as long as the rest of the body; apically it expands somewhat, and the extremity is shaped as in the species mentioned.

Length of body 4.4^{mm}; breadth of thorax 0.75^{mm}.

Staphylinites obsoletum Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 78.—A single specimen found by Mr. Richardson.

NITIDULIDÆ.

Phenolia incapax Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 80.—One specimen and its reverse, found by Mr. Richardson.

CRYPTOPHAGIDÆ.

Antherophagus priscus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 79–80.—Several specimens, found by Mr. Richardson, Mr. Bowditch, and myself.

ELATERIDÆ.

Corymbites velatus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 81.—Found by Mr. Richardson.

PTINIDÆ.

Sitodrepa defuncta Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 82.—A single elytron and its reverse, found by Mr. Richardson.

Anobium? ovale.—A single specimen (No. 4038) exhibits the upper surface of the pronotum and elytra. The insect evidently appertains to a distinct genus of *Ptinidæ*, in which the sides of the body are not parallel, but the body tapers posteriorly much, though not to the same extent, as anteriorly. It is, however, most nearly allied to *Anobium*, in which it is provisionally placed. It is about as large as *Endecatomus rugosus* LeC. The prothorax, viewed from above, is bluntly conical, tapering rapidly. The body is broadest just behind the base of the elytra, and tapers slightly at first, more rapidly afterward, and is rounded posteriorly; thus the whole body has an ovate outline. The pronotum is minutely and very profusely punctulate in black, and appears to have been covered profusely with slight asperities or a coarse pile (much perhaps as in *Endecatomus rugosus*). The elytra, which are nearly three times as long as broad, and taper regularly from near the base to near the tip, show no mark of such asperities, but are profusely punctate in black, made up of scattered punctæ, about 0.03^{mm} in diameter, not altogether irregularly disposed, although at first sight having that appearance, but showing in many places, not uniformly, signs of a longitudinal distribution into from fourteen to sixteen rows. The elytra, indeed, resemble those of *Bostrychus capucinus* (Linn.), but I am not aware that similar markings occur on smaller *Ptinidæ*.

Length of body 4.3^{mm}; breadth of same 2^{mm}; length of elytra 3.15^{mm}.

Anobium ? deceptum.—Another specimen (No. 4086), representing an elytron only, evidently belongs to the same genus as the last, and at first sight appeared to be of the same species, as it belongs to an insect of the same size, and the punctures on the elytra are similarly disposed; they are, however, if anything, more thickly crowded, so as to form about eighteen rows in the rather broader elytron; and not only is the elytron broader and shorter than in the preceding species, being less than two and a half times longer than broad, but it scarcely tapers at all in the basal three-fifths, and beyond that more rapidly than in the species last described.

Length of elytron 3^{mm}; breadth of same 1.25^{mm}.

Anobium lignitum.—A third species of this family, with irregularly punctate elytra, is represented by a single specimen (No. 4082), giving a dorsal view of pronotum and elytra. It differs generically from the two preceding species, and agrees better with *Anobium* proper in having a more gibbous and less conical prothorax, and in having the sides of the elytra parallel through most of their extent. It is considerably smaller than either of the preceding species. The prothorax is one-third the length of the body, minutely punctate and scabrous, tapering only a little in its basal and considerably in its anterior half, the front well rounded. The elytra are about two and a half times longer than broad, equal on the basal two-thirds, and then rounding rapidly inward, so that the posterior outline of the body is more broadly rounded than the anterior outline; the elytra are profusely punctate with little pits, averaging scarcely more than 0.02^{mm} in diameter, distributed at pretty regular intervals, but not forming anything like longitudinal series, and so near together as to be equivalent to about fourteen rows. The whole body is uniformly black.

Length of body 3.75^{mm}, of elytra 2.5^{mm}; width of body 1.9^{mm}.

EROTYLIDÆ.

Mycotretus binotata.—A single specimen with its reverse (Nos. 3990, 4015) represent the dorsal aspect of this species, which closely resembles *M. sanguinipennis* Lac. in shape. It is, however, a little smaller, the thorax tapers less rapidly, and the elytra are not striate. The head is badly preserved, being crowded under the thorax; it appears, however, to be very small, about half as broad as the thorax, with a broadly rounded front, large eyes, and a dark color. The thorax is about two and a half times broader than long, with slightly convex sides, regularly tapering toward the apex, but not so rapidly as would seem to be required for so proportionally narrow a head; the front border broadly concave, the hind border very obtusely angulate, scarcely produced as a broad triangle in the middle; the surface is of a light color, very minutely and profusely punctulate, the hind borders faintly marginate, the margin black and punctate. The elytra are more elongate than, and do not taper so rapidly as, in *M. sanguinipennis*; they are of the color of the thorax, even more delicately punctulate than it, with two small, short, black, longitudinal, impressed dashes just outside the middle, and just before the end of the basal third; the basal edge of the elytra is marked in black, much as the posterior border of the pronotum; and the scutellum is small, owing to the encroachment of the median prolongation of the prothorax.

Total length 3.5^{mm}; length of thorax 0.6^{mm}, of elytra 2.5^{mm}; breadth of head 0.75^{mm}, of thorax in front 1.2^{mm}, behind 1.45^{mm}, of elytra at the spots 2.1^{mm}.

CHRYSOMELIDÆ.

Cryptocephalus vetustus.—This species is fairly represented by a pair of specimens with their reverses (Nos. 4003, 4004; 4039, 4044). One pair exhibits the front, and, by the drooping of the abdomen, the under surface of the insect with expanded elytra (one of them curiously foreshortened), the other the under surface only. The insect is broadly oval, and, except in being much stouter, closely resembles *C. venustus* Fabr., with which it agrees in size. The thorax, as seen on a front view, is arched, and the proportion of the head to the thorax is as in the recent species mentioned. The elytra, which are the part best preserved, are rounded at the extremity, and are furnished with ten slightly arcuate rows of gentle punctures, arranged inconspicuously in pairs, besides a sutural, slightly oblique row on the basal third of the elytra, terminating in the margin. This disposition of the punctures and the character of the head, sunken, as it were, into the thoracic mass, leave little doubt that the insect should be referred to *Cryptocephalus*. The elytra are of a uniform light horn-color, but the body is darker. The body is more oval than in the parallel-sided *C. venustus*.

Length of body 4–4.5^{mm}; breadth of same 2.6–3.2^{mm}; length of elytra 4^{mm}; breadth of one of them 1.8^{mm}.

RHYNCHITIDÆ.

Eugnamptus decemsatus.—A single elytron (No. 4046) with a broken base is all that remains of this species. But this is peculiar on account of the supplementary humeral stria, which seems to be common in the *Rhyn-*

chitidæ, and at least very rare in the allogastral *Rhyncophora*, to which one would at first glance refer this fragment. So far as the material at hand permits determination, it appears to agree best with the genus to which it is referred, on account of the disposition of the punctuation and the form of the tip of the elytron. It represents, however, a very large species, and one whose punctuation is very delicate. The elytron is long and rather narrow, indicating an elongated form for the body, as in this genus, with parallel sides and a bluntly rounded tip. There are ten complete equidistant rows of delicate, lightly impressed punctures, those of the same row less distant than the width of the interspaces; the outer row lies close to the outer border and is seated in an impressed stria, as also is the apical half of the inner row; but the other rows show no such connection between the punctures which compose them; at the base the rows curve very slightly outward to make place for a very short humeral row of punctures, parallel to the inner complete row, and composed of only three or four punctures on the part preserved; the interspaces are smooth.

Length of fragment 4.5^{mm}; width of elytron 1.5^{mm}.

OTIORHYNCHIDÆ.

Epicœrus saxatilis Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 84–85 (*Eudiagogus*).—Twenty-seven specimens of this species have been found by Mr. Richardson, Mr. Bowditch, and myself. This and the two following species cannot be referred to *Eudiagogus* on account of the length of the snout. Although very small for *Epicœri* (especially the present species), they agree so well with *Epicœrus griseus* Schönh. from Mexico—one of the smallest of the group—that they would best be referred here, although they differ from this genus in the brevity and stoutness of the femora, all of which are swollen apically. It is possible that all three of the forms mentioned here should be referred to a single species, as there is certainly very little difference between them excepting in size; this is particularly the case with this and the next species. Together over one hundred of these species have been examined by me; they are, therefore, the most abundant fossils of the insect beds of the Green River shales.

Epicœrus effossus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 85–86 (*Eudiagogus*).—Nearly fifty specimens of this species are at hand, all found in Richardson's shales by Mr. Richardson, Mr. Bowditch, and myself, besides two I found in beds at the same spot, but about thirty metres lower; these were the only *Coleoptera* found at that spot, excepting a single specimen of *Otiorhynchus dubius* Scudd., belonging to the same family.

Epicœrus exanimis Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 58 (*Eudiagogus*).—Thirty-one specimens of this species have been examined.

Ophryastes compactus.—A single specimen (No. 4210), preserved so as to show a lateral view of the insect, appears to indicate an Otiorhynchid allied to *Ophryastes*. The form of the elytra, indeed, does not well correspond, since, in place of their abrupt posterior descent, as seen in *O. cinereus* Schönh. from Mexico, with which it agrees best in general features as also in size, they slope very gradually, and appear to be tumid next the base. But the structure of the stout snout, enlarged apically, with very oblique descending antennal scrobes, the superior transverse furrow at its base giving an increased convexity to the vertex of the head, ally it closely to *Ophryastes*. The ovate eye is longitudinal, the front border of the pronotum nearly straight with no advance of the sides, the prothorax itself faintly rugulose, the elytra coarsely striate, the striæ with feeble, rather distant punctures (the reverse is shown on the stone); the tips of the elytra are right-angled or slightly produced at the extremity, as in recent species.

Length of body, measured from base of rostrum, 7.5^{mm}; height of same 3.5^{mm}; length of elytra 5.5^{mm}, of rostrum beyond front of eyes 1.2^{mm}; breadth of rostrum at base 0.9^{mm}, where largest 1.05^{mm}; length of eye 0.5^{mm}; breadth of same 0.3^{mm}; distance apart of the elytral striæ 0.35^{mm}.

Otiorhynchus perditus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 84.—A single specimen was found by Mr. Richardson; another, found by myself, is doubtfully referred here, but is so fragmentary as to add nothing to the characters already given.

Otiorhynchus dubius.—A cast of an elytron (No. 4204) resembles so closely the elytron of the preceding species, excepting in size, that it is referred to the same genus. Only nine striæ can be counted, but all of those at the outer side may not be seen; the inner stria is very close to the margin, and indeed is lost in it both above and below, but this may be due simply to the preservation. The stone in which they are preserved is coarser than usual, coming from beds about thirty metres directly below the shales which have furnished the other insect remains, and has a greater admixture of sand; consequently the character of the surface of the elytra cannot be determined, but the striæ are sharp and narrow, and filled with longitudinal punctures. With the exception of a couple of poor specimens of *Epicærus effossus* Scudd., this was the only recognizable insect found at this locality.

Length of elytron 4^{mm}; breadth of same 1.5^{mm}.

Eudiagogus terrosus.—This species, which seems more properly referable to *Eudiagogus* than those formerly so named by me, is represented by a single specimen and its reverse (Nos. 4024, 4078), preserved on a side view. The snout is short, as long as the eyes, scarcely so long as the head, and stout; the eyes transverse, rather large, subreniform. The thorax appears to be smooth, like the head, deep and short, its front border extending forward on the sides toward the lower part of the eye. The elytra, the lower surface of which does not appear to be in view, are broad and long, rectangular at tip, furnished with more than eight rows of frequent, rounded, moderately large and shallow punctures, and between each pair of rows a similar row with smaller punctures.

Length of body 6^{mm}, of elytra 4.55^{mm}, of eyes 0.5^{mm}.

CURCULIONIDÆ.

Sitones grandævus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 83–84.—A single specimen, found by Mr. Richardson.

Hylobius provectus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 86.—A single specimen was found by Mr. Richardson. Another specimen (No. 4051), taken by Mr. Bowditch at the same locality, shows the character of the rostrum. The specimen is strangely preserved, as there appears to be a second rostrum, a perfect counterpart of the first, attached to it at the tip; perhaps this belongs to another individual, of which the rostrum only is preserved. The rostrum is about as long as the thorax, scarcely tapering as viewed laterally, gently curved, with a median, lateral, longitudinal groove, directed toward the middle of the eye, just as in *H. confusus* Kirb., besides the antennal scrobes, which are directed obliquely toward its base.

Gymnetron LeContei.—A single well-preserved specimen, with its reverse (Nos. 4030, 4047), lies in such a position as to show a partly lateral and partly dorsal view; the legs are also preserved, so that it is the most perfect of the Green River *Coleoptera*. The small head, long and slender, straight, and drooping snout, the tapering thorax, broad and short striate elytra, thickened femora, and long and slender tibiæ leave little doubt that it should be referred to *Gymnetron* or to its immediate vicinity. It is very nearly as large as *G. teter* Schönh., with which it closely agrees in almost every part. The third tarsal joint is similarly expanded. The real length of the rostrum cannot be determined from the position of the insect, but it is apparently as long as the head and thorax together, is very nearly straight, slender, scarcely enlarged, and obliquely docked at the tip; only a portion of the antennal scrobes can be seen; this is in the middle of the beak, where the groove is narrow, deep, sharply defined, and inclined slightly downward toward the base of the beak. The thorax is subrugulose, and the surface of the elytra smooth, with distinct, but not deeply impressed, very faintly punctured striæ. The whole specimen is piceous.

Length of body 3.15^{mm}, of snout 1^{mm}?, of head and thorax 0.9^{mm}, of thorax 0.75^{mm}, of elytra 2.25^{mm}, of hind tibiæ 1.5^{mm}; distance apart of elytral striæ 0.1^{mm}.

Cryptorhynchus annosus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 86–87.—A single specimen, found by Mr. Richardson.

SCOLYTIDÆ.

Dryocœtes impressus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 83 (*Trypodendron*).—Mr. Richardson obtained a single specimen, upon which the original description was based. Several additional specimens (Nos. 4009, 4048, 4091) were obtained by Mr. Bowditch and myself, and these help to show that the insect would better be referred to *Dryocœtes* than to *Trypodendron* (= *Xyloterus* of LeConte's recent monograph). The species is of about the size of *D. septentrionalis* (Mann.), but has more of the markings of *D. affaber* (Mann.), although the punctuation of the elytra is not so distinctly separable into longitudinal series.

Dryocœtes carbonarius.—Another species, not very closely allied to the last, is represented by a single, rather mutilated specimen (No. 3999), which is pitchy-black, and consists of part of the head, thorax, and elytra. The head is rather long, faintly and not very closely punctured, the eye moderately large and circular. The thorax is proportionally longer than in the preceding species; the front margin recedes a little on the sides, and the surface is subrugose by subconfluent punctures, the walls of which form wavy ridges having a longitudinal direction. The elytra are broken at the tip; their outer anterior angle is obliquely excised, and the outer margin behind it straight, not sinuate, as in the preceding species; the surface is rather coarsely, but very faintly granulate, more distinctly next the base, but even here very vaguely; and there are faint indications of three or four distant, simple, longitudinal striæ.

Length of the fragment as curved 4^{mm}, of head 1.1^{mm}?, of thorax 1.3^{mm}; probable length of elytra 3.15^{mm}; width of same 1.5^{mm}; diameter of eye 0.35^{mm}.

ANTHRIBIDÆ.

Cratoparis repertus.—A single specimen (No. 4035) shows the fragment of an elytron, which is referred to this genus from the character of the punctuation and the arrangement of the striæ. It closely resembles *C. lunatus* Fahr. in these points, but must have belonged to a slenderer insect, about as large as *C. lugubris* Fahr. There are eleven striæ or rows of pretty large, subconfluent, short, longitudinal dashes or oval punctures, deeply impressed, the outer of which follows the extreme margin, excepting apically; the inner stria also runs very near the border; the interspaces between the first and second and between the second and third striæ are equal, and a little broader than the interspaces between the other striæ; the inner margin is delicately grooved next the base, as in *C. confusus.*

Length of fragment 4.3^{mm}; width of elytra 1.6^{mm}; width of interspace between second and third striæ 0.21^{mm}, between third and fourth striæ 0.13^{mm}.

Cratoparis? elusus.—To this I refer doubtfully two specimens (Nos. 4012, 4060), neither of them very perfect, which appear to belong together, and to represent an insect allied at least to *Cratoparis*, and of about the size of *C. lunatus* Fahr. It appears to have a short rostrum, a moderately small, but rather tumid head, with circular eyes; thorax not greatly attenuated anteriorly, but profusely punctate, with moderately large and rather shallow punctures; elytra arched, nearly three times longer than the thorax when measured over the curved back, furnished with slight and faintly impunctured striæ; the surface between the striæ also punctured, but very faintly.

Length of body 7.5^{mm}, of thorax 2.25^{mm}, of elytra 5.5^{mm}.

Brachytarsus pristinus Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. ii, 87.—A single specimen, obtained by Mr. Richardson.

HEMIPTERA.

(HETEROPTERA.)

PENTATOMIDÆ.

(CYDNINA.)

Cyrtomenus concinnus.—This species is represented by a single specimen (No. 4190), a little smaller than *C. mutabilis* (Perty), but closely resembling it in general form. It is broadly ovate; the head large, prominent, well rounded, nearly half the eyes protruding beyond the margin, the ocelli nearly one-fourth the diameter of the eyes, and situated next the hind border, very nearly half-way between the inner margin of the eyes and the middle line of the head. Thorax twice as broad as the head, exclusive of the projecting part of the eye, more than twice as broad as long, the front margin rather deeply and regularly concave, the sides considerably convex, especially on the front half, the hind margin very broadly convex. Scutellum longer than the thorax, scarcely less tapering on the apical than on the basal half, the apex rounded, half as broad as the base, the whole about as long as the breadth at base. Tegmina very faint, but the corium apparently terminating just before the tip of the scutellum. Extremity of the abdomen very broadly rounded. The whole surface of the head, thorax, scutellum, and probably of the corium, uniformly very profusely and minutely punctulate; otherwise smooth, excepting that there are also faint traces of a slight, transverse, median depression, and a similar longitudinal median depression on the thorax.

Length of body 5.25^{mm}, of head 1.2^{mm}, of thorax 1.3^{mm}, of scutellum 1.65^{mm}; breadth of head 2^{mm}, of thorax 3.5^{mm}; diameter of eye 0.25^{mm}.

Aethus punctulatus.—Five specimens of this species were found (Nos. 19^d, 67^c, 74^a, 172, and 4193). Body of nearly equal breadth throughout, the sides of the abdomen a little fuller. Head rounded, small, the part behind the eyes rounded, as deep as the portion in front of them; front, as seen from above, well rounded, well advanced, subangulate; eyes moderately large; ocelli large, situated close to, a little behind, and within the eyes, and about one-third their diameter; surface of head minutely and obscurely granulate. Thorax nearly equal, slightly broadening posteriorly, the anterior angles well rounded, the front border very deeply and roundly excised, the hind border nearly straight; the whole fully twice as broad as the head, and twice as broad as long. Scutellum obscure, but apparently of about equal length and breadth, and regularly triangular. Abdomen well rounded, half as long again as broad. Tegmina obscure or lost in all the specimens seen. Thorax and scutellum minutely granulate, like the head. Posterior half, at least, of the abdomen profusely covered with shallow punctures.

Length of body 3.75^{mm}, of head 0.6^{mm}, of middle of thorax 0.75^{mm}; breadth of head 0.8^{mm}, of thorax 1.8^{mm}, of abdomen 2.25^{mm}.

Cydnus ? mamillanus.—An obscure specimen (No. 39) is of doubtful generic relations, but evidently belongs to the *Cydnidæ.* The body is broad and convex in front, with a rapidly tapering abdomen, scarcely at all rounded, even at the tip. The head, as seen from above, is nearly circular, shaped much as in *Aethus punctulatus,* but more broadly and regularly rounded in front, with the central lobe broad, and defined by rather strongly impressed furrows; the ocelli are large, situated just behind the anterior extension of the thoracic lobes; the surface of the head is rugulose. Thorax more than twice as broad as the head, and more than half as long again; the sides rounded, being broadest at the posterior border, narrowing in front and roundly excised at the anterior angles; front border very deeply hollowed behind the head, leaving prominent front lobes on either side, nearly as large as the head, and strongly mamillate; hind border nearly straight. The surface is minutely granulate; besides which there is a transverse belt of rather large and distant punctures midway between the mamillations and the hind border. The scutellum is very large, rounded-triangular, broader than long, and granulate like the thorax. Corium of tegmina, which occupies their greater portion, obscurely and distantly punctulate; abdomen triangular, the apex bluntly pointed.

Length of body 4^{mm}, of head 0.8^{mm}, of either lateral half of thorax 1.35^{mm}; breadth of head, 1^{mm}, of thorax, 2.4^{mm}.

LYGÆIDÆ.

(Myodochina.)

Rhyparochromus ? terreus.—A single poor specimen (No. 4192) apparently belongs to this subfamily, but is too imperfect to locate with any precision. The body is of nearly equal width, but with a full abdomen. The head is broken, but is as broad at base as the tip of the thorax, has a rounded-angular front, and its surface most minutely punctulate. The thorax was broadest behind, the sides tapering slightly, and gently convex, the front border broadly and shallowly concave, the hind border straight, more than twice as broad as the median length, the surface, like that of the head, with faint distant punctures. Scutellum rather small, triangular, pointed, of equal length and breadth, about as long as the thorax, its surface like that of the thorax, but with more distinct punctures. Abdomen full, well rounded, and very regular. Tegmina obscure (but perhaps extending only a little beyond the scutellum).

Length of body 4^{mm}, of head 0.6^{mm}, of thorax 0.6^{mm}, of scutellum 0.7^{mm}; breadth of head 1.1^{mm}, of thorax 1.5^{mm}, of abdomen 2.1^{mm}.

REDUVIIDÆ.

(REDUVIINA.)

Reduvius ? guttatus.—Two specimens of this species have been found, one with reverses (No. 9^a, 96^b), by Mr. Richardson, the other (No. 4070) by myself. Mr. Richardson's specimens are very obscure and distorted, and without the aid of the other could not have been determined. The insect probably belongs to the genus *Reduvius* (*sens. str.*), or at all events falls in its immediate vicinity. The body has much the form of the common *R. personatus* Linn., of Europe, but is proportionally shorter. All parts are rather obscure, but the head evidently tapers and is roundly pointed in front, the thorax narrows gently from behind forward and is nearly as long as broad; the scutellum is rather small, triangular, the apex bent at a right angle and rounded. The abdomen is ovate, twice as long as broad. The species is marked with round, dark spots, about 0.2^{mm} in diameter, on either side, one at the outer edge of the front of each abdominal segment, and one in the middle of either transverse half of the thorax, a little removed from the outer border; the anterior ones half-way between the border and the middle line. The whole surface appears to be very minutely granulated. The tegmina cannot be seen.

Length of body 5.5^{mm}; breadth of thorax 1.4^{mm}, of abdomen 1.65^{mm}.

[HOMOPTERA.]

JASSIDÆ.

Acocephalus Adæ.—Two specimens (Nos. 72, 100) represent the body of apparently a species of *Acocephalus.* The head projects forward in a triangular form, is rounded at the extreme apex, a little broader than long, and nearly twice as broad between the small eyes as its length in advance of them. The body is slender, the abdomen slightly tapering, rounded at the apex. The tegmina extend a short distance beyond the body with parallel longitudinal veins.

Length of body 5.25^{mm}; breadth of head 1.4^{mm}, of middle of abdomen 1.3^{mm}.

FULGORIDÆ.

(FULGORIDA.)

Fulgora ? granulosa.—A single specimen and its reverse (Nos. 49, 131) show only the thorax and abdomen of an insect belonging to the subfamily of *Fulgorida*, but of which little more can be said. The thorax is large, globose, and black; the scutellum is about half as large as the thorax, longer than broad, and rounded at the apex; the abdomen tapers gently, its apex about half as broad as its base, and is provided with a pair of overlapping, black, roundish, oval plates, giving the appearance of an additional segment. The surface of the thorax and abdomen is thickly and uniformly granulate with circular, dark-edged elevations, averaging 0.04^{mm} in diameter; the scutellum lacks this marking, excepting at the edges, which are more minutely and profusely granulate.

Length of body 8.5^{mm}, of thorax 2.75^{mm}, of scutellum 1.4^{mm}, of appendages 1^{mm}; breadth of thorax 2.5^{mm}, of scutellum 1.25^{mm}, of second segment of abdomen 2.2^{mm}.

Aphana rotundipennis.—This name is proposed for a single broken wing of an Homopteron (No. 175), with which another wing (No. 4187), still more imperfect, appears to agree; and which seem by their obscure venation to belong in the same group as the White River fossil which I have called *Aphana atava.* It differs, however, in having a strongly bowed costa, which is curved more apically than near the base, and continues very regularly the curve of the well-rounded apex; the commissural border is perfectly straight; the principal veins fork near the base, so that there are a number of longitudinal veins a short distance therefrom; no transverse veins are discernible, nor oblique veins at the costal margin, but the longitudinal veins all fork at a similar distance from the apex, so that the apical fifth of the wing is filled with still more numerous longitudinal veins; the tegmina are broadest just beyond the middle.

Length of tegmina 6.75^{mm}; breadth of same 3^{mm}.

Lystra? Richardsoni.—I have before me a number of specimens (Nos. 67, 119, 4076, 4207, 4208, 4212, 4217) of a large Fulgorid, apparently belonging near *Lystra* and *Pœocera*, but which have only been preserved in a fragmentary condition. Enough, however, remains to show several features; the vertex between the eyes is half as broad again as the eyes, and at least as long as broad, projecting beyond the eyes by more than the diameter of the latter, and well rounded. The scutellum is large, fully as long as broad. The longitudinal veins of the tegmina are rather infrequent, forking rarely, and even toward the apex seldom connected by cross-veins; apparently, all the principal veins branch at about the same points, viz, near the middle of the basal and of the apical half; the tegmina somewhat surpass the abdomen. The body is broadest at the second or the third abdominal segment, and tapers rapidly to a point, the segments being equal in length.

Length of body 16^{mm}; probable length of tegmina 15.5^{mm}; breadth of abdomen 5.5^{mm}.

(CIXIINA.)

Cixius? hesperidum.—A single fragment (No. 38), representing a nearly perfect tegmen, with obscure venation, is probably to be referred to *Cix-*

ius, but is unsatisfactory; the costal border is gently and regularly convex, the tip well rounded, with no projecting apex; the tegmen appears to increase very slightly in size to a little beyond the middle, up to which point the borders are nearly parallel; the course and branching of the nervures, so far as they can be made out, seem to indicate an insect allied to *Cixius*, but no cross-veins can be seen.

Length of tegmen 6.2^{mm}; its greatest breadth 2.5^{mm}.

Mnemosyne terrentula.—A single specimen (No. 31^{d}) is preserved, with an indistinct body, broken in front, and the greater part of one of the tegmina, which show it to be very closely related to, if not a member of, this genus. The body is moderately broad, ovate, the tip of the abdomen rounded and slightly produced. The tegmina are regularly enlarged toward the apex and rounded at the extremity, not at all truncate; the interior branch of the radial vein forks near the middle of the wing, and just beyond the first subapical transverse vein; both its branches fork before they have passed more than half-way to the marginal row of elongate cells.

Estimated length of body 6.5^{mm}, breadth of same 2.25^{mm}; length of tegmina 7^{mm}, breadth of same 2.25^{mm}, their extent beyond the abdomen 2.2^{mm}.

(TROPIDUCHIDA.)

Lithopsis (λίθος, ὄψις), nov. gen.

Body oblong, stout, and apparently cylindrical anteriorly, tapering and probably compressed posteriorly. Head broad and short, the front not produced beyond the eyes, broad, transverse, very gently convex. The united thorax and scutellum of about equal length and breadth. Tegmina surpassing considerably the tip of the abdomen, two or three times as long as broad, beyond the middle barely tapering, the sides subequal, the tip obliquely subtruncate, the apex rounded, the costal margin gently convex; margino-costal area broad, broadening regularly toward the apex, and throughout its length traversed by very frequent transverse veinlets, which become more and more oblique toward the apex of the tegmina, where they are supplanted by the similarly close branches of the longitudinal veins; these are united at the origin of the forks by transverse veins in continuity with the costa itself. The radial vein is branched at the base of the tegmina, the inner ulnar vein at some distance before the middle of the wing; and both branches of this vein, and the lower branch of the radial, fork again at half the distance from the first fork of the inner ulnar vein to the tip of the wing, but they are not connected at this point by transverse veins. Wings as long as the tegmina.

This genus seems to belong nearest the South American genus *Alcestis* Stål, but differs decidedly from it in the form of the tegmina, the absence of oblique inferior ramuli to the inner ulnar vein, and the structure of the head.

Lithopsis fimbriata.—A tolerably well-preserved specimen, with its reverse (Nos. 4185, 4189), together with the fragment of a wing (No. 143^c,) are the basis for this species. The vertex between the eyes is more than twice the width of the eyes, and is marked by a slight, median, longitudinal carina; the front of the vertex is nearly straight, does not protrude beyond the eyes, but is retracted next them, making it very broadly convex. The thorax is considerably broader than the head, but the condition of the specimens does not allow a more definite statement. The tegmina are the best-preserved remains of the animal, being perfect, although somewhat obscure, partly from the veins of the underlying wings; they are more than two and a half times longer than broad, the costal margin, especially its basal half, moderately curved, the commissural margin almost perfectly straight, the apex slightly and obliquely truncate, so as to throw its well-rounded apex below the middle; near its extremity the margino-costal field occupies more than a third of the breadth of the tegmina, being double its width near the base; the first branching of the inner ulnar vein is as far from the apex of the tegmina as the second branching is from the base; and the third branching, where, and where only, the longitudinal veins are united by cross-nervures, is midway between the second branching and the apex; close to the apical margin there is an inconspicuous fourth series of furcations.

Length of body 9^{mm}, of tegmina 9.75^{mm}; breadth of the same in the middle 3.65^{mm}, next the third branching of the longitudinal veins 3.25^{mm}.

ORTHOPTERA.

GRYLLIDES.

Nemobius tertiarius.—Two specimens (Nos. 18, 20) represent the hind femora (and No. 18 also the hind tibia and a femur and tibia of the front leg) of a small cricket. The insect must have been rather smaller than our common *N. vittatus* (Harr.), its hind femur being 7^{mm} long, broad and stout, especially near the base, where it measures 2.1^{mm}; its upper half is covered with exceedingly delicate, recumbent hairs, directed backward; there are also a few hairs upon the slender hind tibia, which is broken just where it begins to enlarge, showing signs of the upper spines; this portion is about three-fourths the length of the femur. The front femur and tibia, which are each only 2.25^{mm} long, also indicate a small species and one that is unusually free from spines, no hairs even being discernible on this front leg.

LOCUSTARIÆ.

The only other remains of *Orthoptera* noticed in the Green River shales is a tibia and fragment of the attached femur (No. 2) of what is apparently the middle leg of a Locustarian about the size of a *Phylloptera*.

NEUROPTERA.

ODONATA.

(LIBELLULINA.)

Fragments of an abdomen in obverse and reverse (Nos. 4175, 4176) are probably to be referred to a species of *Libellulina*, but they are insufficient to give further determination. They evidently represent four or five of the terminal segments of the body, there being first three segments of equal breadth and a similar length, a little longer than broad, with a slight median carina; and then three others without a median carina and with continually decreasing length, the first of them (probably the eighth segment) half as long as the preceding, but of the same width; the next half as long as the one which precedes it, but narrower, and the last still narrower (but imperfect).

Length of the fragment 20^{mm}, of its third (seventh? abdominal) segment 4.5^{mm}; breadth of same 3.5.

(AGRIONINA.)

Dysagrion Fredericii Scudd., Bull. U. S. Geol. and Geogr. Surv. Terr. 4, 534–537.—This has already been sufficiently mentioned in the paper cited.

Podagrion abortivum.—A second species of *Agrionina*, at first sight very different from the preceding, proves to belong to the same legion (*Podagrion*); and, so far as its meagre representation by the specimen (No. 4169) goes, to the genus *Podagrion* proper, agreeing with it in the character of the pterostigma and the supplementary sectors. The specimen represents the apical part of a wing with fragments of the middle portion. The pterostigma is a little more than twice as long as broad, and although less oblique on the inner than on the outer side, yet lies at an angle of forty-five degrees with the costal edge, and is therefore more oblique than usual in *Podagrion*; its outer side is arcuate as well as very oblique, but in its entire extent the pterostigma scarcely surmounts two cellules; the outer side is much thicker than the inner, and thickens below as it passes gradually into the lower border, which, like the costal, is much thickened, and appears the more so from being independent of, although in conjunction with, the median nervure. Beyond the pterostigma, the ultranodal approaches the principal nervure very closely, so that they are only half as far apart at the margin as below the pterostigma; there are two supplementary sectors, one between the ultranodal and the nodal, arising below the outer half of the pterostigma, the other between the nodal and subnodal, arising slightly further back; both of these supplementary sectors are straight, but the nodal is slightly undulated after the origin of the supplementary sectors; all the other veins, excepting the extreme tip of the principal, are straight, and the reticulation tetragonal. The wing appears to be hyaline throughout, the pterostigma very slightly infumated, the nervures fusco-castaneous, those about the pterostigma deepening nearly to black. Apically the wing is well rounded, its apex falling in the middle and not at all produced. A species is indicated of about the size of *P. macropus* Sel.

Length of pterostigma along costal edge 1.5^{mm}, of same from inner lower angle to outer upper angle 2.1^{mm}; breadth of pterostigma 0.65^{mm}, of wing in middle of apical half 5.5^{mm}.

ARACHNIDA.

Nos. 3, 4^{a}, 4199, 4200, represent legs of the same or allied species of spider of about the size of *Epeira riparia* Hentz; femora and tibiæ and the sides of the tarsi are abundantly supplied with longitudinal rows of fine, long, black spines, the claw double. No. 36 preserves the spines alone of the same sort of leg.

Length of femora 7^{mm}, of tibiæ 7.75^{mm}, of tarsi 3.25, of claw 0.3^{mm}, of spines 0.75^{mm}.

No. 63 shows the hairy, subfusiform, ovate body of a spider apparently a little smaller than the above.

Length of abdomen 4.5^{mm}; breadth of same 1.8^{mm}.

No. 4201 is the egg-cocoon of a spider, and is of exactly the same size, shape, and general appearance as those from British Columbia, which I have described under the name of *Aranea columbiæ*, excepting that, from a break in the stone, there is no trace of a pedicel.

Length of egg-cocoon 5^{mm}; breadth 4^{mm}.

MYRIAPODA.

Iulus telluster.—A single Myriapod (No. 154^{a}) found by Mr. Richardson in the Green River bed is so fragmentary that it can only be referred to *Iulus* in a broad generic sense. The piece is composed of ten or twelve segments, probably from near the middle of the body, lying in a straight line and crushed, with no trace of any appendages. The segments appear to be composed of a short anterior and a larger posterior division, each independently and very slighly arched; the posterior division is about twice as long as the anterior, and each is transversely regularly and very finely striate parallel to the anterior and posterior margins of the segments. The foramina can be detected on some of the segments, and by their aid the width of the body can be more accurately determined. As crushed, the body is 2.3^{mm} broad, but its probable true width is 1.5^{mm}, while the segments are each about 0.8^{mm} long; the fragment preserved measures 8.5^{mm} long.

ART. XXXIII.—REPORT ON THE COLLECTION OF FISHES MADE BY DR. ELLIOTT COUES U. S. A. IN DAKOTA AND MONTANA DURING THE SEASONS OF 1873 AND 1874.

BY DAVID S. JORDAN, M. D.

[The fishes worked up by Professor Jordan in the present communication represent probably about two-thirds of the collection made during my connection with the United States Northern Boundary Commission, the remainder of the specimens having been lost or mislaid. I am informed, however, that the series submitted to Professor Jordan contains some novelties, rarities, and other specimens of sufficient interest to render publication desirable. I have incorporated a few collector's field-notes with the author's manuscript. The fishes taken in 1873 were secured in the waters of the Red and Mouse Rivers and some of their affluents; those secured in 1874 are from watersheds entirely different both from the last named and from each other, being partly taken from the Milk River and its northern tributaries, and partly from the Saint Mary's River, Chief Mountain Lake, and other headwaters of the Saskatchewan.

For articles on other portions of my collections see this Bulletin, this Vol., No. 1, pp. 259–292; No. 2, pp. 481–518; No. 3, pp. 545–661; No. 4, pp. 801–830.—ED.]

By some accident, the exact record of the localities of some of the smaller fishes has been lost or confused, and some of the specimens collected by Dr. Coues have failed to reach the writer, having probably been distributed through the general collection of the National Museum. I therefore add the field record of Dr. Coues, from which the general field of collection can be ascertained.

Collector's Memorandum.

1000. Catfish. Red River, near Pembina, Dakota. May 30, 1873.

1076. Pike [*Esox lucius*]. Near Turtle Mountain, Dakota. Aug. 10, 1873.

1084. Lot of small fish. Mouse River, Dakota. Aug. 17, 1873.

1100. Shovel-nosed Sturgeon [*Scaphirhynchops platyrhynchus*]. Fort Buford, Dakota. June 12, 1874.

1103–4–5. Catfish [*Ichthælurus punctatus*]. Big Muddy River. June 20, 1874.

1109–10. Lot of small fish [*Hyodon chrysopsis*]. Quaking Ash River. June 26, 1874.

1139. Sucker [*Catostomus teres*]. Two Forks Milk River. July 15, 1874.

1140. Cyprinoid. Two Forks Milk River. July 15, 1874.

1143. Sucker [*Catostomus teres*]. Two Forks Milk River. July 17, 1874.

1144. Cyprinoid. Two Forks Milk River. July 17, 1874.

1155–6. Lot of fish [*Pantosteus virescens*]. Sweetgrass Hills. July 29, 1874.

1162. Sucker [*Catostomus teres*]. Headwaters Milk River. Aug. 9, 1874.

1163–4–5. Lot of fish, three kinds. Headwaters Milk River. Aug. 9, 1874.

1168. Large fish. Headwaters Milk River. Aug. 14, 1874.

1169–70–1–2–3. Lots of fish. Headwaters Milk River. Aug. 14, 1874.

1174. River Trout [*Salmo clarki*]. Saint Mary's River. Aug. 16, 1874.

1175. "Gristle-nosed Fish" [*Polyodon folium ?*]. Saint Mary's River. Aug. 16, 1874.

1176. Pike [*Esox lucius*]. Saint Mary's River. Aug. 16, 1874.
1178. Lake Trout [*Cristivomer namaycush*]. Chief Mountain Lake. Aug. 18, 1874.
1179. Whitefish [*Coregonus quadrilateralis*]. Chief Mountain Lake. Aug. 18, 1874.
1182. Whitefish [*Coregonus couesi*]. Chief Mountain Lake. Aug. 18, 1874.
1189. Head of 18-lb. Salmon [*Salmo stomias*]. Chief Mountain Lake. Aug. 24, 1874.
1192. Sucker [*Catostomus teres*]. Chief Mountain Lake. Aug. 28, 1874.

Family ACIPENSERIDÆ.

Genus SCAPHIRHYNCHOPS Gill.

(*Scaphirhynchus* Heckel preoccupied.)

1.—SCAPHIRHYNCHOPS PLATYRHYNCHUS (Raf.) Gill.

Shovel-nosed Sturgeon.

1820—*Acipenser platorhynchus* RAF., Ich. Oh. p. 80
Acipenser platorhynchus KIRTLAND, Rept. Zool. Ohio, 1838, 196.
Acipenser platorhynchus KIRTLAND, Bost. Journ. Nat. Hist. v, 25.
Acipenser platorhynchus STORER, Synopsis Fish N. A. (1846), 501.
Scaphirhynchus platyrhynchus BAIRD, Iconogr. Encycl. ii, 1850, 238.
Scaphirhynchus platyrhynchus GIRARD, U. S. Pac. R. R. Surv. x, 357.
Scaphirhynchus platyrhynchus JORDAN, Man. Vert. 1876, 312, and of American writers generally.
Scaphirhynchops platyrhynchus GILL, 1867? (in a catalogue of fishes of the Missouri region; the reference not at hand. (Name only.)
Scaphirhynchops platyrhynchus COPE & YARROW, Zool. Lieut. Wheeler's Expl. W. 100th Mer. v, 1876, 639.
Scaphirhynchops platyrhynchus JORDAN & COPELAND, Check List Fishes, 1876, 161.
Scaphirhynchops platyrhynchus NELSON, Bull. Ills. Mus. Nat. Hist. 51, 1876.
Scaphirhynchops platyrhynchus JORDAN, Man. Vert. ed. 2d, 346, 1878.
Scaphirhynchops platyrhynchus JORDAN, Cat. Fishes N. Am. 413, 1878.
1834—*Acipenser cataphractus* GRAY, Proc. Zool. Soc. London, 122.
Scaphirhynchus cataphractus GÜNTHER, Cat. Fishes Brit. Mus. viii, 345, 1870.
1835—*Scaphirhynchus rafinesquii* HECKEL, Ann. Wiener Mus. Naturg. i, 71.
Scaphirhynchus rafinesquii HECKEL, Ann. Wien. Mus. Naturg. i, 72, pl. viii.
Scaphirhynchus rafinesquii BRUTZER, Dissert. Dorpat. 1860.

Dr. Coues writes me that he obtained a fine specimen of this species at Fort Buford, Dakota. I have not seen it, however. This species seems to be abundant in all the large streams between the Alleghanies and the Rio Grande. West of the Rio Grande Basin, it has not yet been noted.

The "Gristle-nosed Fish" from Saint Mary's River, recorded by Dr. Coues, is perhaps *Polyodon folium* Lac. I have not seen the specimen referred to.

Family SILURIDÆ.

Genus ICHTHÆLURUS Rafinesque.

2.—ICHTHÆLURUS PUNCTATUS (Raf.) Jor.

Channel Cat. White Cat. Lady Cat.

1818—*Silurus punctatus* RAF., Amer. Monthly Mag. and Critical Review, Sept. 359.
Ictalurus punctatus JORDAN (1876), Bull. Buff. Soc. Nat. Hist. 95.

Ictalurus punctatus JORDAN (1876), Manual of Vertebrates, 300.
Ictalurus punctatus JORDAN & COPELAND (1876), Check List in Bull. Buff. Soc. Nat. Hist. 159.
Ictalurus punctatus JORDAN (1877), Annals Lyc. Nat. Hist. N. Y. 350.
Ictalurus punctatus NELSON (1876), Bull. Ills. Mus. Nat. Hist. 50.
Ichthælurus punctatus JORDAN (1877), Bull. U. S. Nat. Mus. ix, 38.
Ichthælurus punctatus JORDAN (1877), Bull. U. S. Nat. Mus. x, 76.
Ichthælurus punctatus JORDAN (1878), Man. Vert. ed. 2d, 328.
Ichthælurus punctatus JORDAN (1878), Bull. Hayden's Geog. Geol. Surv. Terr. 415.

1819—*Pimelodus caudafurcatus* LE SUEUR, Mémoires du Muséum, v, 152.
Amiurus caudafurcatus GÜNTHER (1864), Catalogue of Fishes, v, 102.

1820—*Silurus maculatus* RAF., Quarterly Journal of Science, Literature, and Arts, London, 48 (et var. *erythroptera*, 49).
Pimelodus (Ictalurus) maculatus RAF. (1820), Ichthyologia Ohiensis, 62.

1820—*Silurus pallidus* RAF., Quart. Journ. Sci. Lit. Arts, London, 49 (et vars. *marginatus, lateralis, leucoptera*).
Pimelodus pallidus RAF. (1820), Ich. Oh. 63.
Pimelodus pallidus KIRTLAND (1838), Report Zool. Ohio, 169, 194.

1820—*Silurus cerulescens* RAF., Quart. Journ. Sci. Lit. Arts, London, 49 (et var. *melanurus*).
Pimelodus cerulescens RAF. (1820), Ich. Ohiensis, 63.
Pimelodus cerulescens KIRTLAND (1838), Rept. Zool. Ohio, 169, 194; (1846), Bost. Journ. Nat. Hist. iv, 332.
Pimelodus cerulescens STORER (1846), Synopsis Fishes N. A. in Mem. Nat. Acad. Sci. 405.
Ictalurus cœrulescens GILL (1862), Proc. Bost. Soc. Nat. Hist. 43.
Ictalurus cœrulescens COPE (1865), Proc. Acad. Nat. Sci. Phila. 85; (1870), Proc. Am. Philos. Soc. 489.
Ictalurus cœrulescens JORDAN (1874), Ind. Geol. Survey, 222.
Ictalurus cœrulescens GILL (1876), Ich. Capt. Simpson's Exped. 417.
Ichthælurus cœrulescens COPE (1869), Journ. Acad. Nat. Sci. 237.

1820—*Silurus argentinus* RAF., Quart. Journ. Sci. Lit. Arts, London, 50.

1820—*Pimelodus argyrus* RAF., Ichthyologia Ohiensis, 64.

1840—*Pimelodus furcifer* CUV. & VAL., Hist. Nat. des Poiss. xv, 139.
Pimelodus furcifer "HYRTL (1859), Denkschr. Akad. Wiss. Wien, 16".
Pimelodus furcifer "KNER, Sitzgsber. Akad. Wiss. Wien, xxvi, 421".
Ictalurus furcifer GILL (1862), Proc. Bost. Soc. Nat. Hist. 43.
Ictalurus furcifer JORDAN (1876), Manual Vert. 300.

1852—*Pimelodus gracilis* HOUGH, Fifth Ann. Rept. Reg. Univ. Condition State Cabinet Nat. Hist. Albany, 26.
Synechoglanis gracilis GILL (1859), Trans. Lyc. Nat. Hist. 3 (reprint).
Ictalurus gracilis GILL (1862), Proc. Bost. Soc. Nat. Hist. 43.
Ictalurus gracilis COPE (1865), Proc. Acad. Nat. Sci. Phila. 85.
Ictalurus gracilis JORDAN (1876), Man. Vert. 300.
Ictalurus gracilis JORDAN & COPELAND (1876), Check List, 159.

1858—*Pimelodus vulpes* GIRARD, Proc. Acad. Nat. Sci. Phila. 170; (1859), U. S. and Mex. Bound. Surv. 33.
Ictalurus vulpes GILL (1862), Proc. Bost. Soc. Nat. Hist. 43.
Ictalurus vulpes JORDAN & COPELAND (1876), Check List, 159.

1858—*Pimelodus olivaceus* GIRARD, Pac. R. R. Survey, x, 211.
Ictalurus olivaceus GILL (1862), l. c. 43; (1876), Rept. Ichthy. Capt. Simpson's Exp. 417.
Ictalurus olivaceus JORDAN (1876), Man. Vert. 300.
Ictalurus olivaceus JORDAN & COPELAND (1876), Check List, 159.

1859—*Synechoglanis beadlei* GILL (1859), Trans. Lyc. Nat. Hist. N. Y. 2 (reprint).

Ictalurus beadlei GILL (1862), Proc. Bost. Soc. Nat. Hist. 43.
Ictalurus beadlei JORDAN & COPELAND (1876), Check List, 159.
1859—*Pimelodus houghii* GIRARD, Proc. Acad. Nat. Sci. Phila. 159.
1859—*Pimelodus megalops* GIRARD, Proc. Acad. Nat. Sci. Phila. 161.
Ictalurus megalops JORDAN & COPELAND (1876), Bull. Buff. Soc. Nat. Hist. 159.
1859—*Pimelodus graciosus* GIRARD, Proc. Acad. Nat. Sci. Phila. 161.
1860—*Pimelodus hammondii* ABBOTT, Proc. Acad. Nat. Sci. Phila. 568.
1860—*Pimelodus notatus* ABBOTT, Proc. Acad. Nat. Sci. Phila. 569.
1862—*Ictalurus simpsoni* GILL, Proc. Bost. Soc. Nat. Hist. 43; (1876), Ich. Capt. Simpson's Exp. 417.

Heads of three specimens, not obviously different from Eastern specimens of this widely diffused species. The specific names *olivaceus*, *simpsoni*, *hammondi*, and *notatus* have been given to Channel Cats from the Missouri region, chiefly on account of their "remote habitat"; but the examination of specimens does not show a shade of difference.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21203	1103	Big Muddy River, Dak	Dr. Elliott Coues	June 20, 1874.
21204	1104	do	do	do.
21205	1105	do	do	do.

Family CATOSTOMIDÆ.

Genus PANTOSTEUS Cope.

3.—PANTOSTEUS VIRESCENS Cope.

1876—*Pantosteus virescens* COPE, Lieutenant Wheeler's Expl. W. 100 Mer. v, Zool. 675.
Pantosteus virescens JORDAN & COPELAND, Check List Fishes N. A. 156, 1876.
Pantosteus virescens, JORDAN, Bull. U. S. Geol. Surv. Terr. iv, 416, 1878.

Numerous small specimens, from two to seven inches in length, agreeing very well with Professor Cope's description. They all have the peculiar form of mouth, and the semi-cartilaginous maxillary sheath, which the other members of this genus and some of the species of *Catostomus* possess. The head is very short, forming barely one-fifth the length without caudal. The scales are very small, there being from 95 to 100 in the lateral line. All of these specimens have, however, a small fontanelle, which probably becomes closed with age; otherwise the species is to be referred to *Catostomus*. Its relations to *Catostomus discobolus* Cope are very close.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21191	1155	Sweet Grass Hills	Dr. Elliott Coues	July 29, 1874
21191	1156	do	do	do.

Genus CATOSTOMUS Le Sueur.

4.—CATOSTOMUS RETROPINNIS Jordan, sp. nov.

This species belongs to the subgenus of typical *Catostomus*. It is therefore related to *C. latipinnis*, *C. longirostris*, and *C. tahoensis*, and may be briefly characterized as having the body, scales, dorsal and ventral fins of *longirostris*, with the mouth and lips of *latipinnis*. Its nearest relations are, I think, with *latipinnis*, with which species it is compared below.

Body long and slender, subterete, compressed behind, the form therefore essentially that of *C. longirostris*, the depth contained 5½ times in the length. Head large, long, its length contained about four times in the total length without the caudal fin (4½ in *latipinnis*); interorbital space broad and flat, about 2½ times in length of head; eye small, high up, and posterior, entirely behind the middle of the head (near the middle in *latipinnis*); preorbital bone very long, its length about three times its depth (scarcely twice in *latipinnis*); the snout correspondingly prolonged; fontanelle quite small; mouth very large, formed as in *latipinnis*, but rather broader and not so long; upper lip pendent, very large, with a broad, free border, with 5 to 8 series of low tubercles, almost obliterated in the type-specimen, on account of the softening of the skin; lower lip very full, its posterior margin reaching to the nostrils (rather farther in *latipinnis*).

Dorsal fin not large, its rays I, 11 (I, 13, in *latipinnis*); its base about three-fifths the length of the head (five-sixths in *latipinnis*); its insertion unusually backward, much nearer base of caudal than the tip of the snout (much nearer the snout in *latipinnis*); caudal fin large, well forked, its rudimentary basal rays not greatly developed; anal fin long and high, reaching base of caudal; ventrals not reaching to vent (to vent in *latipinnis*); pectoral fins long.

Caudal peduncle rather stout and deep, its least depth more than one-third head (less than one-third in *latipinnis*); its length about two-thirds that of head (seven-eighths in *latipinnis*). In *latipinnis*, the caudal peduncle is notably long and slender.

Scales quite small, about as in *longirostris*, larger behind, the exposed portion not notably lengthened as in *latipinnis;* chest with well-developed scales (these rudimentary and imbedded in *latipinnis*).

The type is a large specimen, 16¾ inches long; a male, as is shown by the presence of tubercles on the anal and caudal fins, a fact confirmed by dissection. In coloration, it is rather dark, with traces of a dusky lateral band, which passes around the snout. This specimen is numbered 21197 on the Register of the National Museum.

Another specimen of this species is in the National Museum, from Platte River. It was identified by me as the female of *C. latipinnis*, the numerous differences in form being supposed to be sexual. As the types both of *latipinnis* and *retropinnis* are adult males, that supposition is not tenable.

So far as is known to me, but one genuine specimen of *C. latipinnis* is now known. It is the original type of Baird and Girard's description, from the Gila Basin, the one figured in the Ichthyology of the United States and Mexican Boundary Survey. It is in fine condition, and is well represented in the figure referred to. This specimen now lies before me, and the comparisons above made were taken from it.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21197	....	...... (?)	Dr. Elliott Coues..........	..... (?).

5.—CATOSTOMUS TERES (Mitchill) Le Sueur.

Common Sucker.

1803—"*Le Cyprin Commersonien*" LACÉPÈDE, Hist. Nat. des Poiss. v, 502, 508.
Catostomus commersonii JORDAN (1878), Man. Vert. ed. 2d, 320.
Catostomus commersoni JORDAN, Cat. Fishes N. Am. (1878), 416.
18——*Cyprinus catostomus* PECK, Mem. Am. Acad. ii, 55, pl. 2. (Not of Forster.)
1814—*Cyprinus teres* MITCHILL, Lit. and Phil. Trans. N. Y. i, 458.
Catostomus teres LE SUEUR (1817), Journ. Acad. Nat. Sci. Phila. 108.
Catostomus teres THOMPSON (1842), Hist. Vt. 134.
Catostomus teres CUV. & VAL. (1844), Hist. Nat. des Poissons, xvii, 468.
Catostomus teres STORER (1846), Synopsis Fish N. A. 423.
Catostomus teres AGASSIZ (1855), Am. Journ. Sci. Arts, 2d series, xix, 208.
Catostomus teres GÜNTHER (1868), Cat. Fishes Brit. Mus. vii, 15.
Catostomus teres COPE (1870), Proc. Am. Philos. Soc. Phila. 468.
Catostomus teres JORDAN (1875), Fishes of Ind. 221.
Catostomus teres JORDAN (1876), Man. Vert. 293.
Catostomus teres NELSON (1876), Bull. No. 1 Ills. Mus. Nat. Hist. 48.
Catostomus teres JORDAN & COPELAND (1876), Check List, 156.
Catostomus teres JORDAN & GILBERT (1877), in Klippart's First Rep. Ohio Fish Com. 84, pl. xii, figs. 18, 19.
Catostomus teres JORDAN (1877), Bull. U. S. Nat. Mus. ix, 37.
1817—*Catostomus communis* LE SUEUR, Journ. Ac. Nat. Sci. Phila. i, 95.
Catostomus communis DEKAY (1842), N. Y. Fauna, part iv, Fishes, 196.
Catostomus communis CUV. & VAL. (1844), Nat. Hist. des Poissons, xvii, 426.
Catostomus communis KIRTLAND (1845), Bost. Journ. Nat. Hist. v, 265.
Catostomus communis STORER (1846), Synopsis, 421.
Catostomus communis COPE (1868), Journ. Acad. Nat. Sci. Phila. 236.
Catostomus communis UHLER & LUGGER (1876), Fishes of Maryland, 138.
1817—*Catostomus bostoniensis* LE SUEUR, Journ. Acad. Nat. Sci. Phila. 106.
Catostomus bostoniensis STORER (1838), Rept. Ich. Mass. 84.
Catostomus bostoniensis CUV. & VAL. (1844), Hist. Nat. des Poiss. xvi, 432.
Catostomus bostoniensis STORER (1846), Synopsis, 423.
Catostomus bostoniensis PUTNAM (1863), Bull. Mus. Comp. Zool. 10.
Catostomus bostoniensis GILL (1865), Canadian Nat. 19, Aug.
Catostomus bostoniensis STORER (1867), Hist. Fishes Mass. 290, pl. xxii, f. 3.
Catostomus bostoniensis THOREAU (1868), Week on Concord and Merrimack, 38.
1820—*Catostomus flexuosus* RAF., Ich. Ohio, 59.

1823—*Catostomus hudsonius* RICH., Franklin's Journ. 717. (Not of Le Sueur.)
Cyprinus (*Catostomus*) *hudsonius* RICH. (1836), Fauna Bor.-Amer. Fishes, 112.
1836—*Cyprinus* (*Catostomus*) *reticulatus* RICHARDSON, Fauna Bor.-Amer. Fishes, 303.
1838—*Catostomus gracilis* KIRTLAND, Rept. Zool. Ohio, 168.
1838—*Catostomus nigricans* STORER, Rept. Ich. Mass. 86. (Not of Le Sueur.)
Catostomus nigricans THOMPSON (1842), Hist. Vt. 135.
1842—*Catostomus pallidus* DEKAY, N. Y. Fauna, part iv, Fishes, 200.
Catostomus pallidus STORER (1846), Synopsis, 426.
1844—*Catostomus aureolus* CUV. & VAL., Hist. Nat. des Poiss. xvii, 439. (Not of Le Sueur.)
Catostomus aureolus GÜNTHER (1868), Cat. Fishes Brit. Mus. vii, 16.
1850—*Catostomus forsterianus* AGASSIZ, Lake Superior, 358. (Not of Rich.)
Catostomus forsterianus AGASSIZ (1855), Am. Journ. Sci. Arts, 2d series, xix, 208.
Acomus forsterianus GIRARD (1856), Proc. Acad. Nat. Sci. Phila. 173.
1856—*Catostomus sucklii* GIRARD, Proc. Acad. Nat. Sci. Phila. 175.
Catostomus sucklii GIRARD (1858), U. S. Pac. R. R. Exp. x, pl. li, 226.
Catostomus sucklii COPE (1872), Hayden Geol. Surv. Wyoming, 434.
Catostomus sucklii JORDAN & COPELAND (1876), Check List, 156.
1860—*Catostomus texanus* ABBOTT, Proc. Acad. Nat. Sci. Phila. 473.
Catostomus texanus JORDAN & COPELAND (1876), Check List, 156.
1860—*Catostomus chloropteron* ABBOTT, Proc. Acad. Nat. Sci. Phila. 473.
Catostomus chloropteron COPE (1865), Proc. Acad. Nat. Sci. Phila. 85.
1876—*Catostomus chloropterus* JORDAN & COPELAND (1876), Check List, 156.

Numerous specimens, not differing in any noticeable respect from Eastern specimens of this universally distributed species. One or two of them have only ten dorsal rays.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
20191	....	....	Dr. Elliott Coues.....	
20194	....	....	......do	

Family CYPRINIDÆ.

Genus PIMEPHALES Rafinesque.

6.—PIMEPHALES PROMELAS Rafinesque.

1820—*Pimephales promelas* RAF., Ich. Oh. 94.
Pimephales promelas KIRTLAND (1838), Rep. Zool. Oh. 194.
Pimephales promelas KIRTLAND (1838), Bost. Journ. Nat. Hist. iii, 475.
Pimephales promelas STORER (1846), Syn. 418.
Pimephales promelas AGASSIZ (1855), Am. Journ. Sci. Arts, 220.
Pimephales promelas PUTNAM (1863), Bull. M. C. Z. 8.
Pimephales promelas GÜNTHER (1868), Cat. Fishes, vii, 181.
Pimephales promelas JORDAN (1874), Ind. Geol. Surv. 224.
Pimephales promelas JORDAN (1876), Bull. Buff. Soc. Nat. Hist. 94.
Pimephales promelas JORDAN (1876), Man. Vert. 275.
Pimephales promelas JORDAN & COPELAND (1876), Check List, 146.
Pimephales promelas NELSON (1876), Bull. Ills. Soc. Nat. Hist. 45.
Pimephales promelas JORDAN (1877), Bull. U. S. Nat. Mus. ix, 32.
Pimephales promelas JORDAN (1878), Man. Vert. ed. 2d, 288.

Pimephales promelas JORDAN, Cat. Fishes N. A. 419.
1856—*Pimephales fasciatus* GIRARD, Proc. Acad. Nat. Sci. Phila. 180.
Pimephales fasciatus GIRARD (1858), Pac. R. R. Surv. x, 234.
1860—*Plargyrus melanocephalus* ABBOTT, Proc. Acad. Nat. Sci. Phila. 325.
Pimephales melanocephalus JORDAN & COPELAND (1876), Check List, 146.
1864—*Pimephales milesii* COPE, Proc. Acad. Nat. Sci. Phila. 282.
Pimephales milesii GÜNTHER (1868), Cat. Fishes, vii, 181.
Pimephales milesii JORDAN (1876), Man. Vert. 276.
1866—*Pimephales agassizii* COPE, Cyp. Penn. 391.
Pimephales agassizii JORDAN (1874), Ind. Geol. Surv. 224.

Numerous specimens, to all appearance precisely like others from the Ohio River; the lateral line is imperfect and extends to a little past the beginning of the dorsal.

Genus COUESIUS Jordan, gen. nov.

7.—COUESIUS DISSIMILIS (Grd.) Jordan.

1856—*Leucosomus dissimilis* GRD., Proc. Acad. Nat. Sci. Phila. 189.
Leucosomus dissimilis GIRARD (1858), U. S. Pac. R. R. Exp. x, 250.
Semotilus dissimilis JORDAN, Bull. U. S. Geol. Surv. Terr. 1878, iv, 427.
1877—*Nocomis milneri* JORDAN, Bull. Nat. Mus. x, 64.
Ceratichthys milneri JORDAN (1878), Bull. U. S. Geol. Surv. Terr. iv, 427.
Ceratichthys milneri JORDAN (1878), Man. Vert. 2d ed. 307.

This species was first described by Girard from specimens from the Upper Missouri region, and referred by him to the genus *Leucosomus* (=*Semotilus*). As he did not describe especially its dentition, it has been presumed by myself and others that the species really was a *Semotilus*, and, if so, probably related to the Eastern *Semotilus bullaris* (*rhotheus* Cope), a species without the usual black dorsal spot.

Specimens collected in Lake Superior by Mr. J. W. Milner were lately described by me as *Nocomis* (=*Ceratichthys*) *milneri*, without a thought as to the necessity of comparing them with one of Girard's *Leucosomi*.

Comparison of the numerous specimens collected by Dr. Coues with Girard's description and my own leaves no doubt whatever in my mind as to their identity both with *Leucosomus dissimilis* and *Ceratichthys milneri*. The specific name *dissimilis*, however, cannot be used for this species, if referred to *Ceratichthys*, as there is already a "*dissimilis*" (*Leuciscus dissimilis* Kirtland) in the genus *Ceratichthys*. The reprehensible custom, so often practised by Girard, of giving, as specific names to new species, names already borne by species of allied genera, always leads to confusion as the boundaries of genera are changed. If referred to *Ceratichthys*, then the species should stand as *Ceratichthys milneri* Jordan.

Since the above was written, the author has reviewed some of the characters on which our current genera of *Cyprinidæ* rest. I am disposed to agree with Professor Cope that the presence or absence of the single tooth forming a second row is not, in most cases at least, a good generic character, as it is subject to many variations. I find, however, that in those species which have *two* teeth in the smaller row, that character is very constant. I find also that in those genera (*Luxilus*, *Alburnops*, *Ceratichthys*, *Cliola*, etc.) in which some of the species possess *two* teeth in the outer row, while others have no teeth or but one, those species with two teeth are strikingly different in general external characters and appearance from the others, and have in each of the above cases been already distinguished as subgenera (*Photogenis*, *Hydrophlox*, *Episema*), and in all but one have received distinctive names. The *Cyprinidæ* are small fishes, of low organization, and the very numerous species are very closely related. It seems advisable to divide the various forms related to *Leuciscus* into groups with distinctive names, which we may call "genera", although they may not be exactly co-ordinate with the genera of some family less rich in species. To combine them all into one genus, as has been attempted by Günther and Valenciennes, has led only to confusion and the almost utter loss of all knowledge of the species. Our tests of a "generic character" in such a group must be, Does it hold? Is it capable of exact definition and determination? Does it set off species really related, from others of more remote affinities? At present, the character of the two inner teeth seems to fill these requirements, and it is therefore held provisionally as a true generic character. It may be premised that this character requires verification in several species now referred to *Notropis*, *Luxilus*, *Cliola*, *Rhinichthys*, etc.

COUESIUS, gen. nov.

TYPE.—*Leucosomus dissimilis* Grd. = *Nocomis milneri* Jordan.

CHARACTERS.—*Leuciscinæ*, with the fins normal, the dorsal over or slightly posterior to ventrals, the basis of the anal short; mouth normal; end of the maxillary bone with a small but conspicuous barbel; scales rather small; lateral line present; intestinal canal short; teeth 2, 4–4, 2, those of the longer row hooked, sharp-edged, without grinding surface; upper jaw protractile.

This genus is dedicated to Elliott Coues, one of the very foremost of American students of vertebrates, to whose activity as a collector we owe the interesting collection which is the subject of the present paper.

The following analysis of the genera of American *Cyprinidæ* which now seem to me worthy of recognition will show the relations of the genus *Couesius* to its affines.

*. Dorsal fin without a strong, developed spine; ventral fins not decurrent on the abdomen.

†. Pharyngeal teeth developed.

‡. Dentary bones straight and flat, united throughout their length; mandible much incurved, tongue-like, a lobe on each side of it at base; air-bladder normal. (*Exoglossinæ*.)

a. Teeth hooked, 1, 4–4, 1, without grinding surface; dorsal fin nearly opposite ventrals; anal basis short; no barbel; premaxillaries not projectile; intestinal canal short. EXOGLOSSUM.

‡ Dentary bones arched, well separated except at their symphysis.

§. Air-bladder suspended in the abdominal cavity, surrounded by many convolutions of the long alimentary canal. (*Campostomatinæ.*)

b. Teeth 4–4 or 1, 4–4, 0, with oblique grinding surface, scarcely hooked; mouth small, inferior; upper jaw protractile; dorsal over, or slightly posterior to ventrals; base of anal short; alimentary canal 6 to 9 times the length of the body; no barbel.. CAMPOSTOMA.

§§. Air-bladder contiguous to the roof of the abdominal cavity, and above the alimentary canal.

¶. Intestinal canal elongate, more than twice the length of the body; peritoneum usually more or less black; premaxillaries projectile. (*Chondrostomatinæ.*)

d. Each jaw provided with a firm, hard, straight, cartilaginous plate, that of the lower jaw hard and conspicuous; peritoneum black; intestinal canal elongate. (*Chondrostomatinæ.*)

c. Teeth 5–4, club-shaped, entire, hooked, with a broad, oblique grinding surface; dorsal fin slightly behind ventrals; anal base scarcely elongate (rays 9); caudal fin very long, with numerous accessory rays recurrent on the caudal peduncle; scales rather small, loosely imbricated; lateral line present; upper jaw protractile.................... ACROCHILUS.

dd. Jaws without conspicuous horny plate.

e. Teeth 6–6, compressed, lanceolate, erect, very slightly bent inward; lower jaw sharp-edged, with a knob at the symphysis; dorsal over ventrals; basal caudal rays largely developed; scales small..... ORTHODON.

ee. Teeth 4–4.

f. Teeth cultriform, with oblique grinding surface and little or no hook; lips attenuate, without sheath; rudimentary dorsal ray firmly attached to the first developed ray.

g. Lateral line complete; dorsal over ventrals; mouth horizontal
—Scales very small............................ ZOPHENDUM.*
— — Scales large............................ HYBOGNATHUS.

gg. Lateral line incomplete; dorsal behind ventrals; mouth oblique............................ COLISCUS.

ff. Teeth short, with grinding surface, and a small hook; rudimentary dorsal ray separated from the first developed ray by membrane; dorsal scales small.

h. Lateral line incomplete; no barbel.............. PIMEPHALES.

hh. Lateral line complete; maxillary with a rudimentary or obsolete barbel.................... HYBORHYNCHUS.

eee. Teeth 5–5 or 5–4, with grinding surface and hook; dorsal behind ventrals.

i. Lateral line incomplete; anal base short; scales very small. CHROSOMUS.

ii. Lateral line complete; anal base elongate; scales moderate; basal caudal rays largely developed.... LAVINIA.

¶¶. Intestinal canal short, little if any longer than the body; peritoneum mostly white. (*Leuciscinæ.*)

j. Teeth raptatorial, those of the main row more or less hooked.

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* *Zophendum*, gen. nov.; type "*Hyborhynchus*" *siderius* Cope.

k. Maxillary without barbel.

l. Anal basis considerably elongate (of 12 to 25, rarely fewer, rays); belly behind ventrals compressed to an edge; lateral line decurved, complete.

m. Teeth 5–5, sharp pointed, with grinding surface; anal rays 11 to 15 .... NOTEMIGONUS.

mm. Teeth 2, 5–5, 2, entire, without grinding surface; anal rays 13 to 30 .... ALBURNUS.*

ll. Anal basis shorter (of 7 to 11 rays); abdomen not compressed to an edge.

n. Teeth 1, 3–3, 1, without grinding surface; dorsal behind ventrals; isthmus very wide .... TIAROGA.

nn. Teeth in the main row 4–4.

o. Opercular and mandibular bones, without externally visible cavernous chambers.

p. Teeth with grinding surface developed.

q. Jaws with a hard, bony sheath, resembling the teeth of *Tetrodon;* teeth 4–4; rudimentary dorsal ray connected by membrane .... COCHLOGNATHUS.

qq. Jaws normal; rudimentary dorsal ray attached.

r. Teeth 4–4 or 1, 4–4, 1; anal basis short (rays 7 to 9).

s. Scales very small .... ALGANSEA.

ss. Scales large.

t. Lateral line complete .... HUDSONIUS.

tt. Lateral line incomplete .... CHRIOPE.†

rr. Teeth 2, 4–4, 2.

u. Dorsal fin over or slightly behind ventrals; anal basis short (8 or 9 rays) .... LUXILUS.

uu. Dorsal fin much behind ventrals; anal basis elongate (10 to 12 rays) .... LYTHRURUS.

pp. Teeth without masticatory surface, their edges serrate or entire.

v. Lips thin, normal; lateral line complete.

w. Teeth 2, 4–4, 2 .... NOTROPIS.

ww. Teeth 4–4 or 1, 4–4, 1 .... CLIOLA.

vv. Lips thin; lateral line incomplete; teeth 1, 4–4, 2. PROTOPORUS.

vvv. Lips thick, fleshy, enlarged behind; mouth small, inferior; dorsal fin beginning in front of ventrals; teeth 4–4; lateral line complete .. PHENACOBIUS.

oo. Opercular and mandibulary bones with externally visible cavernous chambers; teeth 1, 4–4, 0, without grinding surface; lips normal; dorsal over ventrals .... ERICYMBA.

nnn. Teeth in the main row 5–5 or 5–4.

A. Lateral line incomplete.

B. Dorsal fin over ventrals; scales large; teeth 4–5, with grinding surface .... HEMITREMIA.

BB. Dorsal fin behind ventrals; scales small; teeth 2, 5–5, 2 (or 2, 5–4, 2), without grinding surface. PHOXINUS.

AA. Lateral line complete.

C. Teeth raptatorial, entire, without grinding surface, 2, 5–4 or 5, 2 or 1.

**Alburnus* Heckel = *Richardsonius* Grd.

†*Chriope*, gen. nov.; type *Hybopsis bifrenatus* Cope.

D. Teeth subconic, little hooked, wide set. PTYCHOCHILUS.

DD. Teeth compressed, hooked, close set.

— Caudal peduncle very slender, the basal caudal rays much developed .... GILA.

— — Caudal peduncle stout, the basal caudal rays little developed .... TELESTES.*

CC. Teeth raptatorial, with developed grinding surface.

E. Teeth 2, 5–4 or 5, 2 or 1 .... SQUALIUS.†

EE. Teeth 4–5 or 5–5 .... LEUCOS.‡

kk. Maxillary with a small barbel; teeth hooked.

F. Premaxillaries projectile, a groove separating the upper lip from the forehead.

G. Teeth 2, 4–5–2, without grinding surface; barbel minute, not at the end of the maxillary; dorsal more or less posterior to ventrals............ SEMOTILUS.

GG. Teeth 2, 5–4, 2, or 2, 5–5, 2, with grinding surface; barbel terminal.

— Caudal fin symmetrical, the rudimental basal rays little developed .... SYMMETRURUS.§

— — Caudal fin unsymmetrical, the rudimental basal rays largely developed .... POGONICHTHYS.

GGG. Teeth in the principal row 4–4; barbel terminal.

I. Teeth without grinding surface.

J. Dorsal behind ventrals; scales small; teeth mostly 1, 4–4, 1................................... APOCOPE.

JJ. Dorsal over ventrals or slightly posterior; scales moderate or rather large.

K. Teeth 4–4, or 1, 4–4, 1 .... CERATICHTHYS.

KK. Teeth 2, 4–4, 2 .... COUESIUS.

II. Teeth with developed grinding surface.

L. Dorsal fin more or less directly above ventrals; scales large; teeth 2, 4–4, 2.

LL. Dorsal fin wholly behind ventrals; scales small; teeth 4–4 .... AGOSIA.

FF. Premaxillaries not projectile; teeth mostly 2, 4–4, 2, without grinding surface; scales small; dorsal behind ventrals; barbel terminal........ RHINICHTHYS.

jj. Teeth molar, of the grinding type, two or three of the main row blunt and much enlarged; teeth in three rows, the outer deciduous, 2 or 3, 2, 5–4, 2, 2 or 3.

M. Upper jaw not protractile; no barbel; dorsal fin beginning behind ventrals .... MYLOPHARODON.

MM. Upper jaw protractile; maxillary with a barbel; dorsal over ventrals .... MYLOCHILUS.

††. Pharyngeal teeth quite rudimental, replaced by a somewhat uneven ridge of the bone. (*Graodontinæ.*)

N. Dorsal fin short, without spinous ray, opposite ventrals; anal basis short; mouth small, without barbel, the upper jaw somewhat the larger; intestinal canal short; lateral line complete .... GRAODUS.

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* *Telestes* Bonaparte = *Tigoma*, *Siboma*, and *Clinostomus* Grd.

† *Squalius* Bonaparte = *Cheonda* Grd.

‡ *Leucos* Heckel = *Myloleucus* Cope.

§ *Symmetrurus*, gen. nov.; type *Pogonichthys argyreiosus* B. & G.

**. Dorsal fin with a strong spine, which is composed of two, the posterior received into a longitudinal groove of the anterior; inner border of the ventral fins adherent to the body dorsal behind ventrals; teeth hooked, without grinding surface. (*Plagopterinæ.*)

O. Body with small scales; teeth 2, 4-4, 2; no barbel .... LEPIDOMEDA.

OO. Body naked.

P. Teeth 1, 4-4, 1; no barbel .... MEDA.

PP. Teeth 2, 5-4, 2; a barbel at the end of the maxillary .... PLAGOPTERUS.

The relations of the European and American genera of *Cyprinidæ* may be approximately indicated by the following grouping. The clusters of genera here indicated as "groups" have about the value attached by the "ultra conservative" writers to their "genera". The subfamilies here recognized, of *Chondrostomatinæ*, *Leuciscinæ*, and *Abramidinæ*, are very closely connected by their American representatives, perhaps too closely for recognition. The group *Graodontinæ* is admitted provisionally, the singular character ascribed to the genus *Graodus* being possibly erroneous. I have not examined the intestines of *Rhodeus* and *Leucos*, and their positions in the series may require change. The type of the European genus *Squalius* has a narrow grinding surface on its teeth, and it is congeneric with the species referred by Girard to *Cheonda*. In like manner, our current genera *Richardsonius*, *Tigoma*, and *Myloleucus* are equivalent to *Alburnus*, *Telestes*, and *Leucos*.

European genera are designated by an asterisk (*); genera common to Europe and America by a dagger (†).

Subfamily CAMPOSTOMATINÆ.
- *Campostoma* Agassiz.

Subfamily CHONDROSTOMATINÆ.
- Group ACROCHILI.
  - *Acrochilus* Agassiz.
- Group CHONDROSTOMATA.
  - *Chondrorhynchus** Heckel.
  - *Chondrostoma** Agassiz.
- Group ORTHODONTES.
  - *Orthodon* Girard.
- Group LAVINIÆ.
  - *Lavinia* Girard.
- Group RHODEI.
  - *Rhodeus** Agassiz.
- Group CHROSOMI.
  - *Chrosomus* Rafinesque.
- Group HYBOGNATHI.
  - *Zophendum* Jordan.
  - *Hybognathus* Agassiz.
  - *Coliscus* Cope.
  - *Pimephales* Rafinesque.
  - *Hyborhynchus* Agassiz.

Subfamily EXOGLOSSINÆ.
- *Exoglossum* Rafinesque.

Subfamily GRAODONTINÆ.
- *Graodus* Günther.

Subfamily LEUCISCINÆ.
- Group TIAROGÆ.
  - *Tiaroga* Girard.
- Group COCHLOGNATHI.
  - *Cochlognathus* Baird & Girard.
- Group LUXILI.
  - *Alganses* Girard.
  - *Hudsonius* Girard.
  - *Chriope* Jordan.
  - *Cliola* Girard (*Codoma*, *Cyprinella*, etc.).
  - *Protoporus* Cope.
  - *Notropis* Rafinesque.
  - *Lythrurus* Jordan.
  - *Luxilus* Rafinesque.
- Group ERICYMBÆ.
  - *Ericymba* Cope.
- Group PHENACOBII.
  - *Phenacobius* Cope.
- Group RHINICHTHYES.
  - *Rhinichthyes* Agassiz.
- Group CERATICHTHYES.
  - *Agosia* Girard.
  - *Ceratichthys* Baird.
  - *Apocope* Cope.
  - *Couesius* Jordan.
  - *Platygobio* Gill.

Subfamily LEUCISCINÆ.
Group GOBIONES.
*Gobio** Cuvier.
Semotilus Rafinesque.
Symmetrurus Jordan.
Pogonichthys Girard.
Group TINCÆ.
*Tinca** Cuvier.
Group MYLOCHILI.
Mylochilus Agassiz.
Group MYLOPHARODONTES.
Mylopharodon Ayres.
Group LEUCISCI.
*Scardinius** Bonaparte.
*Idus** Heckel.
Ptychochilus Agassiz.
Gila Baird & Girard.
*Telestes**† Bonaparte.
*Squalius**† Bonaparte.
*Phoxinus**† Agassiz.
Phoxinellus Heckel.
*Leucos**† Heckel.
Leuciscus Cuvier.

Subfamily ABRAMIDINÆ.
Group ABRAMIDES.
*Leucaspius** Heckel.
Notemigonus Rafinesque.
*Abramis** Cuvier.
*Blicca** Heckel.
*Alburnus**† Heckel.
*Aspinus** Agassiz.
Group PELECI.
*Pelecus** Agassiz.
Subfamily PLAGOPTERINÆ.
Lepidomeda Cope.
Plagopterus Cope.
Meda Girard.
Subfamily AULOPYGINÆ.
*Aulopyge** Heckel.
Subfamily BARBINÆ.
*Barbus** Cuvier.
Subfamily CYPRININÆ.
Group CYPRINI.
*Cyprinus** Linnæus.
Group CARASSII.
*Carassius** Nilsson.

The following species are to be referred to the genus *Couesius*:—*Couesius dissimilis*, = *Leucosomus dissimilis* Girard; *Couesius prosthemius*, = *Ceratichthys prosthemius* Cope; *Couesius squamilentus*, = *Ceratichthys squamilentus* Cope; *Couesius physignathus*, = *Ceratichthys physignathus* Cope.

In *C. dissimilis*, the dorsal fin is almost directly over the ventrals; the mouth is large and quite oblique, the jaws being about equal; the maxillary barbel is very distinct; the scales are about 11–70–9. In the collection are 50 specimens of all sizes, from one inch in length to about five.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21206	....	..... (?)	Dr. Elliott Coues..........	.....(?).

Genus RHINICHTHYS Agassiz.

8.—RHINICHTHYS MAXILLOSUS Cope.

1864—*Rhinichthys maxillosus* COPE, Proc. Ac. Nat. Sci. Phila. 278.
Rhinichthys maxillosus GÜNTHER (1868), Cat. Fishes Brit. Mus. vii, 190.
Rhinichthys maxillosus JOR. (1878), Bull. U. S. Geol. Sur. Terr. iv, 426.

Forty-three specimens of this species were obtained, from one to four inches in length. The species is somewhat intermediate between the Eastern *R. cataractæ* (*R. nasutus* Ag.) and *R. atronasus*. The specimens agree well with Professor Cope's figure in the Report of the Ichthyology of Lieutenant Wheeler's Explorations, but they differ slightly in proportions from the original description. *Rhinichthys dulcis* Girard is apparently a different fish, similar to and probably identical with *Rhinichthys obtusus* Ag. (=*Rhinichthys lunatus* Cope).

Genus CLIOLA Girard.

9.—CLIOLA CHLORA Jordan, sp. nov.

A small pale species, resembling a *Notropis*. Body slender, compressed, resembling in form that of *Notropis rubrifrons* Cope, the greatest depth, at the beginning of the dorsal, contained about five times in the length. Head rather small, 4¼ in length, the eye rather large, longer than snout, forming about one-third the length of the head, about equal to the width of the interorbital space; mouth small, quite oblique, the lower jaw included when the mouth is closed, the maxillary scarcely reaching to the front of the eye.

Scales very large, 4–35–3, about 12 in front of the dorsal fin; body entirely scaly except the thoracic region; lateral line decurved in front, thence nearly straight.

Dorsal fin beginning about midway of the body, directly over the ventrals, rather high, its rays, I, 7; anal fin short and high, I, 7; pectorals not reaching nearly to ventrals, the latter almost to vent.

Teeth hooked, without masticatory surface, in one row, 4–4.

Coloration quite pale; back greenish; cheeks and sides with a silvery band, belly white. No spots on the fins except sometimes a dusky shade at base of caudal; no dusky or plumbeous shading on the body.

Length of types about 2½ inches each. There are twelve of these typical examples, numbered 20193 in the United States National Museum.

The affinities of this small species seem to be rather with the Texan species, *C. vivax* and *C. velox*, than with the other forms now referred to this genus.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
20193	....	...... (?)	Dr. Elliott Coues	.... (?).

Genus PROTOPORUS Cope.

10.—PROTOPORUS, sp. nov.?

Mixed with the specimens of *Cliola chlora* were several individuals in poor condition, with the teeth 4–4, hooked, without grinding surface, and the lateral line incomplete. If this latter character is permanent, and a lateral line is not developed with age, the species is perhaps referable to the genus *Protoporus*. The only species of that genus, *P. domninus* Cope, has two rows of teeth (teeth 2, 4–4, 1), so that the present species, if a *Protoporus*, is at least specifically distinct. My specimens are, however, neither adult nor in good condition, and I prefer to leave the task of describing a new species to some later observer.

Family HYODONTIDÆ.

Genus HYODON Le Sueur.

11.—HYODON (ELATTONISTIUS) CHRYSOPSIS Rich.

Gold Eye. Northern Moon-eye. "Naccaysh."

1823—*Hyodon clodalus* RICH., Franklin's Journal, 716. (Not of Le Sueur.)
1836—*Hyodon chrysopsis* RICH., Fauna Bor.-Am. iii, 532.
Hyodon chrysopsis DEKAY, New York Fauna, Fishes, 1842, 267.
Hyodon chrysopsis STORER, Synopsis Fishes N. A. 1846, 463.
Hyodon chrysopsis JORDAN, Bull. U. S. Nat. Mus. x, 67, 1878.
Hyodon chrysopsis JORDAN, Man. Vert. ed. 2d, 277, 1878.
Hyodon chrysopsis JORDAN, Bull. Hayden's Geol. Surv. Terr. iv, 429.

This beautiful species was first described by Richardson from specimens obtained in the Saskatchawan region. For a time after Richardson's day the species was kept alive by compilers, but for the last twenty-five years it has been generally ignored or considered a mere synonym of *Hyodon tergisus*. For its rediscovery science is indebted to the collection now under consideration. Its resemblance to *H. tergisus* is not very great; the body is very much more compressed than in the latter species, the abdomen being almost cultrate, while the dorsal fin is reduced in size, having only about nine developed rays. In view of these peculiarities, Dr. Gill and myself have proposed for it the subgeneric name of *Elattonistius*. At present, *Elattonistius* is considered as a subgenus of *Hyodon*, but if no intermediate forms occur it may require elevation to full generic rank. The following analysis of the species of *Hyodon* gives the principal distinctive characters of the three species now known: *Elattonistius chrysopsis*, *Hyodon tergisus* Le S., and *Hyodon selenops* Jordan & Bean.

*. Dorsal fin reduced, and with only about nine fully developed rays; abdomen sharply carinated (*Elattonistius*):

†. Dorsal fin very small, of about nine *developed* rays (besides the two or three rudiments), the length of its longest rays half greater than the length of the base of the fin; body deep, closely compressed, the belly strongly carinated both before and behind ventrals; eye moderate (about 3½ in head); scales rather closely imbricated, 5–58–8; pectoral fins falcate, nearly as long as the head, nearly or quite reaching ventrals; anal with 30 or 31 developed rays; head 4⅓ in length; depth 3¼ .... CHRYSOPSIS.

**. Dorsal fin moderate and with eleven or twelve fully developed rays; abdomen more or less obtuse (*Hyodon*):

†. Dorsal fin larger, of about 12 developed rays; its longest rays scarcely longer than the base of the fin; form of body intermediate; the belly in front of ventrals obtusely carinated; eye large, about 3 in head; scales medium, 5–58–8; pectoral fins decidedly shorter than head, not reaching nearly to ventrals; anal rays 28 or 29; head 4⅓ in length, the depth about 3 .... TERGISUS.

††. Dorsal fin moderate, of 11 or 12 developed rays, nearly as long as high in front; body elongate, not greatly compressed; the belly in front of ventrals transversely rounded, not carinated; eye very large, about 2½ in head; scales loosely imbricated, 4-50-7; pectoral fins considerably shorter than head, not reaching nearly to ventrals; anal rays 27; head 4⅓ in length; depth about 4 ....SELENOPS.

Numerous specimens are in the collection, obtained by Dr. Coues in Quaking Ash River, a tributary of the Upper Missouri, June 26, 1874.

Family SALMONIDÆ.

[I obtained no *Salmonidæ* from any of the Missouri or Milk River waters, but found this family abounding in the lake and river headwaters of the Saskatchewan. The St. Mary's, for instance, was full of the beautiful trout identified by Prof. Jordan as *S. clarki* var. *aurora*, and in Chief Mountain Lake, at an elevation of about 4,000 feet, the Great Mackinaw Trout, *Cristivomer namaycush*, was very plentiful. There being no tackle in the party stout enough to handle these fellows with, the men used to catch them with hooks made from the handles of camp-kettles, attached to a piece of tent-rope and baited with salt pork; usually pushing out on the lake on a raft, and hauling in the game just as a fisherman would take cod. I think there are in these same waters one or two other *Salmonidæ*, besides the two Whitefish.—C.]

Genus COREGONUS Linnæus.

12.—COREGONUS COUESI Milner.

Chief Mountain Whitefish.

1874—*Coregonus couesi* MILNER, Rept. Com. Fish and Fisheries for 1872-73, 88.
Coregonus couesi JORDAN & COPELAND, Check List Fishes N. A. 145, 1876.
Coregonus couesi JORDAN, Man. Vert. 2d ed. 276, 1878.
Prosopium couesi MILNER, MSS.—JORDAN, Man. Vert. 2d ed. 362, 1878.
Coregonus couesi JORDAN, Bull. U. S. Geol. Surv. iv, 429, 1878.

This interesting species was described by Mr. Milner from the specimen in the present collection. I have nothing new to add to his very complete account.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
14146	1182	Chief Mountain Lake.............	Dr. Elliott Coues......	Aug. 19, 1874.

13.—COREGONUS QUADRILATERALIS Richardson.

Menomonee Whitefish. Shad-waiter.

1823—*Coregonus quadrilateralis* RICHARDSON, Franklin's Journal, 714.
Coregonus quadrilateralis RICHARDSON, Fauna Bor.-Am. iii, 204, pl. 89, f. 1.
Coregonus quadrilateralis CUVIER & VALENCIENNES, Hist. Nat. des Poiss. xxi, 512.
Coregonus quadrilateralis DEKAY, New York Fauna, Fishes, 249, 1842.
Coregonus quadrilateralis STORER, Synopsis Fishes N. A. 453, 1846.
Coregonus quadrilateralis AGASSIZ, Lake Superior, 351, 1850.
Coregonus quadrilateralis GÜNTHER, Cat. Fishes Brit. Mus. vi, 1867, 176.

Coregonus quadrilateralis MILNER, Rept. Comm. Fish and Fisheries for 1872–73, 49, 1874.

Coregonus quadrilateralis JORDAN & COPELAND, Check List Fishes N. A. 145, 1876.

Coregonus quadrilateralis JORDAN, Man. Vert. ed. 2d, 276, 1878.

Prosopium quadrilatcrale, MILNER, MSS.—JORDAN, Man. Vert. ed. 2d, 276, 1878.

Coregonus (*Prosopium*) *quadrilateralis* JORDAN, Bull. U. S. Geol. Surv. iv, 429, 1878.

1851—*Coregonus novæ-angliæ* PRESCOTT, Silliman's Am. Journ. Sc. Arts, xi, 342.

Coregonus novæ-angliæ GÜNTHER, Cat. Fishes Brit. Mus. vi, 186, 1867.

A single specimen, in poor condition, but probably referable to this species, is in the collection. The head is somewhat crushed, so that the form of the mouth is not shown. Both this species and the preceding belong to a well-marked subgenus, called by Mr. Milner *Prosopium*.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21202	1179	Chief Mountain Lake.............	Dr. Elliott Coues......	Aug. 18, 1874.

Genus CRISTIVOMER Gill & Jordan.

14.—CRISTIVOMER NAMAYCUSH (Walbaum) Gill & Jordan.

Mackinaw Trout. Great Lake Trout. Longe. Togue.

1792—*Namaycush salmon* (not "*Salmo namaycush*", as quoted by authors) PENNANT, Arctic Zoology, Introduction, 141; vol. ii, 139. (British America.)

Salmo namaycush WALBAUM, Artedi Pisc. p. —.

Salmo namaycush BLOCH, Schneider, Syst. Ich. 1801.

Salmo namaycush RICH., Fauna Bor.-Amer. iii, 179, pl. 79, and pl. 85, f. 1, 1836.

Salmo manycash (*sic*) KIRTLAND, Rept. Zool. Ohio, 105, 1838.

Salmo namaycush KIRTLAND, Bost. Journ. Nat. Hist. iv, 25, pl. 3, f. 2, 1842.

Salar namaycush CUV. & VAL., Hist. Nat. des Poissons xxi, 348, 1848.

Salmo namaycush AGASSIZ, Lake Superior, 331, 1850.

Salmo namaycush GÜNTHER, Cat. Fishes Brit. Mus. vi, 123, 1867.

Salmo namaycush MILNER, Rept. Comm. Fish and Fisheries for 1872–73, 38, 1874.

Salmo namaycush SUCKLEY, Monograph Genus Salmo, 151, 1874.

Salmo namaycush JORDAN, Man. Vert. 260, 1876.

Salmo namaycush NELSON, Bull. Ills. Mus. Nat. Hist. 44, 1876.

Salmo namaycush, JORDAN, Man. Vert. ed. 2d, 272, 1878.

Cristivomer namaycush GILL & JORDAN, MSS.—JORDAN, Man. Vert. ed. 2d, 359, 1878.

Cristivomer namaycush JORDAN, Bull. U. S. Geol. Surv. Terr. iv, 430, 1878.

1817—*Salmo pallidus* RAFINESQUE, Am. Month. Mag. and Critical Review, 120. (Lake Champlain.)

1818—*Salmo amethystus* MITCHILL, Journ. Acad. Nat. Sci. Phila. v. 1, 410. (Great Lakes.)

Salmo amethystus DEKAY, New York Fauna, Fishes, 240, pl. 76, 1842.

Salmo amethystus STORER, Synopsis Fishes N. A. 193, 1846.

1842—*Salmo confinis* DEKAY, New York Fauna, Fishes, 238. (Louis Lake, N. Y.)

Salmo confinis STORER, Synopsis Fishes N. A. 193, 1866.

Salmo confinis SUCKLEY, Monograph Genus Salmo, 153, 1874.

Salmo confinis JORDAN, Man. Vert. 261, 1876.
Salmo confinis JORDAN, Man. Vert. ed. 2d, 273, 1878.
1850—*Salmo symmetrica* PRESCOTT, Silliman's Am. Journ. Sci. Arts, 2d series, xi, 340, 1850. (Lake Winnipiseogee.)
Salmo symmetrica SUCKLEY, Monograph Genus Salmo, 157, 1874.
Salmo symmetrica JORDAN, Man. Vert. 261, 1876.
Salmo symmetrica JORDAN, Man. Vert. ed. 2d, 273, 1878.
1863—*Salmo toma* HAMLIN, Second Annual Rept. Nat. Hist. and Geol. Maine for 1862, p.—. (Lakes of Maine.)
Salmo toma HAMLIN, Rept. Comm. Fish and Fisheries for 1872–73, 354, 1874.
1864—*Salmo adarondacus* NORRIS, Angler's Guide, p. —. (Adirondack Region.)

The head and caudal fin of a large specimen from Chief Mountain Lake. It does not differ in any obvious respect from Lake Michigan specimens. On examination of specimens supposed to be typical of each of the various nominal species included above, I am unable to see that they differ in any respect likely to prove constant.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21200	1178	Chief Mountain Lake............	Dr. Elliott Coues......	Aug. 18, 1874.

Genus SALMO Linnæus.

Subgenus SALAR Valenciennes.

15.—SALMO STOMIAS Cope.

Big-mouthed Trout.

1872—*Salmo (Salar) stomias* COPE, Hayden's Geol. Surv. Wyoming for 1870, 433.
Salmo stomias COPE, Hayden's Geol. Surv. Montana for 1871, 470, 1872.
Salmo stomias COPE & YARROW, Wheeler's Expl. W. 100th Mer. v, 684, 1876.
Salmo stomias HALLOCK, Sportsman's Gazetteer, 346, 1877.
Salmo stomias var. *stomias* JORDAN, Man. Vert. ed. 2d, 358, 1878.
Salar stomias JORDAN, Catalogue of Fishes N. A. 431, 1878.

This species is represented in the collection by a single head, 5½ inches in length, accompanied by the caudal fin. Before seeing specimens of this species, I had presumed that it might have been based on some one of the numerous varieties of *Salmo pleuriticus* Cope. There can be, however, no doubt of its specific distinctness. The following description is taken from this head, No. 21199, from Chief Mountain Lake:—

Head very long, rather pointed, broad and flat above, not carinated; the snout not at all gibbous or convex from the eyes forward, the head thus having a depressed and pike-like appearance.

Mouth very wide, the broad curved maxillary reaching much beyond the eye; eye moderate; snout in this specimen prolonged, emarginate at the end, receiving the swollen tip of the lower jaw; caudal fin scarcely emarginate and unspotted, as is the head.

Hyoid bone with a band of rather strong teeth. This character will at once separate it from *S. pleuriticus*, which has similarly small scales, as that species never has hyoid teeth; the relations of this fish are therefore as much with *S. clarki* and *S. henshawi*, as with *spilurus* and *pleuriticus*. From both *S. henshawi* and *S. clarki* it differs in the form of the head and small size of the scales; from *S. henshawi* notably in the form of the caudal fin. The following are the measurements of the head:—

Snout in head 3½; eye in head 6⅔; interorbital space in head 3⅗; maxillary in head 2¼; mandible in head 1⅕; length of head in inches 5½. The snout and bones of jaws are doubtlessly shorter in the female.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21199	1189	Chief Mountain Lake.............	Dr. Elliott Coues......	Aug. 24, 1874.

16.—SALMO CLARKI Rich.

Var. *aurora* (Grd.) Gill & Jordan.

Missouri River Trout. Utah Trout.

Var. *clarki.*

1836—*Salmo clarkii* RICHARDSON, Fauna Bor.-Amer. iii, 225.
Salmo clarkii STORER, Synopsis Fishes N. Am. 197, 1846.
Salmo clarkii HERBERT, Frank Forrester's Fish and Fishing, Suppl. 40, 1850.
Salmo clarkii SUCKLEY, Nat. Hist. Wash. Terr. 344, 1860.
Salmo clarkii SUCKLEY, Monograph Genus Salmo, 112, 1874.
Salmo clarkii JORDAN, Man. Vert. ed. 2d, 359, 1878.
Salar clarkii JORDAN, Bull. U. S Geol. Surv. Terr. 430, 1878.
1856—*Fario stellatus* GRD., Proc. Ac. Nat. Sc. Phila. 219.
Fario stellatus GIRARD, U. S. Pac. R. R. Exp. Fish, 316, pl. 69, f. 5–8.
Fario stellatus SUCKLEY, Nat. Hist. Wash. Terr. 346, 1860.
1861—*Salmo brevicauda* SUCKLEY, Ann. N. Y. Lyc. Nat. Hist. vii, 308.
Salmo brevicauda GÜNTHER, Cat. Fishes Brit. Mus. vi, 120, 1867.
Salmo brevicauda SUCKLEY, Monograph Gen. Salmo, 140, 1874.

Var. *aurora.*

1856—*Fario aurora* GRD., Proc. Ac. Nat. Sc. Phila. 218. (Based on two young specimens.)
Fario aurora GRD., Pac. R. R. Rep. x, 308, 1858.
Salmo aurora SUCKLEY, Nat. Hist. Wash. Terr. 343, pl. 68, 1860.
Salmo aurora GÜNTHER, Cat. Fishes Brit. Mus. vi, 119, 1867.
Salmo clarkii var. *aurora* JORDAN, Man. Vert. ed. 2d, 359, 1878.
Salar clarkii var. *aurora* JORDAN, Bull. U. S. Geol. Surv. Terr. iv, 430, 1878.
1856—*Salar lewisi* GIRARD, Proc. Ac. Nat. Sc. Phila. 219.
Salar lewisi GIRARD, U. S. Pac. R. R. Expl. Fish, 318, pl. 72, 1858.
Salmo lewisi SUCKLEY, Nat. Hist. Wash. Terr. 348, 1860.
Salmo lewisi GÜNTHER, Cat. Fishes Brit. Mus. vi, 122, 1867.
Salmo lewisi SUCKLEY, Monograph Genus Salmo, 139, 1874.
1856—*Salar virginalis* GIRARD, Proc. Ac. Nat. Sc. Phila. 220.
Salar virginalis GIRARD, Pac. R. R. Expl. Fish, 320, pl. 73, f. 1–4, 1858.
Salmo virginalis SUCKLEY, Nat. Hist. Wash. Terr. p. —, 1860.
Salmo virginalis GÜNTHER, Cat. Fishes Brit. Mus. vi, 123, 1867.
Salmo virginalis SUCKLEY, Monograph Gen. Salmo, 135, 1874.

Salmo virginalis COPE & YARROW, Wheeler's Expl. W. 100th Mer. 685, 1876.
1872—? *Salmo carinatus* COPE, Hayden's Geol. Surv. Montana for 1871, p. 471.
1874—*Salmo utah* SUCKLEY, Monograph Genus Salmo, p. 136, 1874.

A single head of this abundant species is in the collection. It is to all appearance entirely typical of what I call var. *aurora*.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21201	1174	St. Mary's River..................	Dr. Elliott Coues......	Aug. 16, 1874.

Family ESOCIDÆ.

17.—ESOX LUCIUS Linnæus.

Common Pike.

SYNONYMY FOR EUROPEAN SPECIMENS.*

The Pike. Hecht. Brochet. Lucio or *Luzzo. Gädda* (Sweden).
Lucius, BELLON, De Aquat. p. 296.—RONDEL. ii, p. 188.—SALV. pp. 94, 95.—SCHONEV. p. 44.—ALDROV., De Pisc. p. 630.—JONSTON, iii, t. 3, c. 5, t. 29, f. 1.—GESNER, De Pisc. p. 500.—WILLUGH. p. 236, tab. P, 5, f. 2.—RAY, Syn. p. 112.—KLEIN, Miss. Pisc. v, p. 74, tab. 20, f. 1.
Esox No. 1, ARTEDI, Synon. p. 26; Gen. p. 10, and spec. 53.—GRONOV., Zoophyl. No. 361.
Esox lucius L., Syst. Nat. i, p. 516.—BLOCH, Fische Deutschl. i, p. 229, t. 32; Bl. Schn. p. 390.—LACÉPÈDE, v, p. 297.—REISINGER, Prodr. Ichth. Hung. p. 47.—DONOVAN, Brit. Fishes, v, pl. 109.—FLEM., Brit. An. p. 184.—JURINE, Mém. Soc. Phys. et Hist. Nat. Genève, iii, 1825, p. 231, pl. 15.—EKSTRÖM, Fische Mörko, p. 78.—FRIES & EKSTRÖM, Scand. Fisk. p. 49, t. 10.—NILSS., Prodr. p. 36, and Scand. Faun. Fisk. p. 348.—PALL., Zoogr. Ross.-As. iii, p. 336.—PARNELL, Wern. Mem. vii, p. 272.—YARR., Brit. Fishes, 1st ed. 1, p. 383; 2d ed. 1, p. 434; 3d ed. 1, 343.—SÉLYS-LONGCH., Faune Belge, p. 223.—CUV. & VAL., xviii, p. 279.—KRÖYER, Danm. Fisk. iii, p. 236.—GRONOV., Syst. ed. Gray, p. 146.—GÜNTHER, Fische des Neckars, p. 107.—RAPP, Fische des Bodensees, p. 11.—HECKEL & KNER, Süsswasserfische, p. 287.—SIEBOLD, Süsswasserfische, p. 325.—GÜNTHER, Cat. Fishes Brit. Mus. vi, p. 226, and of all authors since Linnæus.

SYNONYMY FOR AMERICAN SPECIMENS.

1818—*Esox estor* LE SUEUR, Journ. Acad. Nat. Sci. Phila. i, 413.
Esox estor GÜNTHER, Cat. Fishes Brit. Mus. vi, 228, 1867. (Excl. syn. pars. Not of Richardson, DeKay, and others, which is *E. nobilior* Thompson.)
Esox lucius var. *estor* JORDAN, Man. Vert. 255, 1876.
Esox lucius var. *estor* NELSON, Bull. Ills. Mus. Nat. Hist. 1876.
Esox lucius estor JORDAN & COPELAND, Check List Fishes, 143, 1876.
1836—*Esox lucius* RICHARDSON, Fauna Bor.-Am. iii, Fishes, 124.
Esox lucius ? DEKAY, New York Fauna, Fishes, 226, 1842.
Esox lucius ? STORER, Synopsis Fishes N. A. 438, 1846.
Esox lucius COPE, Proc. Ac. Nat. Sc. Phila. 79, 1865.
Esox lucius COPE, Trans. Am. Philos. Soc. Phila. 408, 1866.
Esox lucius GÜNTHER, Cat. Fishes Brit. Mus. vi, 227, 1867.
Esox lucius JORDAN, Bull. U. S. Nat. Mus. x, 55, 1877.
Esox lucius JORDAN, Man. Vert. ed. 2d, 266, 1878.
Esox lucius JORDAN, Bull. U. S. Geol. Surv. Terr. 432, 1878.

* Copied from Günther, Cat. Fishes Brit. Mus. vi, p. 226, 1867.

1846—*Esox reticulatus* KIRTLAND, Bost. Journ. Nat. Hist. v, 233, pl. 10, f. 2. (Not of Le Sueur; first carefully distinguished from the Muskallunge.)
1846—? *Esox deprandus* (LE SUEUR) CUV. & VAL. xviii, 336.
? *Esox deprandus* COPE, Proc. Ac. Nat. Sci. Phila. 79, 1865.
? *Esox deprandus* COPE, Trans. Am. Philos. Soc. 408, 1866.
? *Esox deprandus* GÜNTHER, Cat. Fishes Brit. Mus. vi, 2, 1867.
1850—*Esox boreus* AGASSIZ, Lake Superior, 317, 1850.
Esox lucioides AUCT.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
21195	1076	Turtle Mountain	Dr. Elliott Coues	Aug. 10, 1873.
....	1176 (head)	St. Mary's River, Rocky Mountains	........do........	Aug. 18, 1874.

The Common Pike is very abundant in all waters of Northern Asia, Northern Europe, and of North America north of about the latitude of the tributaries of Lake Erie, to Quincy, Ill., and northwestward to Alaska. It is one of the very few fresh-water fishes common to the eastern and western continents. I have carefully compared Swedish and American specimens, and I am unable to detect any specific differences whatever. No other strictly fresh-water species is known to be common to Europe and America. I have, however, little doubt of the identity of the American *Lota maculosa* (Le S.) with the European *Lota vulgaris* Cuv. In this case, the American species has the prior name.*

The number of nominal species of the genus *Esox* is greatly in excess of the number of definable forms. Those apparently worthy of recognition may be grouped in three subgeneric sections as follows:—

I. MASCALONGUS Jordan: Species of the largest size, with the branchiostegals in increased number (17 to 19), and the lower half of the cheeks and of the opercles bare of scales; coloration dark-spotted on a lighter ground. "Muskallunges."..*nobilior.*

II. ESOX Linnæus: Species of large size, with the branchiostegals 15 or 16 in number; coloration pale-spotted on a darker ground; fins black-spotted. "Pikes." *lucius.*

III. PICORELLUS Rafinesque: Species of medium or small size, with the branchiostegals 12 to 15 in number; coloration reticulated or barred with dark green on a lighter ground or nearly plain. "Pickerels." *reticulatus, americanus, raveneli, cypho, salmoneus.*

Family ETHEOSTOMATIDÆ

Genus ALVORDIUS Girard.

18.—ALVORDIUS MACULATUS Girard.

Black-sided Darter.

1841—*Etheostoma blennioides* KIRTLAND, Boston Journ. Nat. Sci. iii, 348. (Not of Raf.)
Etheostoma blennioides STORER, Syn. Fishes N. A. 270, 1846.
Etheostoma blennioides AG., Amer. Journ. Sci. Arts, 305, 1854.
Etheostoma blennioides COPE, Proc. Ac. Nat. Sci. Phila. 233, 1864.
Etheostoma blennioides VAILLANT, Recherches sur les Poissons, etc. 70, 1873.

* This conclusion has been already independently reached by Dr. T. H. Bean of the Smithsonian Institution.

1859—*Alvordius maculatus* GIRARD, Proc. Ac. Nat. Sci. Phila. 67.
1859—*Hadropterus maculatus* GIRARD, Proc. Ac. Nat. Sci. Phila. 100.
Etheostoma maculatum COPE, Am. Philos. Soc. 449, 1870.
Etheostoma maculatum VAILLANT, Recherches sur les Poissons, etc. 54, 1873.
Alvordius maculatus JORDAN, Man. Vert. 2d ed. 220, 1878.
Alvordius maculatus JORDAN, Bull. U. S. Geol. Surv. Terr. iv, 438, 1878.
1877—*Alvordius aspro* COPE & JORDAN, Proc. Ac. Nat. Sci. Phila. 51.
Alvordius aspro JORDAN, Bull. Nat. Mus. x, 14, 1877.

Numerous young specimens with the coloration obliterated, but not apparently different from ordinary Indiana specimens.

Smithsonian number.	Collector's number.	Locality.	Collector.	Date.
20193	....	....	Dr. Elliott Coues	....

ART. XXXIV.—CATALOGUE OF PHÆNOGAMOUS AND VASCULAR CRYPTOGAMOUS PLANTS COLLECTED DURING THE SUMMERS OF 1873 AND 1874 IN DAKOTA AND MONTANA ALONG THE FORTY-NINTH PARALLEL BY DR. ELLIOTT COUES U. S. A.: WITH WHICH ARE INCORPORATED THOSE COLLECTED IN THE SAME REGION AT THE SAME TIMES BY MR. GEORGE M. DAWSON.

BY PROF. J. W. CHICKERING.

[The present article is based primarily upon the collection of plants made by me during my connection with the United States Northern Boundary Commission. Those collected in 1873 were secured along the northern border of Dakota, in the valleys of the Red River of the North and of the Souris or Mouse River; and notably at Pembina, Dak. The collecting season of 1874 was along the northern border of Montana, and in the Rocky Mountains, at latitude 49° N.

With the species represented in my own collection, Professor Chickering has, at my suggestion, incorporated those procured by my colleague of the British contingent of the Survey, as published by Mr. Dawson in his report (8vo, Montreal, 1875, pp. 351–379); thereby presenting a fair idea of the flora of the belt of country surveyed by the Boundary Commission. The species not represented in my collection, but derived from Mr. Dawson's list, are marked with the asterisk (*).

For papers on other portions of my collections, see this Bulletin, this Vol., No. 1, pp. 259–292; No. 2, pp. 481–518; No. 3, pp. 545–661; No. 4, pp. 777–799.—ED.]

This catalogue comprises 692 species, besides quite a number of varieties, and is of much value and interest, not so much for the number of new species enumerated as for the information supplied respecting the range of many species known to be common farther east, west, or south.

A hasty comparison gives about 390 species found in New York or New England, about 80 distinctively Western in their habitat, and about 215 which belong on the plains and the Rocky Mountain region.

The *Leguminosæ* and the *Compositæ* are, of course, very largely represented, and exhibit a number of species peculiar to the region. The fact that but few collections were made previous to June will explain the absence of many spring flowers, which, from the character of the flora of summer, we should expect to find on that parallel.

Allium stellatum, Nutt., *Anemone Pennsylvanica*, L., and *Campanula rotundifolia*, L., var. *linifolia*, were noticed as so abundant on the prairie as to give character to the landscape.

Yucca angustifolia, Nutt., was collected along the Missouri River, probably reaching here its northern limit.

The species common to this region and the East show, for the most part, the effect of the drier climate and the scorching sun of the plains in smaller, thicker, more hirsute leaves.

Among the *Cactaceæ* but two species are found, *Mammillaria vivipara* and *Opuntia Missouriensis*, quite abundant along the central region, from 103° to 111° west longitude, limited very abruptly by increasing moisture of soil and climate.

Salicornia herbacea and *Rumex maritimus* suggest the saline character of the soil, and flourish as luxuriantly as if the sea still washed those inland shores.

The paucity in species of trees, excepting *Coniferæ*, is in striking contrast to the variety of the East, and may in part arise from the fact that so many trees are out of flower before the beginning of June.

The *Orchidaceæ* would naturally be poorly represented.

Carices and *Gramineæ* are quite abundant and interesting, while *Filices* make but a scanty display.

Doubtless a careful examination of certain localities through the entire season would add many species to the list, but the present catalogue serves very well to convey to the botanist a good idea of the characteristic flora of the 49th parallel.

RANUNCULACEÆ.

1. *Clematis verticillaris*, DC.
   1874. July, August. Frenchman's Creek to Rocky Mountains.
2. *Clematis ligusticifolia*, Nutt.
   1874. July. Along Frenchman's Creek.

*3. *Anemone alpina*, L.

*4. *Anemone multifida*, DC.

*5. *Anemone nemorosa*, L.

*6. *Anemone parviflora*, Mx.

7. *Anemone patens*, L., var. *Nuttalliana*, Gray.
   1873. July, August. Between Pembina and Mouse River. Apparently an autumnal inflorescence, the buds and flowers appearing with the mature leaves.
8. *Anemone Pennsylvanica*, L.
   1873. July. Pembina. Very abundant.
   1874. July. Prairie near Milk River.

*9. *Thalictrum cornuti*, L.

10. *Thalictrum dioicum*, L.
    1873. July. Pembina. Very common, on the prairie.
11. *Thalictrum purpurascens*, L.
    1873. July, August. Pembina and along Mouse River.

*12. *Ranunculus abortivus*, L.

*13. *Ranunculus affinis*, R. Br.
Ranunculus affinis, R. Br., var. *cardiophyllus*.
1873. July. Pembina.
14. *Ranunculus aquatilis*, L., var. *trichophyllus*.
1873. August, September. Mouse River.
14[a]. *Ranunculus aquatilis*, L., var. *capillaceus*.
1874. July. Frenchman's Creek.
15. *Ranunculus cymbalaria*, Pursh.
1873. July. Pembina. In company with *Lemna trisulca*.
1874. August. Rocky Mountains. On wet prairie.
*16. *Ranunculus Flammula*, L., var. *reptans*.
*17. *Ranunculus hispidus*, Mx.
*18. *Ranunculus Purshii*, Rich.
*19. *Ranunculus pygmæus*, Wehl.
20. *Ranunculus repens*, L.
1873. July. Pembina. Very hirsute.
1874. July. Frenchman's Creek.
*21. *Ranunculus rhomboideus*, Gold.
*22. *Myosurus minimus*, L.
*23. *Caltha palustris*, L.
*24. *Coptis trifolia*, Salisb.
*25. *Aquilegia Canadensis*, L.
*26. *Aquilegia flavescens*, Watson.
27. *Aquilegia vulgaris*, L., var. *brevistyla*.
1873. July. Pembina.
*28. *Delphinium azureum*, Mx.
29. *Actæa spicata*, L., var. *rubra*.
1873. July. Pembina and along Mouse River.
1874. August. Rocky Mountains. In fruit.

MENISPERMACEÆ.

*30. *Menispermum Canadense*, L.

BERBERIDACEÆ.

*31. *Berberis* (*Mahonia*) *aquifolium*, Pursh.

NYMPHACEÆ.

*32. *Nuphar advena*, Ait.

SARRACENIACEÆ.

*33. *Sarracenia purpurea*, L.

PAPAVERACEÆ.

*34. *Sanguinaria Canadensis*, L.

FUMARIACEÆ.

*35. *Corydalis glauca*, Pursh.
*36. *Corydalis aurea*, Willd.

CRUCIFERÆ.

*37. *Nasturtium palustre*, D. C.
*38. *Nasturtium tanacetifolium*, Hook.
*39. *Arabis hirsuta*, Scop.
40. *Arabis lyrata*, L.
1874. August. Base of Rocky Mountains. In fruit.
*41. *Arabis perfoliata*, Lam.
42. *Erysimum cheiranthoides*, L.
1873. July. Pembina.
1874. July. Missouri Coteau to Milk River.
43. *Erysimum asperum*, DC.
1874. July. Frenchman's Creek. In fruit.
43[a]. *Erysimum asperum*, DC., var. *pumilum*.
1874. August. Near Milk River. With long pods, 4′.
*44. *Erysimum lanceolatum*, R. Br.
*45. *Sisymbrium brachycarpum*, Hook.
46. *Sisymbrium canescens*, Nutt.
1873. July. Between Pembina and Mouse River, on open prairie. A very canescent form.
47. *Stanleya pinnatifida*, Nutt.
1874. July. Frenchman's Creek.
*48. *Camelina sativa*, Crantz.
*49. *Capsella Bursa-pastoris*, Moench.
*50. *Thlaspi arvense*, L.
51. *Raphanus sativus*, L.
1873. July. Pembina.
*52. *Sinapis arvensis*, L.
*53. *Vesicaria didymocarpa*, Hook.
*54. *Vesicaria Ludoviciana*, DC.

CAPPARIDACEÆ.

55. *Cleome integrifolia*, T. & G.
1873. August. Mouse River.
1874. August. Milk River.
A very showy plant on dry sub-saline soil.
*56. *Polanisia graveolens*, Raf.

VIOLACEÆ.

*57. *Viola Canadensis*, L.
58. *Viola delphinifolia*, Nutt.
1873. July. Plains around Pembina.

*59. *Viola cucullata*, Ait.
60. *Viola pubescens*, Ait.
1873. July. Pembina. Woods.
*61. *Viola Nuttallii*, Pursh.
*62. *Viola pedata*, L.

DROSERACEÆ.

*63. *Drosera longifolia*, L.

HYPERICACEÆ.

*64. *Hypericum Scouleri*, Hook.

CARYOPHYLLACEÆ.

*65. *Silene antirrhina*, L.
*66. *Silene Douglasii*, Hook.
*67. *Silene longifolia*, Muhl.
68. *Arenaria lateriflora*, L.
1873. July. Pembina, in thickets.
69. *Arenaria stricta*, Mx.
1874. August. Milk River. In fruit.
*70. *Arenaria nardifolia*, Ledeb.
*71. *Arenaria pungens*, Nutt.
72. *Stellaria longifolia*, Muhl.
1873. July. Pembina.
*73. *Cerastium nutans*, Raf.
*74. *Cerastium oblongifolium*, Torr.

MALVACEÆ.

75. *Malvastrum coccineum*, Gray.
1873. August. Abundant along Mouse River on dry plains.
1874. July, August. Frenchman's Creek, Milk River.
76. *Sphæralcea acerifolia*, Nutt.
1874. August. Base of Rocky Mountains. In flower.

LINACEÆ.

77. *Linum perenne*, L.
1873. July, August, September. Common all the way on the plains from Pembina to Mouse River.
1874. Missouri Coteau to base of Rocky Mountains.
78. *Linum rigidum*, Pursh.
1874. July. Frenchman's Creek.

GERANIACEÆ.

*79. *Geranium Carolinianum*, L.
*80. *Geranium Fremontii*, Torr.

81. *Geranium Richardsonii*, F. & M.
 1874. August. Along Milk River.

81[a]. *Geranium Richardsonii*, F. & M., var. *incisum*.
 1874. July. Frenchman's Creek.

OXALIDACEÆ.

82. *Oxalis stricta*, L.
 1873. July. Pembina.

BALSAMINACEÆ.

*83. *Impatiens fulva*, Nutt.

ANACARDIACEÆ.

*84. *Rhus aromatica*, Gray.

85. *Rhus Toxicodendron*, L.
 1873. July. Pembina. In flower.
 1874. July. Missouri River.

*86. *Rhus glabra*, L.

VITACEÆ.

87. *Vitis cordifolia*, Mx., var. *riparia*.
 1873. July. Pembina. Thickets.

*88. *Ampelopsis quinquefolia*, Mx.

CELASTRACEÆ.

89. *Pachystima myrsinites*, Raf.
 1874. August. Base of Rocky Mountains.

RHAMNACEÆ.

*90. *Ceanothus velutinus*, Doug.

*91. *Rhamnus alnifolius*, L'Her.

SAPINDACEÆ.

*92. *Acer rubrum*, L.

93. *Negundo aceroides*, Moench.
 1874. July. Near Fort Buford. Sugar is often made from its sap.

POLYGALACEÆ.

94. *Polygala alba*, Nutt.
 1874. July. Prairie around Fort Buford.

*95. *Polygala polygama*, Walt.

*96. *Polygala Senega*, L.

LEGUMINOSÆ.

97. *Lupinus argenteus*, Pursh.
 1874. August. Base of Rocky Mountains.

98. *Hosackia Purshiana*, Benth.
 1874. June. Missouri River.

99. *Psoralea argophylla*, Pursh.
    1873. August. Dry prairie along Mouse River.
    1874. July. Missouri River.

*100. *Psoralea brachiata*, Doug.

101. *Psoralea hypogæa*, Nutt.
    1874. July. Milk River.

102. *Psoralea lanceolata*, Pursh.
    1874. July. Frenchman's Creek.

103. *Petalostemon candidus*, Mx.
    1873. July. Pembina.
    1874. June. Missouri River.

104. *Petalostemon violaceus*, Mx.
    1873. July. Pembina. Both this and the last species are very abundant on the dry prairie.
    1874. August. Frenchman's Creek.

105. *Amorpha canescens*, Nutt.
    1873. August. Open plains.

106. *Amorpha nana*, Nutt.
    1873. August. Plains near Turtle Mountain.

*107. *Astragalus aboriginorum*, Rich.

108. *Astragalus adsurgens*, Pall.
    1874. June. Prairie around Fort Buford.

109. *Astragalus bisulcatus*, Gray.
    1874. June. Prairie around Fort Buford.

*110. *Astragalus Bourganii*, Gray.

*111. *Astragalus cæspitosus*, Gray.

112. *Astragalus Canadensis*, L.
    1873. September. Along Mouse River. In fruit.

*113. *Astragalus caryocarpus*, Ker.

*114. *Astragalus flexuosus*, Doug.

115. *Astragalus hypoglottis*, L.
    1873. July. Plains near Pembina.

116. *Astragalus Missouriensis*, Nutt.
    1874. July. Missouri River.

117. *Astragalus pectinatus*, Doug.
    1874. July. Milk River.

118. *Astragalus pictus*, Gray.
    1874. June. Missouri River.

119. *Astragalus Purshii*, Doug.
    1874. July. Milk River. In fruit.

*120. *Astragalus tegetarius*, Watson.

121. *Oxytropis Lamberti*, Pursh.
    1874. June. Missouri River.

122. *Oxytropis splendens*, Dougl.
    1873. August. Dry prairie near Turtle Mountain. Leaflets strongly verticillate.
    1874. August. Milk River.

123. *Glycyrrhiza lepidota*, Nutt.
1873. August. Along Mouse River.
1874. July, August. Missouri River. Milk River.
124. *Hedysarum boreale*, Nutt.
1874. August. Base of Rocky Mountains.
*125. *Desmodium Canadense*, D. C.
126. *Vicia Americana*, Muhl.
1873. July. August, Pembina to Mouse River. Common in thickets and on the plains.
1874. June. Missouri River.
127. *Lathyrus ochroleucus*, Hook.
1873. August. Near Turtle Mountain. In thickets.
*128. *Lathyrus maritimus*, Big.
129. *Lathyrus venosus*, Muhl.
1873. August. In company with preceding species.
130. *Thermopsis rhombifolia*, Nutt.
1874. June. Missouri River.

ROSACEÆ.

*131. *Prunus Americana*, Marsh.
*132. *Prunus depressa*, Pursh.
*133. *Prunus Pennsylvanica*, L.
134. *Prunus Virginiana*, L.
1873. August. Mouse River. In fruit. Used as food by the Indians.
1874. July. Missouri River. In fruit.
135. *Spiræa salicifolia*, L.
1873. July. Pembina. Forming thickets.
1874. July. Milk River.
*136. *Spiræa betulifolia*, Pall.
137. *Agrimonia Eupatoria*, L.
1873. August. Thickets.
138. *Dryas octopetala*, L.
*139. *Geum macrophyllum*, Willd.
*140. *Geum triflorum*, Pursh.
141. *Geum strictum*, Ait.
1873. August. Near Turtle Mountain. With preceding.
1874. August. Milk River.
*142. *Sibbaldia procumbens*, L.
143. *Potentilla anserina*, L.
1873. July. Pembina.
1874. July. Frenchman's Creek.
144. *Potentilla arguta*, Pursh.
1873. July. Pembina. On prairie. Silky-pubescent.
1874. August. Milk River.

145. *Potentilla fruticosa*, L.
1874. August. Milk River. Abundant.
*146. *Potentilla effusa*, Doug.
*147. *Potentilla glandulosa*, L.
148. *Potentilla gracilis*, Doug.
1873. August. Second prairie plateau.
1874. August. Frenchman's Creek.
*149. *Potentilla hippiana*, Lehm.
150. *Potentilla Norvegica*, L.
1873. July. Pembina.
1874. August. Frenchman's Creek.
*151. *Potentilla palustris*, Scop.
152. *Potentilla Pennsylvanica*, L.
1873. August. Second prairie plateau.
*153. *Potentilla tridentata*, Ait.
154. *Fragaria Virginiana*, Ehrh.
1873. July. Pembina.
1874. August. Sweetgrass Hills, abundant.
*155. *Fragaria vesca*, L.
156. *Rubus strigosus*, Mx.
1874. July. Frenchman's Creek. Thickets.
157. *Rubus triflorus*, Rich.
1873. July. Pembina.
*158. *Rubus Nutkanus*, Moc.
159. *Rosa blanda*, Ait.
1873. July. Pembina. Everywhere on the prairie, especially on the edges of woods along the streams.
160. *Cratægus tomentosa*, L., var. *punctata*.
1873. July. Pembina. In flower.—September. Along Mouse River. In fruit.
*161. *Cratægus coccinea*, L.
162. *Pyrus sambucifolia*, Ch. & Sch.
1874. August. Base of Rocky Mountains.
163. *Amelanchier Canadensis*, L., var. *alnifolia*.
1873. July. Pembina. In fruit.
1874. July. Milk River.

SAXIFRAGACEÆ.

164. *Ribes aureum*, Pursh.
1874. July. Missouri River. In fruit.
*165. *Ribes Cynosbati*, L.
166. *Ribes floridum*, L'Her.
1873. July. Pembina. In thickets.
167. *Ribes hirtellum*, Mx.
1874. July. Along Frenchman's Creek.
*168. *Ribes rotundifolium*, Mx.

*169. *Ribes rubrum*, L.
*170. *Parnassia Caroliniana*, L.
171. *Parnassia fimbriata*, Banks.
1874. August. Milk River.
172. *Parnassia palustris*, L.
1874. July. Frenchman's Creek.
*173. *Saxifraga bronchialis*, DC.
*174. *Saxifraga Eschscholtzii*, Sternb.
*175. *Saxifraga Dahurica*, Pall.
*176. *Saxifraga heteranthera*, Hook.
*177. *Saxifraga vernalis*, Willd.
*178. *Heuchera cylindrica*, Doug.
*179. *Heuchera Richardsonii*, R. Br.
*180. *Leptarrhena pyrolifolia*, Brown.
*181. *Mitella nuda*, L.
*182. *Mitella pentandra*, Hook.
*183. *Tiarella unifoliata*, Hook.

CRASSULACEÆ.

*184. *Sedum Rhodiola*, DC.
*185. *Sedum stenopetalum*, Pursh.

HALORAGEÆ.

186. *Myriophyllum spicatum*, L.
1874. August. Along branch of Milk River and all the prairie pools.

ONAGRACEÆ.

187. *Gaura coccinea*, Nutt.
1874. July. Frenchman's Creek.
188. *Circœa alpina*, L.
189. *Epilobium coloratum*, Muhl.
1873. August. Near Turtle Mountain.
*190. *Epilobium palustre*, L., var. *lineare*.
*190[a]. *Epilobium palustre*, L., var. *albiflora*.
191. *Epilobium tetragonum*, L.
1874. July. Frenchman's Creek.
*192. *Epilobium origanifolium*, Lam.
193. *Epilobium angustifolium*, L.
1874. August. Branch of Milk River.
*194. *Epilobium latifolium*, L.
195. *Epilobium paniculatum*, L.
1873. August. Plains.
1874. August. Frenchman's Creek.
196. *Œnothera albicaulis*, Nutt.
1873. August. Mouse River.
1874. July. Missouri River.

*197. *Œnothera marginata*, Nutt.

198. *Œnothera biennis*, L.

1873. August. Dry plains between Pembina and Mouse River.

1874. July. Missouri River.

199. *Œnothera serrulata*, Nutt.

1873. August. With preceding species.

200. *Œnothera heterantha*, Nutt.

*201. *Œnothera leucocarpa*, Comien.

*202. *Œnothera pumila*, L.

LOASACEÆ.

203. *Mentzelia ornata*, Pursh.

1874. August. Base of Rocky Mountains.

CACTACEÆ.

204. *Mammillaria (Coryphantha) vivipara*, Haw.

1873. Extends eastward of the Missouri Coteau, in the valley of the Mouse River.

205. *Opuntia Missouriensis*, DC.

1873. September. Begins a little east of the Missouri Coteau, and is found all the way to the Rocky Mountains. Not in Red River Valley.

CUCURBITACEÆ.

206. *Echinocystis lobata*, T. & G.

UMBELLIFERÆ.

207. *Sanicula Marilandica*, L.

1873. July. Pembina.

*208. *Carum Gairdneri*, Benth. & Hook.

209. *Heracleum lanatum*, Mx.

1873. August. Dry prairie.

210. *Thaspium aureum*, Nutt.

1873. July. Pembina.

211. *Thaspium trifoliatum*, Gray.

1873. July. Pembina. Immature in open woods.

212. *Bupleurum ranunculoides*, L.

1874. August. Branch of Milk River.

213. *Cicuta virosa*, L.

1873. July. Pembina. This species exhibits forms running toward *C. maculata*.

1874. July. Frenchman's Creek.

214. *Cicuta maculata*, L.

*215. *Sium lineare*, Mx.

*216. *Osmorrhiza brevistylis*, DC.

217. *Osmorrhiza longistylis*, DC.
 1873. July. Pembina.

ARALIACEÆ.

218. *Aralia nudicaulis*, L.
 1873. July. Pembina. In woods.

*219. *Aralia hispida*, Mx.

CORNACEÆ.

*220. *Cornus Canadensis*, L.

*221. *Cornus paniculata*, L'Her.

222. *Cornus stolonifera*, Mx.
 1873. July. Pembina. In flower.—August. Near Turtle Mountain. In fruit.
 1874. July, August. Along river-bank.

CAPRIFOLIACEÆ.

*223. *Linnœa borealis*, Gron.

*224. *Symphoricarpus occidentalis*, R. Br.
 1873. September. Mouse River. In fruit.—July. Pembina. In flowers. Occurring in masses in thickets.
 1874. August. Sweetgrass Hills.

225. *Symphoricarpus racemosus*, Mx.
 1874. August. Base of Rocky Mountains.

*226. *Lonicera involucrata*, Banks.

227. *Lonicera hirsuta*, Eaton.
 1873. July. Pembina. In thickets.

*228. *Lonicera oblongifolia*, Muhl.

*229. *Lonicera parviflora*, Lam.

230. *Viburnum Lentago*, L.
 1873. July. Pembina.

231. *Viburnum Opulus*, L.
 1873. July. Pembina.

*232. *Diervilla trifida*, Mœnch.

RUBIACEÆ.

233. *Galium boreale*, L.
 1873. July. Pembina. Very abundant on the prairie.
 1874. June. Missouri River.—August. Rocky Mountains.

234. *Galium triflorum*, Mx.
 1873. July. Pembina.

*235. *Galium trifidum*, L.

*236. *Houstonia ciliolata*, Torr.

*237. *Houstonia tenuifolia*, Nutt.

VALERIANACEÆ.

*238. *Valeriana sylvatica*, Rich.

COMPOSITÆ.

239. *Liatris punctata*, Hook.
1874. July. Prairie, near Frenchman's Creek.

240. *Liatris scariosa*, L.
1873. August. Second prairie.

241. *Brickellia grandiflora*, Nutt.
1874. August. Thickets. Milk River.

*242. *Eupatorium perfoliatum*, L.

243. *Eupatorium purpureum*, L.
1873. August. Thickets, on plains.

*244. *Nardosmia sagittata*, Pursh.

*245. *Aster carneus*, Nees.

246. *Aster lævis*, L.
1873. September. Mouse River, in thickets.
1874. August. Milk River.

*247. *Aster graminifolius*. Pursh.

248. *Aster Lamarckianus*, Nees.
1873. September. Mouse River.

*249. *Aster miser*, L.

*250. *Aster macrophyllus*, L.

251. *Aster multiflorus*, L.
1873. August. Mouse River Plain. Abundant. Specimens very rugose; leaves almost cuspidate.

252. *Aster ptarmicoides*, T. & G.
1873. August. Second prairie.

*253. *Aster salsuginosus*, Rich.

*254. *Aster tenuifolius*, L.
1873. August. Near Turtle Mountain.

*255. *Erigeron alpinum*, L.

*256. *Erigeron compositum*, Pursh.

257. *Erigeron glabellum*, Nutt.
1873. August. Mouse River Plain. Very abundant all over the prairie.

*258. *Erigeron Canadense*, L.

259. *Erigeron Philadelphicum*, L.
1873. July. Pembina.

*260. *Erigeron strigosum*, L.

261. *Erigeron pumilum*, Nutt.
1874. July. Prairies near Frenchman's Creek.

*262. *Machæranthera canescens*, Gray.

263. *Gutierrezia Euthamiæ*, T. & G.
1873. August. Mouse River, on dry plain.
1875. August. Frenchman's Creek.

*264. *Diplopappus umbellatus*, T. & G.

265. *Boltonia glastifolia*, L'Her.
1873. September. Mouse River.

*266. *Solidago Canadensis*, L

267. *Solidago gigantea*, Ait.
1873. July, August. From Pembina to Mouse River.
1874. August. Milk River.

*268. *Solidago Virga-aurea*, L.

269. *Solidago Virga aurea*, L., var. *humilis*.
1874. August. Rocky Mountains.

*270. *Solidago Virga-aurea*, L., var. *alpina*.

271. *Solidago incana*, T. & G.
1874. August. Milk River.

*272. *Solidago lanceolata*, Ait.

*273. *Solidago nemoralis*, Ait.

274. *Solidago Missouriensis*, Nutt.
1873. August. Mouse River.

*275. *Solidago stricta*, Ait.

*276. *Solidago serotina*, Ait.

277. *Solidago rigida*, L.
1873. August. Open prairie. Very abundant.
1874. August. Milk River.

*278. *Solidago tenuifolia*, Pursh.

*279. *Bigelovia graveolens*, Gr.

*280. *Bigelovia Howardii*, Gr.

281. *Aplopappus lanceolatus*, T. & G.
1874. August. Milk River.

*282. *Aplopappus Nuttallii*, T. & G.

283. *Aplopappus spinulosus*, DC.
1873. August. Mouse River. On very dry plains. Plant about six inches high.

284. *Grindelia squarrosa*, Dunal.
1873. August. Mouse River.
1874. August. Frenchman's Creek.
Very abundant on the plains. Used by the Indians as an anti-syphilitic, in decoction.

285. *Chrysopsis villosa*, Nutt.
1873. August. Dry plains.
1874. July, August. Prairies along Missouri River.

Chrysopsis villosa, Nutt., var. *hispida*.
1874. July. Missouri River.

*286. *Chrysopsis hispida*, Hook.

*287. *Iva axillaris*, Pursh.

288. *Ambrosia psilostachya*, DC.
1873. August. Mouse River. On dry plains.

*289. *Ambrosia trifida*, L., var. *integrifolia*.

*290. *Xanthium echinatum*, Murr.

291. *Xanthium strumarium*, L.
    1874. August. Along Missouri and Milk Rivers.

*292. *Heliopsis scabra*, Dun.

293. *Heliopsis lævis*, Pursh.
    1873. July, August. Pembina and westward. Abundant.

*294. *Echinacea purpurea*, Moench.

295. *Echinacea angustifolia*, DC.
    1873. August. Dry plains.

*296. *Rudbeckia fulgida*, Ait.

297. *Rudbeckia hirta*, L.
    1873. July. Pembina. Dry plains, as at the East.

298. *Rudbeckia laciniata*, L.
    1873. August. Mouse River Plain, in thickets.

299. *Lepachys columnaris*, T. & G.
    1873. August. Mouse River. Very abundant on prairies.

*300. *Helianthus giganteus*, L.

301. *Helianthus petiolaris*, Nutt.
    1874. August. Dry prairie, near base of Rocky Mountains.

*302. *Helianthus rigidus*, Desf.

303. *Bidens frondosa*, L.
    1873. July. Pembina.

*304. *Bidens Beckii*, Torr.

*305. *Bidens chrysanthemoides*, Mx.

306. *Gaillardia aristata*, Pursh.
    1873. August. Mouse River Plain.
    1874. August. Prairies along Frenchman's Creek.

*307. *Gaillardia pinnatifida*, Torr.

308. *Gaillardia pulchella*, Foug.
    1874. July, August. Dry prairies along Frenchman's Creek.

309. *Coreopsis tinctoria*, Nutt.
    1874. August. Along Frenchman's Creek.

310. *Hymenopappus luteus*, Nutt.
    1874. July. Prairie near Missouri River.

311. *Actinella Richardsonii*, Nutt.
    1874. July. Along Missouri River.—August. Along Milk River.

*312. *Actinella acaulis*, Nutt.

313. *Helenium autumnale*, L.
    1873. August. Mouse River. Slightly pubescent.

314. *Achillea millefolium*, L.
    1873. July. Pembina.
    1874. June. Fort Buford.

315. *Artemisia cana*, Pursh.
    1874. July. Dry plains, Missouri River.

316. *Artemisia Canadensis*, Mx.
1873. August. Mouse River. On dry prairie.
1874. July. Frenchman's Creek.

*317. *Artemisia Douglasiana*, Bers.

318. *Artemisia frigida*, Willd.
1874. July. Branch of Milk River.

*319. *Artemisia discolor*, Doug.

*320. *Artemisia dracunculoides*, Pursh.

321. *Artemisia Ludoviciana*, Nutt.
1873. September. Mouse River. Dry prairie. One of the species known as "sage".
1874. August. Milk River.

*322. *Gnaphalium polycephalum*, Mx.

*323. *Antennaria alpina*, Gaertn.

*324. *Antennaria dioica*, var. *rosea*, Gaertn.

*325. *Antennaria plantaginifolia*, Hook.

*326. *Arnica angustifolia*, Vahl.

*327. *Arnica longifolia*, Eaton.

*328. *Arnica Menziesii*, Hook.

*329. *Amida hirsuta*, Nutt.

330. *Senecio aureus*, L.
1874. August. Rocky Mountains.

330[a]. *Senecio aureus*, L., var. *Balsamitæ*.
1873. July. Pembina.

*331. *Senecio canus*, Hook.

*332. *Senecio Fremontii*, T. & G.

333. *Senecio eremophilus*, Hook.
1873. August. Prairie.

*334. *Senecio lugens*, Rich.

*335. *Senecio resedifolius*, Lessing.

*336. *Senecio triangularis*, Hook.

*337. *Cirsium altissimum*, Spring.

*338. *Cirsium undulatum*, Spring.
1873. September. Missouri Coteau.
1874. June. Plains near Fort Buford.

*339. *Cirsium muticum*, Mx.

340. *Troximon glaucum*, Nutt.
1874. July. Along Missouri River.

340[a]. *Troximon glaucum*, Nutt., var.
In company with the typical form.

341. *Troximon cuspidatum*, Pursh.
1873. July. Pembina and westward, on prairies.

*342. *Stephanomeria minor*, Nutt.

343. *Hieracium Canadense*, Mx.
1873. July. Pembina, in thickets.
1874. August. Along branch of Milk River.

*344. *Hieracium albiflorum*, Hook.
345. *Hieracium scabrum*, Mx.
1873. July. Pembina.
346. *Hieracium Scouleri*, Hook.
1874. August. Near Rocky Mountains.
*347. *Hieracium triste*, Willd.
*348. *Hieracium venosum*, L.
349. *Nabalus albus*, Hook.
1873. August. Mouse River Plain.
*350. *Nabalus Boottii*, DC.
351. *Nabalus racemosus*, Hook.
1873. September. Along Mouse River.
352. *Lygodesmia juncea*, Don.
1873. September. Mouse River. Abundant westward.
1874. July, August. Along Missouri and Milk Rivers.
*353. *Crepis elegans*, Hook.
*354. *Macrorhynchus glaucus*, Torr.
355. *Macrorhynchus troximoides*, T. & G.
1873. July. Pembina.
*356. *Taraxacum Dens-leonis*, Desf.
*357. *Lactuca elongata*, Muhl.
*358. *Mulgedium acuminatum*, DC.
*359. *Mulgedium leucophæum*, DC.
360. *Mulgedium pulchellum*, Nutt.
1873. August. Mouse River Plain.
1874. July, August. Along Missouri and Milk Rivers.

LOBELIACEÆ.

*361. *Lobelia Kalmii*, L.
362. *Lobelia spicata*, Lam.
1873. August. Second prairie.

CAMPANULACEÆ.

*363. *Campanula aparinoides*, Pursh.
364. *Campanula rotundifolia*, L., var. *linifolia*.
1873. July. Pembina. Everywhere on the prairie.
1874. July. Frenchman's Creek.

ERICACEÆ.

*365. *Vaccinium myrtilloides*, Hook.
366. *Arctostaphylos Uva-ursi*, Spring.
1874. July, August. Base of Rocky Mountains.
*367. *Gaultheria procumbens*, L.
*368. *Cassandra calyculata*, L.
*369. *Andromeda polifolia*, L.

*370. *Menziesia glanduliflora*, Hook.
*371. *Menziesia Grahami*, Hook.
*372. *Ledum latifolium*, Ait.
*373. *Pyrola elliptica*, Nutt.
*374. *Pyrola secunda*, L.
*375. *Pyrola rotundifolia*, L.
*376. *Pyrola asarifolia*, Mx.
*377. *Moneses uniflora*, Gray.
*378. *Monotropa uniflora*, L.

PLANTAGINACEÆ.

379. *Plantago eriopoda*, Torr.
1874. July. Dry prairie. Missouri River.
380. *Plantago Patagonica*, Jacq.
1874. July. Missouri River.
381. *Plantago Patagonica*, var.
With preceding.
*382. *Plantago major*, L.
*383. *Plantago Bigelovii*, Gray.

PRIMULACEÆ.

*384. *Androsace occidentalis*, Pursh.
*385. *Androsace septentrionalis*, L.
*386. *Dodecatheon integrifolium*, Mx.
*387. *Glaux maritima*, L.
388. *Lysimachia ciliata*, L.
1873. July, August. Pembina and westward, on the borders of thickets.
1874. July, August. Frenchman's Creek to Rocky Mountains.
*389. *Lysimachia thyrsifolia*, L.
*390. *Trientalis Americana*, Pursh.

LENTIBULACEÆ.

391. *Utricularia vulgaris*, L.
1874. August. Frenchman's Creek. Swamp.

SCROPHULARIACEÆ.

*392. *Chelone glabra*, L.
*393. *Pentstemon acuminatus*, Doug.
*394. *Pentstemon confertus*, Doug.
*395. *Pentstemon dasyphyllus*.
396. *Pentstemon gracilis*, Nutt.
1873. August. Dry prairie.
*397. *Pentstemon glaucus*, Grah.
*398. *Pentstemon Menziesii*, Hook.

*399. *Pentstemon procerus*, Doug.
*400. *Pentstemon pubescens*, Soland.
401. *Mimulus luteus*, L.
1874. August. Milk River.
*402. *Mimulus Lewisii*, Pursh.
*403. *Mimulus ringens*, L.
*404. *Gratiola Virginiana*, L.
*405. *Veronica Americana*, Schwein.
1874. August. Milk River.
*406. *Veronica alpina*, L.
*407. *Veronica peregrina*, L.
*408. *Gerardia purpurea*, L.
*409. *Castilleia coccinea*, Spring.
410. *Castilleia pallida*, Kunth.
1874. August. Base of Rocky Mountains.
410[a]. *Castilleia pallida*, Kunth., var. *miniata*.
1874. August. Milk River.
*411. *Castilleia sessiliflora*, Ph.
*412. *Rhinanthus Crista-Galli*, L.
*413. *Pedicularis Canadensis*, L.
*414. *Pedicularis bracteosa*, Benth.
*415. *Melampyrum Americanum*, Mx.
416. *Orthocarpus luteus*, Nutt.
1874. July. Near Three Buttes.

VERBENACEÆ.

417. *Verbena bracteosa*, Mx.
1874. July. Frenchman's Creek.
*418. *Verbena hastata*, L.

LABIATÆ.

419. *Mentha Canadensis*, L.
1873. August. Along Mouse River.
1874. August. Frenchman's Creek.
*420. *Lycopus sinuatus*, Gray.
*421. *Lycopus Virginicus*, L.
422. *Monarda fistulosa*, L.
1873. August. Turtle Mountain.
422[a]. *Monarda fistulosa*, var. *mollis*.
1874. August. Frenchman's Creek.
423. *Lophanthus anisatus*, Benth.
1873. August. Near Turtle Mountain.
424. *Dracocephalum parviflorum*, Nutt.
1873. August. Turtle Mountain.
*425. *Physostegia Virgiana*, Benth.

*426. *Brunella vulgaris*, L.

*427. *Scutellaria galericulata*, L.

*428. *Galeopsis Tetrahit*, L.

429. *Stachys aspera*, Mx.
1873. July. Pembina.

430. *Stachys palustris*, L.
1874. July. Missouri River and Frenchman's Creek.

BORRAGINACEÆ.

*431. *Onosmodium Virginianum*, DC.

432. *Lithospermum canescens*, Lehm.
1873. July. Pembina. Dry plains.

*433. *Lithospermum longiflorum*, Spreng.

*434. *Mertensia paniculata*, Don.

435. *Eritrichium Californicum*, DC.
1874. July. Frenchman's Creek.

436. *Eritrichium crassisepalum*, T. & G.
1874. August. Dry plains. Base of Rocky Mountains.

437. *Eritrichium leucophæum*, DC.
1874. August. Base of Rocky Mountains.

*438. *Eritrichium glomeratum*, DC.

*439. *Myosotis alpestris*, Schmidt.

*440. *Echinospermum floribundum*, Lehm.

*441. *Echinospermum Lappula*, Lehm.

*442. *Echinospermum patulum*, Lehm.

443. *Cynoglossum Virginicum*, L.
1873. July, August. Pembina and westward.

POLEMONIACEÆ.

444. *Phlox Douglassii*, Hook.
1874. July. Near Three Buttes.

*445. *Phlox canescens*, T. & G.

*446. *Phlox pilosa*, L.

447. *Collomia linearis*, Nutt.
1874. July. Dry prairies, Missouri River.

448. *Gilia minima*, Gr.
1874. July. Near Three Buttes.

CONVOLVULACEÆ.

449. *Calystegia sepium*, R. Br.
1873. July. Pembina.
1874. July. Missouri River.

450. *Calystegia spithamæa*, Pursh.
1873. July. Pembina, in woods.
1874. July. Missouri River.

451. *Cuscuta Gronovii*, Willd.
1873. August. Turtle Mountain. On *Ribes rotundifolium*.

SOLANACEÆ.

*452. *Physalis viscosa*, L.

453. *Solanum rostratum*, Dunal.
1874. July. Frenchman's Creek.

454. *Solanum triflorum*, Nutt.
1874. July. Prairies, Frenchman's Creek.

GENTIANACEÆ.

*455. *Halenia deflexa*, Griseb.

456. *Gentiana affinis*, Griseb.
1874. August. Milk River.

457. *Gentiana Amarella*, L.
1874. August. Rocky Mountains.

*458. *Gentiana acuta*, Mx.

*459. *Gentiana Andrewsii*, Griseb.

*460. *Gentiana crinita*, Froel.

*461. *Gentiana detonsa*, Fries.

*462. *Gentiana Menziesii*, Griseb.

463. *Gentiana puberula*, Mx.
1873. September. Mouse River.

APOCYNACEÆ.

464. *Apocynum androsæmifolium*, L.
1873. July. Pembina, in thickets.

465. *Apocynum cannabinum*, L.
1873. July. Very abundant in thickets. The fibre used by the Indians for cordage. It may eventually have some economic value.
1874. July. Missouri River.

ASCLEPIADACEÆ.

466. *Asclepias ovalifolia*, Dec.
1873. July. Pembina, in woods.

467. *Asclepias speciosa*, Torr.
1873. August. Plains near Turtle Mountain.
1874. July. Wet places along Frenchman's Creek.

468. *Asclepias verticillata*, L.
1873. July. Pembina.

*469. *Asclepias incarnata*, L.

*470. *Asclepias variegata*, L., var. *minor*, Hook.

*471. *Asclepias viridiflora*, Ell.

ARISTOLOCHIACEÆ.

*472. *Asarum Canadense*, L.

NYCTAGINACEÆ.

473. *Oxybaphus hirsutus*, Sweet. Var.
1874. July. Missouri River.
*474. *Oxybaphus nyctagineus*, Sweet.

CHENOPODIACEÆ.

*475. *Chenopodium album*, L.
476. *Chenopodium leptophyllum*.
1874. August. Dry plains west of Frenchman's Creek.
*477. *Blitum Bonus-Henricus*, L.
*478. *Blitum capitatum*, L.
479. *Blitum glaucum*, Koch.
1874. August. Milk River.
480. *Atriplex Nuttallii*, Watson.
1874. July. Missouri River.
481. *Atriplex Endolepis*, Watson.
1874. August. Frenchman's Creek.
*482. *Salicornia herbacea*, L.
483. *Suæda depressa*, Ledeb.
1873. July. Pembina, dry plains.
484. *Sarcobatus vermiculatus*, Torr.
1874. July. Saline soil. West of Frenchman's Creek.

AMARANTACEÆ.

*485. *Amarantus retroflexus*, L.

PARONYCHIÆ.

486. *Paronychia sessiliflora*, Nutt.
1873. September. Along Mouse River, on dry banks.
1874. August. Milk River.

POLYGONACEÆ.

487. *Polygonum amphibium*, L.
1874. July. Frenchman's Creek.
*487[a]. *Polygonum amphibium*, L., var. *terrestre*.
487[b]. *Polygonum amphibium*, L., var. *aquaticum*.
1873. August. Mouse River Plain, in wet places.
*488. *Polygonum aviculare*, L.
488[a]. *Polygonum aviculare*, L., var. *erectum*.
1874. August. Base of Rocky Mountains.
*489. *Polygonum cilinode*, Mx.
*490. *Polygonum dumetorum*, L.
*491. *Polygonum hydropiperoides*, Mx.
492. *Polygonum lapathifolium*, Ait., var. *incanum*.
1874. August. Frenchman's Creek.

*493. *Polygonum Pennsylvanicum*, L.
*494. *Polygonum tenue*, Mx.
*495. *Oxyria digyna*, Campd.
496. *Rumex maritimus*, L.
 1874. August. Saline plains, west of Frenchman's Creek.
497. *Rumex salicifolius*, Weinm.
 1873. July. Pembina.
 1874. June, July. Missouri River. Frenchman's Creek.
498. *Rumex venosus*, Pursh.
 1874. July, August. Frenchman's Creek and westward.
499. *Eriogonum flavum*, Nutt.
 1874. July, August. Missouri River to Rocky Mountains.
500. *Eriogonum umbellatum*, Torr.
 1874. July. Frenchman's Creek.
*501. *Eriogonum crassifolium*, Benth.

ELÆAGNACEÆ.

502. *Elæagnus argentea*, Pursh.
 1873. August. Vicinity of Turtle Mountain, very common in patches.
*503. *Shepherdia argentea*, Nutt.
*504. *Shepherdia Canadensis*, Nutt.

SANTALACEÆ.

505. *Comandra pallida*, DC.
 1874. June, July. Missouri River.
506. *Comandra umbellata*, Nutt.
 1873. July. Pembina.

EUPHORBIACEÆ.

*507. *Euphorbia glyptosperma*, Engl.

URTICACEÆ.

508. *Humulus Lupulus*, L.
 1873. August, September. Turtle Mountain to Mouse River.
509. *Urtica gracilis*, Ait.
 1873. August. Second prairie.
 1874. August. Frenchman's Creek.
510. *Laportea Canadensis*, Gaudich.
 1873. July. Pembina.
511. *Ulmus Americana*, L.
 1873. June. Pembina.

CUPULIFERÆ.

*512. *Corylus Americana*, Walt.
513. *Quercus macrocarpa*, Mx.
 1873. Pembina, common, of large size along the river.

BETULACEÆ.

514. *Betula occidentalis*, Hook.
1874. August. Rocky Mountains.

SALICACEÆ.

515. *Salix lucida*, Muhl.
1873. August. Mouse River.
516. *Salix rostrata*, Richardson.
1873. July. Pembina, in fruit.
*517. *Salix nigra*, Marsh.
*518. *Populus balsamifera*, L., var. *candicans*.
*519. *Populus monilifera*, Ait.
*520. *Populus tremuloides*, Mx.

CONIFERÆ.

*521. *Pinus Banksiana*, Lambert.
*522. *Pinus contorta*, Doug.
*523. *Pinus resinosa*, Ait.
524. *Abies Douglasii*, Lindl.
1874. Rocky Mountains.
*525. *Abies alba*, Mx.
*526. *Abies Engelmanni*, Parry.
*527. *Abies nigra*, Torr.
*528. *Abies balsamea*, Marshall.
*529. *Larix Americana*, Mx.
*530. *Thuja occidentalis*, L.
531. *Juniperus communis*, L.
1874. August. Rocky Mountains.
532. *Juniperus Sabina*, L.
1874. August. Base of Rocky Mountains.
*533. *Juniperus Virginiana*, L., var. *procumbens*.

ARACEÆ.

534. *Arisæma triphyllum*, Torr.
1873. July. Pembina.
*535. *Calla palustris*, L.
*536. *Acorus Calamus*, L.

LEMNACEÆ.

537. *Lemna trisulca*, L.
1873. Pembina, with *Ranunculus cymbularia*.
*538. *Lemna minor*, L.

TYPHACEÆ.

*539. *Typha latifolia*, L.
540. *Sparganium simplex*, Huds.
1873. July. Pembina.
*541. *Sparganium eurycarpum*, Eng.
*542. *Sparganium natans*, L.

NAIDACEÆ.

543. *Potamogeton pectinatus*, L.
1873. August. Near Turtle Mountain.
544. *Potamogeton marinus*, L.
1873. August. Near Turtle Mountain.
*545. *Potamogeton natans*, L.
546. *Potamogeton perfoliatus*, L., var. *lanceolatus*.
1874. August. Near Turtle Mountain.
*547. *Potamogeton pusillus*, L.

ALISMACEÆ.

548. *Alisma Plantago*, L.
1874. July. Frenchman's Creek.
*549. *Triglochin maritimum*, L.
*550. *Triglochin palustre*, L., var. *elatum*.
551. *Sagittaria variabilis*, Eng.
1873. August. Mouse River.
1874. July. Frenchman's Creek.

ORCHIDACEÆ.

552. *Habenaria hyperborea*, R. Br.
1874. August. Rocky Mountains.
*553. *Habenaria bracteata*, R. Br.
*554. *Habenaria psycodes*, Gray.
*555. *Spiranthes cernua*, Rich.
*556. *Calopogon pulchellus*, R. Br.
*557. *Cypripedium pubescens*, Willd.

AMARYLLIDACEÆ.

*558. *Hypoxis erecta*, L.

IRIDACEÆ.

*559. *Iris versicolor*, L.
560. *Sisyrinchium Bermudiana*, L., var. *anceps*.
1873. July. Pembina.
*561. *Sisyrinchium mucronatum*, Mx.

SMILACEÆ.

562. *Smilax herbacea*, L.
1873. July. Pembina.

LILIACEÆ.

563. *Zygadenus glaucus*, Nutt.
1873. July. Pembina.
564. *Zygadenus Nuttallii*, Gray.
1874. June. Prairie along Missouri River.

*565. *Veratrum album*, var. *Eschscholtzii*, Gray.
*566. *Xerophyllum tenax*, Pursh.
*567. *Tofieldia glutinosa*, Willd.
568. *Prosartes trachycarpa*, Watson.
1874. August. Rocky Mountains.
569. *Clintonia uniflora*, Menz.
1874. August. Rocky Mountains.
*570. *Smilacina bifolia*, Ker.
571. *Smilacina trifolia*, Desf.
1873. July. Pembina, in woods.
572. *Smilacina racemosa*, Desf.
1874. August. Rocky Mountains.
573. *Smilacina stellata*, Desf.
1873. July. Pembina.
1874. June. Fort Buford.
574. *Polygonatum giganteum*, Dietrich.
1873. July. Pembina, shady bank of the river.
575. *Lilium Philadelphicum*, L.
1873. June, July. Pembina. Very abundant on the prairie.
576. *Calochortus Nuttallii*, T. & G.
1874. June. Fort Buford.
577. *Allium cernuum*, Roth.
1874. August. Base of Rocky Mountains.
578. *Allium Schœnoprasum*, L.
1874. August. Rocky Mountains.
579. *Allium stellatum*, Nutt.
1873. August. Mouse River Plain. Very abundant.
*580. *Allium reticulatum*, Frazer.
581. *Yucca angustifolia*, Nutt.
1874. July. Missouri River.

JUNCACEÆ.

*582. *Juncus acuminatus*, Mx.
*583. *Juncus alpinus*, var. *insignis*, Fries.
584. *Juncus Balticus*, Deth.
1873. July. Pembina.
*584[a]. *Juncus Balticus*, Deth., var. *montanus*.
*585. *Juncus Mertensianus*, Doug.
*586. *Juncus nodosus*, L.
*587. *Juncus xiphioides*, E. Mayer.
*588. *Luzula parviflora*, Desv., var. *melanocarpa*.

COMMELYNACEÆ.

589. *Tradescantia Virginica*, L.
1874. June. Prairies near Fort Buford.

CYPERACEÆ.

*590. *Eleocharis acicularis*, R. Br.
591. *Eleocharis palustris*, R. Br.
1873. August. Mouse River Plain.
1874. July. Missouri River.
*592. *Scirpus Eriophorum*, Mx.
593. *Scirpus fluviatilis*, Gray.
1873. July. Pembina.
594. *Scirpus maritimus*, L.
1873. August. Vicinity of Turtle Mountain.
1874. July. Missouri River.
595. *Scirpus pungens*, Vahl.
1874. July. Missouri River.
596. *Scirpus validus*, Vahl.
1873. July. Pembina.
1874. July. Missouri River.
*597. *Eriophorum latifolium*.
*598. *Eriophorum polystachyon*, L.
*599. *Carex adusta*, Boot.
1873. July. Pembina.
*600. *Carex alopecoidea*, Tucker.
*601. *Carex aperta*, Boot.
602. *Carex aristata*, R. Br.
1873. July. Pembina.
*603. *Carex atrata*, L.
*604. *Carex aurea*, Nutt.
*605. *Carex Douglasii*, Hook.
*606. *Carex festiva*, Dew.
*607. *Carex lanuginosa*, Mx.
1874. July. Missouri River.
*608. *Carex longirostris*, Torr.
*609. *Carex lupulina*, Muhl.
*610. *Carex marcida*, Boott.
*611. *Carex polytrichoides*, Muhl.
*612. *Carex Pseudo-Cyperus*, L.
613. *Carex retrorsa*, Schw.
1873. August. Mouse River.
*614. *Carex rosea*, Schk.
*615. *Carex Richardsonii*, R. Br.
*616. *Carex rigida*, Good.
*617. *Carex riparia*, Curtis.
*618. *Carex scirpoidea*, Mx.
*619. *Carex siccata*, Dew.
*620. *Carex straminea*, Schk.
*621. *Carex straminea*, Schk., var.
1873. July. Pembina.

*622. *Carex supina*, Wahl.
*623. *Carex stricta*, Lam.
*624. *Carex stenophylla*, Wahl.
*625. *Carex utriculata*, Boott.

GRAMINEÆ.

*626. *Zizania aquatica*, L.
*627. *Alopecurus alpinus*, Smith.
*628. *Phleum alpinum*, L.
*629. *Agrostis scabra*, Willd.
630. *Calamagrostis Canadensis*, Beauv.
1873. July, August. Pembina. Near Turtle Mountain.
631. *Calamagrostis stricta*, Trin. Var.
1873. August. Turtle Mountain.
1874. July. Frenchman's Creek.
*632. *Eriocoma cuspidata*, Nutt.
633. *Stipa comata*, Trin.
1873. August. Turtle Mountain.
634. *Stipa spartea*, Trin.
1874. July. Frenchman's Creek.
635. *Stipa viridula*, Trin.
1873. August. Second prairie.
1874. July. Frenchman's Creek.
636. *Spartina cynosuroides*, Willd.
1873. August. Mouse River.
637. *Spartina gracilis*, Roth.
1873. July. Turtle Mountain.
1874. July. Frenchman's Creek.
638. *Bouteloua oligostachya*, Torr.
1873. August. Turtle Mountain westward, forming compact sod, on dry prairie.
639. *Kœleria cristata*, Pers.
1873. August. Second prairie.
1874. July. Frenchman's Creek.
640. *Glyceria airoides*, Thurber.
1874. July. Missouri River.
*641. *Glyceria nervata*, Trin.
*642. *Catabrosa aquatica*, Beauv.
*643. *Poa alpina*, L.
644. *Poa alsodes*, Gray.
1873. July. Pembina.
*645. *Poa cæsia*, Smith, var. *strictior*.
646. *Poa compressa*, L.
1873. July. Pembina.
*647. *Poa flexuosa*, Muhl.
*648. *Poa pratensis*, L.

649. *Poa serotina*, Ehrh.
1873. July, August. Pembina. Turtle Mountain.
*650. *Festuca borealis*, Mert.
*651. *Festuca ovina*, L.
652. *Bromus ciliatus*, L.
1873. August. Mouse River.
1874. August. West of Frenchman's Creek.
653. *Phragmites communis*, Trin.
1873. August. Prairie, on borders of little pools.
*654. *Lepturus paniculatus*, Nutt.
655. *Triticum caninum*, L.
1873. August. Near Turtle Mountain, in thickets.
656. *Triticum repens*, L.
1874. July. Frenchman's Creek.
*657. *Triticum strigosum*, Steud.
658. *Hordeum jubatum*, L.
1873. July. Pembina, on prairie.
1874. July. Missouri River.
659. *Hordeum pratense*, Huds.
1874. August. West of Frenchman's Creek.
660. *Elymus Canadensis*, L.
1873. August. Turtle Mountain, thickets.
*661. *Elymus Canadensis*, var. *glaucifolius*.
662. *Elymus Sibiricus*, L.
1874. August. Rocky Mountains.
663. *Elymus Virginicus*, L.
1873. August. Near Turtle Mountain.
*664. *Danthonia spicata*, Beauv.
*665. *Avena striata*, Mx.
666. *Aira cæspitosa*, L.
1874. August. Base of Rocky Mountains.
667. *Phalaris arundinacea*, L.
1873. July, August. Pembina. Turtle Mountain, thickets.
1874. July. Frenchman's Creek.
*668. *Hierochloa borealis*, R. & G.
669. *Beckmannia erucæformis*, Host.
1874. July, August. Missouri River. Frenchman's Creek.
*670. *Panicum pauciflorum*, Ell.
671. *Panicum virgatum*, L.
1873. August. Mouse River.
*672. *Andropogon furcatus*, Muhl.
673. *Andropogon scoparius*, Mx.
1873. September. Mouse River, dry prairie.

EQUISETACEÆ.

674. *Equisetum arvense*, L.
1873. July. Pembina.

*675. *Equisetum hyemale*, L.
*676. *Equisetum lævigatum*, Braun.
*677. *Equisetum limosum*, L.
678. *Equisetum robustum*, Braun.
1874. June. Missouri River.

FILICES.

*679. *Polypodium vulgare*, L.
*680. *Phegopteris Dryapteris*, Fee.
*681. *Aspidium Lonchitis*, Swz.
*682. *Aspidium spinulosum*, Willd.
*683. *Onoclea sensibilis*, L.
*684. *Cystopteris bulbifera*, Bernh.
*685. *Cystopteris fragilis*, Bernh.
*686. *Woodsia Ilvensis*, R. Br.
*687. *Botrychium lunarioides*, Swz.
*688. *Botrychium Virginicum*, Swz.

LYCOPODIACEÆ.

*689. *Lycopodium complanatum*, L.
*690. *Lycopodium lucidulum*, Mx.
691. *Selaginella rupestris*, Spreng.
1874. August. Base of Rocky Mountains, and almost anywhere eastward, in some places covering the face of the country and forming much of the sod on sterile hills.

LICHENES.

692. *Evernia alpina*.
1874. August. Rocky Mountains.

ART. XXXV.—ON SOME STRIKING PRODUCTS OF EROSION IN COLORADO.

BY F. M. ENDLICH, S. N. D.

During the progress of the geological and geographical survey of Colorado, under the direction of Dr. F. V. Hayden, every portion of that interesting State was explored. Numerous data were obtained, important not only to the geologist, but furnishing ample material to the artist, enjoyment to the traveller. Few States, perhaps, are so well favored by nature as Colorado. Some of the grandest mountain scenery within the United States is there to be found; mineral wealth is treasured up within the earth's interior. Farms and meadow land, rich in their yield, are scattered throughout the State; and, again, the traveller may visit within this State regions that will forcibly remind him of the Sahara. Now that its exploration is finished and its features throughout are thoroughly known, we are enabled to present more connected discussions upon the characteristic forms there observed. No group of forms, probably, is so unique as that showing numberless changes produced by the sculpturing hand of nature. Erosion, its artistic agent, has furnished us, in Colorado, with results at once striking and singularly beautiful in detail. To these the following pages shall be devoted. Fully aware that no pen-picture can convey an adequate idea of the subject, I may still hope that an accurate description may be of some service to those seeking information thereupon.

For many years the classical region of Monument Park has been known. The singular shapes of its rocks and brilliancy of their colors have given a justly earned celebrity to the place. Since that time many other localities have been discovered, some of them even surpassing the former in grandeur and beauty. Lying farther toward the interior of the State, the regular tourist has not yet reached these spots, and the revelation of their wonders has thus far been made to a favored few only. In the course of years, no doubt, as communications shall be more completely established, these places, too, will be visited, and will elicit admiration equal to that now bestowed upon Monument Park. Until that time arrives, however, descriptions must be accepted which cannot possibly do justice to the subject.

EROSION.

Two classes of erosive agents may be distinguished, *chemical* and *physical.* Of these, the former has but one function, the latter two.

Chemical agents produce such changes in the rock as may, and most frequently do, result in its partial or complete decomposition. This decomposition is the destruction of original and the consequent formation of new compounds. Very often it is accompanied by an increase of volume, whereby the original molecular cohesion is disturbed. On the other hand, it may result in the removal of certain constituents, thus producing an effect directly inverse to the former. By either of these processes, the mass is disturbed in such a manner as to render it less impregnable to the attacks of physical erosives. Although we cannot have, therefore, a truly chemical erosion in all instances, we are justified in using the term, because the chemical action is the immediate means by virtue of which the mechanical work may be accomplished.

Most prominent among the chemical agents facilitating mechanical erosion are water, either pure or charged with various gases, and growing vegetation. Minerals like feldspar, anhydrite, and others absorb water, and are changed into caolinite and gypsum respectively. Both of these secondary products are less able to withstand erosion than the original compounds. This represents the case where changes of chemical composition prepare the material in such a manner as to offer the least resistance to physical erosives. Water charged with gases, more particularly carbonic acid gas, will dissolve certain compounds readily and carry away portions thereof in solution. Hot and cold water, pure, will act in the same manner, but to a less degree. Growing vegetation will chemically absorb certain ingredients of rocks upon which its roots may be resting, thus either directly removing small quantities of the material or changing its chemical composition. This erosive action by vegetation becomes insignificant, however, when compared with the far superior physical force growing plants exhibit. Gases contained in the atmosphere have some effect upon rocks of varying constitution, but frequently one that tends rather to preserve than to destroy the material acted upon. Oxydation is the most widely distributed result of such influence.

Most prominent among the agents of physical or mechanical erosion is the action of water, wind, and growing vegetation. Again, we find that by vegetation the subsequent absolute removal of material is prepared. The growth of roots in minute crevices of rocks may frequently result in a disruption of the cohesion, thus either directly removing a fragment or placing it into such a position as to make its removal imminent. To every one is known the enormous expansive power of growing roots, and it will readily be seen how very severely a large mass of them may affect a rock that has, for instance, the physical constitution of a sandstone.

Flowing water, with or without sand and detritus in suspension, is one of the most directly acting agents, and is productive of results upon a grand scale. Analogous thereto, though more restricted in occurrence, is the action of moving ice. Precipitated water presents results similar to the foregoing, but on a small scale. Water entering fissures and seams, or saturating porous rocks, severely affects them by expansion incident upon freezing. Within certain classes of rocks, this process, preparatory to the final removal of material, is one of great importance. Not only are those that may be regarded as mechanical deposits thereby affected, but also the crystalline aggregates. Water entering minute openings between the cleavage-planes of crystals will gradually produce a separation so great as to render the original position of the crystal no longer tenable. This mode of separation is analogous, in its results, to the effects produced by growing roots. For flowing and precipitated water is reserved the ultimate transportation of such loosened material from its original place of occurrence.

Wind, finally, is the last of the important agents of erosion. By its force, small, loosened particles are removed and are carried away. Sand carried before the wind is capable of producing very marked results. By the frequent repetition and violence of the concussions caused by grains of sand striking against some fixed obstacle, a type of erosion is produced that may be regarded as unique in its detail characteristics. While the cutting action of the sand detaches fragments of the rock, the wind rapidly carries them off, thus ever offering fresh surfaces to the attacks of the rapidly abrading material. The comparatively small amount of work that is apparently accomplished by this powerful factor of erosive agents may be due to the fact that peculiar positions of the eroded material are required. Unless these conditions be complied with, the sand will speed harmlessly upon its way, or produce such results as furnish no adequate examples of its power.

Reviewing, briefly, the characteristics resulting from the various methods of erosion, we observe that certain analogous physical causes produce essentially the same forms. Water acts as a solvent agent upon many of the minerals constituting rocks. Although the quantity of mineral matter taken into solution by pure water is, as a rule, indefinitely small, the presence of carbonic acid gas makes a great difference in its solvent power. Frequently exposures of limestones may be seen, exhibiting a minutely corrugated surface. Gypsum is affected in the same way by chemical aqueous erosion. Admixtures of silex and clay in either limestones or gypsum produce definite results, which lead to a recognition of their presence. Although the chemical erosion caused by growing vegetation in the aggregate will show extensive results, its direct evidence is not very manifest. Owing to the distribution of minute root-fibers, their chemical action is spread so uniformly that it can be recognized as such only in rare instances.

Perhaps the most universally observed products of erosion are those shaped by flowing water. Channels are worn into yielding rocks, rough places are smoothed, soft inclosures in hard rocks are removed, and, throughout, the outlines are modified. These results are, in a great measure, dependent upon the quantity and quality of the material which the water may carry in suspension. Moving ice and its accompanying mass of detritus manifests the same ultimate achievements. Hard, resisting rocks are smoothed and planed, softer ones are deeply cut into, thus changing the minor orographic features of a region. Dependent, in part, upon the physical constitution of the rocks affected, is the action produced by the freezing of water saturating them. In case the conditions be favorable, we may find a more or less completely developed system of foliation. Minute fragments are separated from the main rock, and frequently, by a process of regelation within fissures thus formed, large slabs are removed. Certain rocks, less homogeneous than others, absorb a great deal of water, which forces off innumerable particles upon freezing. In this connection may be mentioned the phenomenon of "exfoliation". According to the interpretation usually given to this term, it signifies a scaling-off of some rocks, dependent upon reaching certain temperatures through the action of the sun's rays. Physically this is certainly possible, but I am of the opinion that in reality it does not often occur. Although during the warmer season of the year, rocks exposed to the sun's rays frequently acquire a comparatively high temperature, it seems improbable that this could produce the result of extensive fissures. If we take into consideration the coefficient of expansion of the various minerals composing such rocks, and furthermore consider their points of fusion, the suggestion seems still less tenable.

Wind-erosion, in some highly favored localities, is productive of very striking results. Usually, however, its action is confined to the shaping of minor details. Wherever the wind can have full sweep and the sand may find objects upon which to expend its work, there we will soon recognize the peculiar workmanship of this agent. Attacking most rapidly those portions which offer least resistance, the sand will carve out forms which will indicate the physical structure of the eroded material. Exposed surfaces will be modified in such a way as to denote the prevalent direction of the wind, and so as to furnish an idea of the relative amount of sand utilized in the "blast".

It would carry us altogether too far were any attempt here made of giving even only the general results of the various kinds of erosion upon different rocks. In the subjoined pages we will have to deal with mainly one class, that produced by mechanical deposition. We shall see that even slight variations in the constitution of this material may be productive of far-varying results. We have for our consideration a series of forms, referable to several groups, each one of which may be considered as an expression of definite, pre-existing conditions. It shall therefore be the object of this paper to present them in such a manner as to comprehend their present and eventual form, the materials composing them, and the mode of their formation.

In order to discuss the material at hand in a somewhat systematic manner, it may appropriately be classified. Among the most prominent forms in Colorado are those that for many years have been known by the appellation of "Monuments". Related to them are statuesque and mural products of erosion. Caves and arches, so far as belonging in this category, follow, and isolated forms, varying in their character, occurrence, and method of genesis, complete the list.

Applying such subdivisions as are warranted by the occurrences observed, we arrive at—

MONUMENTS.
- *Normal.*
- *Accidental.*

STATUESQUE FORMS.

MURAL FORMS.
- *Normal.*
- *Intruded.*

ARCHITECTURAL FORMS.

CAVES.

ARCHES.

ISOLATED FORMS.

NORMAL MONUMENTS.

MONUMENT PARK.

During the great "Pike's Peak" excitement in 1857, this famous spot was discovered. To the adventurous pioneers, forsaking all comfort and risking their lives in the search after the promised gold, this region appeared as one of surpassing beauty. After the wearisome and dangerous march across the plains, those early travellers at last found themselves at the immediate base of a high range of mountains. Foot-hills forming the transition from rocky, barren slopes to the plains, contained many little valleys, rich in verdure and pleasant scenery. It is scarcely to be wondered at, then, that the men who for months had rarely seen anything but sage-brush and cactus should express their extravagant admiration in such terms as the "Garden of the Gods". Not only was a place of rest here offered them, but they met with forms to them utterly unknown. Beyond the outside sharp ridges, the classical "hog-backs", lay narrow, fertile valleys. Rising behind were densely timbered, partly precipitous hills, and in the distance the snow-capped or bleak summit of Pike's Peak towered far above them.

In these little valleys were first found the typical "monuments". Fashioned after one general pattern, though ever varying in their detail-features, they produce an indelible impression upon any one who has ever seen them. Brilliant in coloring, contrasting sharply with the vegetation, and admirably set off by the background of hills and mountains, they present a view that pen or pencil is not able to describe. It required but a very short time for rumors of these almost fabulous forms to spread far and wide, and many tourists travelled to these famous regions. Within a brief period, the distinguishing feature of Colorado was, to strangers, its marvellous "monuments", and hearsay studded the entire territory with such products of erosion. For a long time, indeed, their horizontal distribution was essentially a mythical one, and it is to Colorado's geological explorers mainly that we owe the first definite knowledge with regard thereto. To-day, all the localities are known, many of the most prominent monuments have received names dictated by the impulse of imagination, and of more than one thus favored spot have minute detail-maps been prepared. In presenting the facts connected with the case, we regret that all myth and much of the poesy must rudely be dispelled, as the geologist, in his discussions, deals directly with the questions involving "cause and effect".

Monument Park is located a few miles south of north latitude 39°, on the eastern border of the Front Range. In 1869, Dr. Hayden visited the region, and referred the sandstones composing the monuments to the Tertiary period.* He mentions their characteristics and the surprising evidences of erosion shown by them. All along Monument Creek, on its western bank, these singular forms can be observed. At times they appear ornamenting a steep rock wall, and again they stand isolated among treees or in the grass. Following down Monument Creek, we reach the Park. Passing through the Park, in a southerly direction, we are led into the Garden of the Gods. As these two localities are but a very short distance apart and show the same typical developments produced by erosion, they shall here be discussed together. Usually the monuments are found clustered in small groups, each of which presents a perfect picture in itself. Varying in size, in shades of color, and in their surroundings, every group, though essentially a repetition of every other one, offers new features to the observer. The weird form, unusual to the eye, and the strange contrasting of colors, possess attractions that cannot be resisted. Dr. Hayden very truly says:—"The whole region would be a paradise for an artist."

The form of these monuments is a characteristic one, and is found to present but one main type throughout that entire section of country. A more or less cylindrical or conical column rises vertically from its surroundings, and sustains upon its top a tablet of greater diameter than the upper portions of the supporting rock. Perhaps the most appropriate comparison as to shape would be with a bottle. Usually narrow at the immediate base, the shaft widens out a little higher up until, analogous to the neck of the bottle, it grows narrow again. Upon this neck rests the large mass of rock, apparently most delicately poised. The shape of the "head" varies considerably. In one instance it may be a perfectly flat tablet, resting squarely on the column, as if placed there artificially, and again the neck may gradually widen, so as to mediate a transition between the two portions. This latter is the more frequent occurrence. A more or less corrugated surface combines with the colors exhibited to produce the effect of prominent relief. Al-

* Rep. U. S. Geol Surv., reprint, 1867 to 1869, p. 140.

though retaining the general outline of form, the monuments vary in height. They are found from 4 feet to 30 feet high, grouped together often as an affectionate family might be supposed to place itself. Within certain areas an arrangement of the monuments in rows is sometimes noticeable. This is due to the influences of primary erosion.

Structurally the monuments present very definite features. They are composed of sandstone, varying in texture. Portions of it are exceedingly fine-grained, while others show the character of conglomerates. *A priori* it must be accepted that the protecting cap is formed of harder material than the column. Dr. Peale furnishes* a description from Monument Park. According to his and Mr. Taggart's examinations, "the lower third of the exposed rock is fine-grained, containing argillaceous layers". Above that the sandstones become coarser, "almost conglomeratic". The capping of these monuments is formed by a hard conglomerate, firmly cemented by clay-iron-stone. While the shaft exhibits mainly lighter shades, the "cap" is of a dark-red or rusty-brown color. White, grayish, yellow, and pink tints are exhibited by the column, often blending into each other very well. Surmounting this is the prominent, dark cap-stone. So thoroughly has this resisted erosion that not unfrequently the caps of several columns are formed by the same piece of conglomerate. All the bright colors exhibited, among which green may sometimes be found, are due to the presence of ferric oxygen-compounds. The entire monument represents an unbroken series of mechanically deposited sediment. From the base to the capstone, the rock belongs to one definite period, and must be regarded as a unit. It is with especial reference to this point that I have distinguished between *normal* and *accidental* monuments. Each rock that to-day stands isolated speaks to us of the history of its locality. It is the mute yet convincing witness to conditions existing long before the history of man. It tells us of the great changes that time and nature's agents have wrought in a region that now bears no resemblance to what it formerly was. Where broad valleys with streams and fertile meadows may at present be found, sandstones and conglomerates originally covered the entire region. Where deep ravines and narrow cañons contain swiftly flowing streams, there nothing existed formerly but an even, gentle slope eastward. Viewing thus the testimony furnished by the existence of these monuments, we cannot but marvel at the enormous amount of work done by the never-ceasing action of nature's agents. Masses have been removed and transported for many miles, that would form mountains could they be collected together. Decomposition, erosion, and removal of the material have so thoroughly altered the character of that section of country, that, were it not for the monuments, we should be at a loss how to reconstruct it. As it is, we have at hand applicable data to guide our inference, and founding our arguments upon observation, they stand or fall with the accuracy of the latter. Transportation

* Rep. U. S. Geol. Surv., 1873, p. 200.

of material has taken place at other localities on even a grander scale than here, but we have, in the presence of the monuments, a suggestion that forcibly appeals to the human understanding. Not often do we find a spot where the great activity and the results of erosion are so directly and intelligibly placed before us as here.

Regarding the formation of these monuments, we are enabled to gather sufficient data thereupon by observations made on the spot. By primary erosion, due mainly to flowing water, the horizontal distribution of the monument-groups was determined. Channels were cut into the readily yielding material, and thus more or less isolated ridges or groups of the sandstones remained. In part by flowing water, in part by meteoric agents, the soft rock was gradually eroded. Such portions as were most loosely cemented were first attacked, resulting in the formation of excavations of greater or smaller extent. The hard resisting stratum above alluded to as being a red conglomerate acted as a barrier to the encroachments of erosion. Protecting, in a great measure, the underlying soft material, it gave way only when its supports eventually broke down. The constitution of these underlying sandstones is such that they will readily absorb a large quantity of water. By the expansion accompanying the freezing of this water, considerable quantities will be "scaled off". If this process continues for a sufficiently great length of time, the weight of the conglomerate will crush its supporting portions, and isolated remnants will mark the direction of a previous continuity. Rain, snow, and other atmospheric precipitations will add their share in detaching and removing particles and fragments of the rocks. From such influence the cap-stone will partly protect the column or series of columns supporting it. Erosion by sand can become very aggressive in such instances, provided the wind has ample sway. The sharp particles rapidly eat away the more yielding portions, reducing gradually the diameter of the shaft in certain directions. Its repeated action produces a corrugated surface, indicating the locations of the most readily yielding masses. It is due to this influence, probably, that the "neck" of the monument is generally very much narrower than the base. The sand striking against the cap rebounds, and a larger quantity than perhaps otherwise would be the case finds an opportunity to expend its force upon that portion. Totally dependent upon the physical constitution of the eroded rocks are the detail-features they exhibit. In case they are composed of very homogeneous material, the result will be a highly symmetrical product. Inclusions of either harder or softer masses, or a varying density of the rock, will necessarily be made manifest upon erosion. Thus we are enabled to judge, even from the exterior form, as to the general composition of the monument.

In the course of time, the sustaining column is worn so thin that it can no longer carry the weight of the cap. This falls off, and before long the once stately monument is reduced to a mound of gravel and sand. For a time, the cap may remain comparatively intact, after it no longer occupies its prominent position. Numerous fragments or bowlders of the characteristic red conglomerate give testimony of the former existence of monuments.

Reference to the Report of the United States Geological and Geographical Survey for 1873, Figures 4 and 5, and Plate III, opposite pages 32 and 36, will furnish some idea as to the forms of such products. The monuments therein represented occur in Monument Park, and the collection may be regarded as presenting typical forms of these curious products. Any description of them must necessarily fall short, and may easily fail entirely to convey an adequate impression. To one who has never seen either these or similar occurrences, it must be a difficult matter to appreciate the great variety of form and coloring.

DOUGLAS'S CREEK.

Similar in shape, though of different structure as compared with those near the Front Range, are some monuments on Douglas's Creek. This stream is one of the largest southerly tributaries of White River, entering it about 15 miles east of the western boundary of Colorado, near north latitude 40° 05′. For a long distance, Douglas's Creek, so named after the head-chief of the White River Utes, passes through sandstones and shales belonging to the Wasatch Group of the Tertiary. Steep bluffs enclose the valley of the stream, showing along their edges unmistakable evidence of aqueous erosion. Although the entire region is a very dry one during certain seasons, large quantities of water flow there at times. It was on the top of a small bluff that a number of "monuments" were noticed in this region.* A cylindrical or somewhat angular column of argillaceous, partly arenaceous shales, sustains a huge slab of sandstone. Standing, as they do, near the upper, steep edge of a bluff, these rocks resemble more nearly mushrooms than anything else in their general outlines. They are from 8 to 12 feet high. Gray, yellow, and brownish shales make up the column, showing very clearly the planes of original stratification. Slight changes of color or of shades produce a banded appearance. Upon this base rests a protecting cap of fine-grained yellow sandstone.

Considerable interest attaches itself to the formation of this group. Originally the joints of the sandstone probably afforded the first cause for their present existence. Water entering and gradually widening these fissures, during its flow from the top of the bluff towards its steep edge, eventually succeeded in isolating certain portions of the rock-mass. Having been aided by the existing joint-fissures, this isolation was a matter of little difficulty. Atmospheric agents rapidly attacked the shales supporting fragments of sandstone, and reduced the diameter of the columns. Frost, probably, here proved to be the most destructive factor. The large number of small jointing-planes traversing the shales greatly facilitated the process of reduction. In addition to aiding the

* Compare illustrations in Report of the United States Geological and Geographical Survey for 1876.

erosion by frost, these fissures allowed considerable quantities of the shale to drop off on account of the pressure produced by the cap-stone. Dependent upon the direction and extent of the fractures is the transverse section of the column. If they are continuous, and mainly trend in one direction, it will be elliptic. If not continuous, and running in several directions, the shaft will more probably have a round cross-section. Frost and pressure, then, may be regarded as the chief agents in determining, in this instance, the form of the column. Sand will have but little direct effect upon shales, as they do not offer resistance sufficiently great to produce direct fracture.

In the course of time, the supporting column of shale becomes so thin that it can no longer sustain the weight of the cap. It is crushed, and soon nothing remains to mark the former monument but a small mound of arenaceous clay. The duration of products of erosion like these on Douglas's Creek must necessarily be shorter than that shown by the analogous forms of Monument Park. Not unfrequently very small ones may be found, but I have nowhere seen any comparable in size to those just described. In a region so monotonous as regards scenery as the one south of White River, even a slight variation from the typical bluff and rocky wall produces a pleasing impression. Though the rocks there afford ample opportunity for the formation of such groups, their perishable nature probably accounts for the rarity of the occurrence.

ACCIDENTAL MONUMENTS.

As accidental monuments I designate such having a different genesis from those described above. Whereas the former represent a certain unbroken portion of one specific geognostic group, these latter are composed of members of two groups mainly. Thus the conglomerate, capping the monuments of the Garden of the Gods, is the next youngest product of deposition to the neck of the column. In accidental monuments, however, no such relation exists. I have considered it advisable to make this distinction, as the very classification conveys a certain amount of information. We have, in Colorado, numerous representatives of both types, and have had occasion to study both of them thoroughly. As will be seen, the monuments of this class may lay claim to greater grandeur than the preceding ones. Less accessible, as to location, than the latter, they will probably remain unvisited for many years, until the energetic tourist may finally conquer all obstacles and disturb their present seclusion.

SOUTH RIVER.

South River heads on the continental divide about west longitude 107° and north latitude 37° 34′, and flows in a northerly direction. After a course about 10 miles in length, it enters the Rio Grande del Norte, a few miles below Antelope Park. Rising near South River Mountain, 13,160 feet high, this stream swiftly flows through its narrow valley. Heavily timbered on either side, the immediate surroundings of the creek show green meadow-land and groves of quaking-asp. Pine-forests rise upon the steep slopes and continue unbroken to the summits of dividing ridges.

Riding up this stream, from the Rio Grande, it was that we discovered in 1875 a series of erosion-products that for unique character and beauty is possibly nowhere equalled. Gradually ascending on a dim Indian trail, we found the continuity of the timber farther up-stream broken. Rocky, precipitous cliffs appeared high above the trees, entirely closing, as it seemed, the valley. Progressing farther on our march, the indistinct masses slowly resolved themselves into group upon group that can be "seen but not described". From the steep slope to the eastward of South River, massive walls of dark brown rock jutted out, transversely trending across into the valley. As we still further approached them, we found that every one of these walls was profusely ornamented by "monuments". Deep ravines existed between them, filled, in the most chaotic manner, by trees, monuments, and enormous masses of *débris*. It required but a moment to recognize the beauty of these groups. For a long distance they stretched along the slope, the largest one of them being about half a mile in length. In the background, toward the divide eastward, were visible steep, inaccessible, mural faces, from which the walls above mentioned originated. Varying in height from 100 to 600 feet, these cliffs produced a very great impression. Few trees only were found on the tops of the walls, and the bare rock was most effectually exposed to the erosive action of nature's agents. No one could but admire the results produced. Thousands of monuments, of every size and shape, ranging in height from 2 feet to 400 feet, densely studded the summits and lower edges of the walls. Groups of a hundred or more occupied some prominent spot, and large pines appeared as pigmies by the side of the towering forms. Caves have been cut deeply into the yielding rocks, and through arches of ample dimensions glimpses of more distant groups may be obtained. Climbing up on one of the projecting walls within the largest groups, the sight was surpassingly beautiful. Standing thus isolated, far above all immediate surroundings, the observer might count hundreds of slender monuments at his feet, looking down upon the almost bewildering scene. Pine timber, appearing like a freshly started growth in size, covered intervening portions between clusters of gigantic dimensions. Grouped together so as to be united at the base, the graceful spires rose high up from the ground, and separating into columns, each one supplied with its accessories, the total effect was one strikingly resembling that of the ornate style of Gothic architecture. Looking down toward the base of the wall, a perfect sea of conical and cylindrical shafts were seen, most of them protected by the characteristic cap-stone. Farther off, in the distance, monuments projected above the surrounding timber, until the last ones were lost as a mere line against the bright horizon. Bowlders, huge and angular, broken off from the walls or precipitous cliffs, have rolled down among the timber and marked their courses by devastation. Piled up sometimes at the base of a monument-group, they impart a wild effect to the strange picture. Fissures, cracks, and narrow ravines, channels for rushing water during the heavy rains of the "wet season", are cut into the cliffs. Bordered by the monuments and containing the *débris* incident upon their formation, they look dark and weird. Caves extending into the readily yielding rocks appear as inviting abodes for the bears for which that region is noted.

Though much might be written about this curious spot, the pen can convey no adequate idea of its impressive beauty. It seems as though nature had here furnished, with a lavish hand, designs to be imitated by man, designs that for the singularity of their form and depth of expression must necessarily inspire the seeker after severe beauty and harmony. As the growing vegetation has been employed in furnishing us with one of the noblest styles of architecture, so could these forms be utilized to produce impressions appropriate to the purposes for which they might be adopted.

It will, perhaps, best serve the purposes of this paper to describe a few of the groups observed, and to permit each reader therefrom to construct for himself a picture of what was seen. An illustration given in the Annual Report for 1875, Plate XIX, page 156, may serve more readily to interpret what will be said regarding the forms it exhibits.

Near the top of one of the walls mentioned above, I found a small group, thoroughly characteristic. The highest one of the monuments measures about 35 feet. Essentially all of them are "bottle-shaped". A heavy mass near the base, more or less angular, diminishes in diameter either gradually or rapidly, thus forming the slender "neck". This supports a protecting cap of proportionate size. Small, lateral monuments are constantly being formed or being destroyed. A singular instance was observed in the group under discussion: one monument placed on top of the other. The poise is so true that both may go on diminishing in size for many years to come and may yet retain their relative positions. Deeply furrowed sides very aptly illustrate the word "weather-beaten". Similar in structure and general appearance are the large monuments located between some of the projecting walls. From a base of 60 to 100 feet in diameter, more frequently oval than round, they rise to a height of 400 feet.* Often small columns, with or without cap-stones, ornament their sides for a long distance upward. One striking dissimilarity between the forms of this region and those of Monument Park exists in their varying height. While at the latter place definitely located strata determine the relative height of the columns, we have here an absolutely irregular distribution of the capping-stones, resulting in the great variations of relative size. In this feature, per-

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* Measurements of heights were made by means of aneroid and hand-level.

haps, lies the charm of attraction that the groups of South River possess, besides that imparted to them by their wild surroundings.

Mr. Rhoda has described the monuments from this region in the Annual Report of 1875. He aptly expresses the feeling impressed upon the observer of those enormous masses in the following words:—"These are sentinels in more senses than one—sentinels guarding from profane eyes the holy secrets of nature—for the stones which they bear upon their shoulders, far over the traveler's head, carry a menace not to remain unheeded." The seclusion of the spot and its location away from the general route of travel or mining exploration have permitted this wonderful occurrence on South River to remain hidden thus far from the sight of the white man. Indians, in former days, attracted probably more by the presence of game and grass than by the beauty here exhibited, made frequent visits to the valley, as their trails and old remains of camps testify. To them the animate portion of this world appeals more directly than the mute witnesses of nature's skillful power.

Structurally the monuments of South River differ widely from those heretofore described. In giving the definition of such as may be classified "accidental", mention has indirectly been made thereof. The material out of which the forms of this locality were carved is a heavy deposit of trachytic conglomerate. Its thickness may be regarded, at this locality, as exceeding 600 feet. Almost every variety of conglomerate is here represented. Taking it as a whole, it is composed of bowlders of varying size, cemented by a mixture of sand and clay. Wherever, during the process of deposition, these latter constituents have become predominating, the rock assumes the character of a typical sandstone. At such places, too, stratification may sometimes be observed. The main mass of the conglomerate, however, shows no stratification, and regular deposition of the bowlders is a very subordinate feature. Trachytic material makes up the entire mass, clay, sand, and bowlders. It is evident that ultimately the height or size of the monument must be determined by the dimensions and weight of the cap-stone. We find single blocks sometimes weighing several tons. A secondary product, acting as cement, may be noticed in the form of quartz, intimately associated with argillitic matter. Were this to occur throughout large masses of the conglomerate, then it would far more persistently repel the action of erosive agents; but its appearance is very limited. In color, the monuments and walls are brown, showing numerous shadings into red, yellow, gray, and white. In part, such changes are due to the physical constitution of the conglomerate. Wherever it more nearly resembles sandstone, the shades become lighter. An admixture of magnetite, which is contained in the trachytes, upon decomposition produces bright red or brownish-red colors. Owing to the character of the mass containing it, however, this mineral cannot be decomposed, excepting at such places where the rock is comparatively protected from erosion. At other points, the removal of material progresses so rapidly that not sufficient time is afforded for the completion of the chemical change. Such material as was most readily transportable during the period of formation of the conglomerate is, by reason of its lighter specific gravity, comparatively free from the coloring ingredient. In one feature, perhaps, may this conglomerate be regarded as exceptional if compared with others. This consists in the irregular accumulations of physically differing masses. Irregularly shaped masses of fine-grained, loosely cemented material may be regarded as inclusions within the normal conglomerate. Their existence is taken advantage of by erosive forces, and they rapidly yield to the oft-repeated attacks.

Within the various groups exhibited on South River, the process of their formation could be most admirably studied. Erosion by flowing water, assisted probably by the movements of temporary glaciers, have first shaped the general outlines of the valley. Thus was the conglomeritic deposit cut apart after a portion of the hard trachyte protecting it had been removed. Subsequent flows, more particuarly from the high ground east of the valley, cut parallel gorges and ravines into the readily yielding conglomerate. These had a trend at approximately right angles to the course of South River. The ridges, formerly dividing them, now remain, in consequence of still further denudation, as the transverse walls above mentioned. Their relative position to the main cliffs eastward supports this view. While most likely fluviatile erosion determined the first great separations of the mass into groups, other agents were employed to carve out the individual forms. From observations made on the ground, it would appear that the walls were slowly growing thinner, owing to the gradual separation of columns from their sides. Among the most potent agents preparing absolute removal of material, we must count the influence of frost. During probably eight months of the year the temperature falls below the freezing-point at night, while during more than one-third of the time the heat of the day will produce a complete remelting of the frozen water. Wherever, then, we have loosely cemented material, readily saturated by water, we will find that the repeated expansion upon freezing eventually places the component particles of rock in such positions as to be easily removed. It was observed that innumerable bowlders of varying sizes projected from the steep walls. Precipitated moisture, finding its way down along the steep surface, will encounter one of these obstacles, and, concentrating its volume along one line, will follow down along either one side or the other of the erratic block. Thus gradually a groove will be eroded downward from either side of the bowlder. If we continue this process for a long period of time, it must finally result in an isolation of a columnar mass, with the bowlder as a protecting cap. Examinations showed that this method of formation would satisfactorily explain not only the form, but more particularly the distribution, of the monuments. They occur most densely clustered along the base of the walls and along their edges. Again they closely stud the sides of newly worn ravines and gullies. This species of formation is greatly facilitated by the action of pluvial erosion. Rain beating against walls, which have at certain places been prepared for its transporting force, can readily carry away such portions that the isolation of columns will be accomplished. After the column is once formed, erosion by sand driven before the wind will have a very appreciable effect upon the detail ornamentation and sculpturing of its exterior. From the illustration above referred to may be recognized more clearly what has here been said. Scarcely any one monument can be found which does not show either completed accessories, or such in the course of formation. In intimate relation to the distribution of bowlders within the faces of the walls, is the grouping of future monuments. How slowly or how rapidly they may be formed, however, cannot even be surmised.

In the course of time, the supporting column can no longer sustain the weight of the capping stone and this drops off. This result is hastened by the decrease of the diameter of that portion which has been designated as the "neck". Upon the removal of the cap, therefore, the former monument presents the appearance of a tall, slender, more or less conical shaft. These forms I have termed "needles" in previous reports. When the destruction of the monument has progressed so far, its end is hastened. Rapidly the conglomeritic mass loses in height, becomes more obtuse, and unless new obstacles present themselves to arrest the progress of the truncation, the only remnant of the former monument will be a small mound of irregular-shaped bowlders and sand. On the other hand, if the original form was a high one or broad, it is very probable that from the ruins of former beauty will rise new forms, smaller in dimensions, but similar in construction. Throughout the entire locality, observations were made with a view to determine as accurately as possible the method of formation of these interesting products of erosion. They have led to the results above enumerated, and, although much more might be said with regard thereto, but little could be added tending to throw further applicable light upon the subject.

After ages have passed, the features for which this region may now justly be called unique will have disappeared. The sure hand of erosion will gradually cut down what even to-day are but the remnants of a former extensive deposit. It is possible that the removal of soil and the trachytes overlying the conglomerate may expose fresh surfaces to attacks by erosion, and that thus the forms may be perpetuated. I am acquainted with no locality which presents monuments that can appropriately be compared to those of South River. Perhaps the nearest approximation in form thereto may be found in the Tyrol, near Bozen. They are composed of different material, however, but their genesis is essentially the same.* At no place in Colorado certainly do we find so complete a series of such forms, and one so advantageously situated as to surroundings.

* Compare Lyell, Principles of Geology, vol. i, p. 336.

UNCOMPAHGRE REGION.

On one of the small branches of Henssen's Creek, a tributary of the Lake Fork, we were camped for several days during 1874. Our location there was about west longitude 107° 30′, north latitude 38°. Heading at a rhyolitic peak, southwest of the great Uncompahgre Peak, a swift little mountain stream flowed through its narrow valley in an easterly direction. Above the camp, massive basaltic rocks protruded through the broken rhyolites, forming steep, almost inaccessible walls. Farther down stream, the valley widened a little, bordered on its south side by timbered hills, on the north by a long-extended, grassy slope. Several thousand feet above this slope, black basalt presented vertical walls, the crumbling masses of which rolled down into the valley below.

Cut in the form of a horseshoe into the grassy slope was an extensive excavation, filled with "monuments". In height they ranged from 2 to 30 feet, forming a most striking contrast with their surroundings. Rising from a massive base, the conical columns supported heavy blocks of black basalt. Grooved and corrugated surface, pyramidal lateral points, and the almost white color of the monuments denoted them as belonging to a curious type. Little rills and grooves covered the entire exterior portion of the shaft, terminating often in small cave-like excavations. Densely clustered together, the total isolation of this occurrence appeared as thoroughly characteristic. Black or red bowlders of basalt strewn throughout the monuments relieved the color, and the bright green of the hillside formed an admirable frame for the picture.

An illustration given in the Annual Report for 1874 (fig. 1, page 195) represents two of the monuments near the entrance of the horseshoe. Imagining the entire space, about 150 yards long and 100 yards wide, filled with forms of this kind, varying in height and essentially white and black in color, we can construct for ourselves a picture of the scene. Deep, narrow gullies are worn down through the edges of the horseshoe, and dry runs separate the several most prominent monument groups.

A trachytic tuff, that has been designated as Trachyte No. 1, composes the columns. Local accumulations of this material occur throughout the region, and generally give rise to the formation of more or less picturesque products of erosion. Physically, this tuff is a loosely cemented agglomeration of feldspathic and quartzitic constituents mainly, yielding readily to fluviatile and pluvial erosion. Admixtures of caolinite render it less liable to successful attacks by sand-blasts, but afford an opportunity for the greatest possible effect that can be produced by frost. The grooving and fluting, caused either by beating rain or by slowly moving water, shows conclusively, by its arrangement, the thorough preparation which the material has undergone. Blocks of black, sometimes red, basalt form the protecting caps imposed upon the white or light yellow, rarely pink, columns. Their origin must be looked for at the steep faces of the plateau edge, high above their present level.

Torrents caused by violent rain-storms, and by sudden melting of the accumulated masses of snow higher up, have given the first impulse to the formation of this interesting group. Sweeping down the hill-side, over the impregnable masses of trachyte, they have reached this easily eroded deposit of "ash". Rapidly cutting down into the soft material, no resistance has been offered to the eroding action, save by the erratic blocks of basalt scattered along the slope. There the water must separate, thus carving, primarily, sharp, narrow ridges out of the tuffs. Subsequent erosion caused transverse separation of portions of these ridges, and the bowlders that first determined their preservation remained as protectors upon the tops of more or less pyramidal forms. Rain, hail, snow, frost, and wind were the artists that eventually moulded the monuments into their present shape. Ever changing in their detail-features, losing material day after day, they gradually approach that time when the cap can no longer be sustained. Without the protection of this accidentally placed rock, the column rapidly goes toward its final destruction. The constant denudation, the never-ceasing exposure of fresh surface, has precluded the possibility of any vegetation thriving within the area assigned to these monuments. Though utterly devoid of this feature, which constitutes so large a portion of the charm at South River, the exquisite workmanship of the detail-carving and the pure colors exhibited, readily allow one to forget its absence. About two hundred of these monuments are here grouped together, varying in size and in arrangement. Small ones occupy isolated positions, caused not unfrequently by the protection of the basalt after it had abandoned the first column by which it was supported. The largest ones are near the walls of the horseshoe, frequently having one common base, and separating from each other at different points of height.

PLATEAU CREEK.

Dr. Peale, in 1874, found some very prominent occurrences belonging to this class.* Plateau Creek flows into the Grand River north of the Great Mesa. About west longitude 108° and north latitude 39° 20′, the monuments in question were observed. Tertiary shales compse the bluffs bordering upon the creek. A number of the ridges composed thereof are covered by basalt, which had its origin to the northeast. Erosion has isolated a number of these bluffs, and their edges, fronting the creek, are formed by high, massive monuments. Weathering and fluviatile action has separated portions of the superincumbent basalt, and the fragments form the cap-stones upon the columns. Shales, of light yellow and gray colors, nearly horizontally stratified, are cut into more or less regular cones, and support blocks of black basalt. Dr. Peale says:— "The covering of basalt which once covered it has been partially removed. The remnants left reach from 200 to 250 feet above the general

* Rep. U. S. Geol. Surv. for 1874, p. 91.

level, forming monument-like points that are visible from a great distance." Slower, probably, in their process of formation, a long time, too, will be required ere these groups yield to final destruction. Massive and solid as they are, they can for ages withstand the attacks of erosive forces.

STATUESQUE FORMS.

As such we may designate products of erosion not modelled after one definite type. They are more or less irregular in form, unsymmetrical, and represent not unfrequently figures that a lively imagination can readily compare with well-known subjects of the plastic art, or with animate beings. Popular discrimination has endowed them with names referring to the originals of which they remind the observer. Not only have animate objects and artificial representations thereof been utilized for the comparisons, but even the ruler of the infernal abode has received tribute in the polite appellations some rocks have received. Were it possible to collect and enumerate all those forms of erosion that within Colorado may lay claim to resemble subjects above named, we should be able to produce a very formidable array. As it is, however, I desire to confine myself to such occurrences which may be regarded as characteristic for the geognostic formations containing them. Definite conditions, both constitutional and active, are requisite for the production of results referable to this category. Isolated instances are almost innumerable, but cannot enter into consideration here, as their discussion would lead us far beyond our limits.

WHITE RIVER REGION.

No locality in Colorado, perhaps, is more favored with exhibitions of statuesque forms than the White River region. West of the one hundred and ninth meridian, the light gray and yellow shales of the Tertiary Green River Group are overlaid by massive beds of yellow and brown sandstones. For several reasons, these furnish an almost unequalled material for the production of statuesque forms. While examining that section of country during 1876, every turn led us to new and most grotesque figures. From the river-valley steep walls rise to an elevation of about 1,200 feet. On the summits of the ridges leading down to the stream and on small hills, remaining as evidence of active erosion, we find the groups in question. Appearing at times in the form of walls, simulating ruins of castles of enormous dimensions, the smaller groups may often be compared to statuary or to animate creatures. A certain amount of latitude must necessarily be allowed for the comparison, but not unfrequently the forms are so striking as to suggest, at once, a similarity. Located upon prominent points, such as the summit of a ridge or the top of a small hill, the eroded rocks stand out boldly, changing in outline and relief as the observer changes his position. Thus one rock, about 18 feet high, from a distance appeared as representing the bust and head of a most venerable-looking, bald-headed man. Changing slightly our course, the spectacles of the old man turned into the shield of a cap, his bald head grew elongated and was onamented by a round button on top; his nose grew longer; the chin retreated and with it the prominent breast, while a corresponding curvature of the upper portions of the spine took place. We had, instead of an eminent-looking man, a typical representation of the race-course. Not long, however, did this figure last, for a short turn, shortly after, revealed to us the characteristic features and head of a negro baby. Numerous such instances could be described from that locality, instances where the most absurd caricatures were seen on a gigantic scale.

I have selected for illustration in the Annual Report for 1876 a small group within the cañon of White River at the junction of a small stream therewith. Three isolated columns, approximately round upon cross-section, occupy the summit of a small, smooth hill. The highest one is about 80 feet high. A little behind it stands one less regular in outline, and to one side is the smallest, very thin shaft. Struck by the appropriate and almost affectionate disposition of the group, we at once designated the figures as the "Happy Family". Quietly and in harmony they have thus stood side by side for centuries, probably, and they well merit recognition at the hands of explorers.

The first essential structural condition of rocks exhibiting such features is the lack of homogeneousness. Differences of texture must occur, not along the planes of bedding, but irregularly distributed throughout the mass. In order that this may be accomplished, it is necessary that the rock should not be separated into thin strata or layers, but should form thick, heavy masses. In that case, the percolation of mineralized waters and the action of other agents producing chemical changes can result in a thorough disturbance of a uniform constitution. Within the White River region we find that the Upper Green River sandstones contain irregular admixtures of cementing material, thus rendering them, firstly, of unequal hardness, and, secondly, producing unequal resistance to eroding agents. This condition is a necessary one for the occurrence of forms such as have been described. Were it not for this textural inequality, the processes of abrasion and decomposition must simply take place in accordance with the climatal conditions of the country and the composition of the sandstones, without producing the results observed. In this instance, however, portions that are constantly exposed to atmospheric influences, more so than others, have been able to withstand them by virtue of these physical variations.

Fluviatile erosion gave the first direction as to the distribution of monumental and other forms. Evidence there obtained tends to show that extensive transverse fractures—joints—more or less open must have traversed the sandstones. These were undoubtedly taken advantage of by the flowing waters. While on the one hand they facilitated the extension of textural irregularities within the masses, they, on the other hand, greatly aided the rapid accomplishment of disintegration and transportation. After valleys, mostly narrow, had been cut into the yielding rock, the space afforded to the water was sufficiently great to remove it from the summits of hills and ridges. Thus the remnants we now find there were preserved, surrounded by a talus formed from their own detritus. Pluvial erosion and chemical changes within the rock itself wrought many changes, lessening and modifying the remaining rock-masses. Frost prepared the softer portions for removal, and sand-blasts carved, most skilfully, the intricate forms we often observe. Sandstones can be found in that region, as in others also, that show very remarkable reticulation upon their surfaces. It is not so evident, at first sight, whereby and why this curious effect of erosion is produced. This species of reticulation manifests itself in a manner as if the material composing the net were laid upon the surface of the rock. The meshes are excavated proportionately to the size of the reticles, and often show a remarkably regular arrangement. Such occurrences can be observed both parallel with the stratification of the sandstones and at varying angles to it. Primarily, this result may be derived from the existence of argillitic inclusions within the sandstone. They are less able to resist eroding influences, and by gradually disappearing from the exposed surface may produce the effect of reticulation if somewhat regularly distributed. This, however, appears to be the less frequent mode of formation. It may be assumed that minute joints, now closed, traversed in various directions the sandstones. Infiltration of water containing certain minerals, either in solution or in suspension, will tend to render those portions immediately adjoining the joints harder, more compact. Complete evidence is extant, proving that very many of the sandstones are laminated as to texture, while structurally they may appear perfectly homogeneous. Such lamination is one that can readily be detected by testing the hardness at right angles to the stratification. We have, then, the result: a block of sandstone traversed in various directions by alternately soft and hard zones. Upon exposure, frost will rapidly take advantage of this feature, and other erosive agents will soon remove the more easily yielding portions, leaving the harder ones in the form of reticulated *bas-reliefs*. Within certain formations, more particularly the Upper Cretaceous and Lower Tertiary sandstones of Southern Colorado, this occurrence may be regarded as characteristic. Erosion by sand-blast is probably one of the most effective in producing the result described.

Dependent upon the amount of erosive influence to which the statuesque rocks are exposed will be the maintenance of their forms. It is scarcely possible to give any general rule for the shape and continuity of the harder, permeating portions, unless they reach the extreme form of concretionary inclusions. Although these are by no means wanting in the sandstones of the White River region, the results we have above mentioned are due to irregular changes of texture within the sandstones.

They might be characterized, perhaps, as unequal impregnation by the cementing material. Within the group we have been discussing they form a distinguishing feature, although not found occurring absolutely uniformly throughout its entire horizontal and vertical extent.

POLE CREEK.

Pole Creek flows southward into the Rio Grande, which it joins at about west longitude 107° 30′ and north latitude 37° 45′. Its course, just before the junction, lies through a narrow, grassy valley. Within this may be found small local accumulations of trachytic tuffs. On the east side of the creek, about 4 miles from the river, a very curious group of eroded rocks occurs. They are composed of light tuffs, more or less firmly cemented. Located immediately upon the bank of the stream, they rise abruptly from 12 to 30 feet above the surrounding soil. No connection, above the surface, is maintained with any other outcrops of the same material. Owing to a change in the character of the feldspathic cement, the eroded rocks have assumed most fantastic shapes. A ready imagination can soon recognize in them a venerable exhorter, located within a pulpit, and an appreciative audience of eight or ten persons, either seated or standing in front of him. Were it not for the incongruity, the attempted portrayal of dress might lead the observer to picture to himself a diminutive congregation of devout Knickerbockers. Their stately repose and dignified bearing scarcely disturb the resemblance.

It may here be stated that not unfrequently the trachytic tuffs of various localities show a tendency to weathering in statuesque forms. Often differences can be observed in successive layers; and again, the admixture of quartzose matter will be productive of similar results. In the process of their formation, they are analogous to the sandstones above discussed. Dependent upon the composition, however, is the effect which sand-blast will have upon them. If the material is yielding—not brittle—then the transportation thereof will be much impeded.

Besides these localities, there are others in Colorado exhibiting similar features. Textural variations in sandstones, belonging to the Triassic and Cretaceous formations, are productive of forms that may be classed as statuesque. Taking into consideration, however, the occurrences best known, we may say that we shall not invariably expect to find such products of erosion exhibited in more than the two groups above mentioned—in the Upper Green River and in the lowest trachytic series. Others will more properly find their place in the class of "isolated forms".

MURAL FORMS.

We may appropriately distinguish two groups of mural forms: those resulting from partial removal of continuous series of deposits, and those primarily produced by the intrusion of foreign material within the limits of different deposits. The latter are of plutonic or volcanic origin, and, so far as entering into consideration here, may be comprised under the name of "dikes". Although a large portion of the erosive work accomplished is necessarily of the same character in both cases, the requirements for the production of the first group differ materially from those of the second. Under the definition of "mural forms", I place such products of erosion which may resemble single walls more nearly than any attempt at architectural design. From the nature of the subject it is evident that hard strata resisting erosion, if placed on end, may for a long time retain their position. By virtue of the stratigraphical disturbances they have taken part in, they have acquired positions which are merely rendered more prominent by erosion. They do not owe their present relations to surroundings primarily to erosion, and will, therefore, not be considered here.

A.—First Group.

WHITE RIVER REGION.

Near and on White River, within the same sandstone that is so prolific in the production of statuesque forms, we find very good illustrations of walls caused purely by erosion. The primary formation of valleys there has been discussed above. It may here be added, that the gradual transportation of material from between two ridges caused portions of the overhanging sandstones to drop down. Aided by the prevalence of joints or similar fractures, the disruption was more readily accomplished, the fresh surface exposed became more uniform in shape. If we carry out the widening and deepening of erosive valleys to such an extent that the ridges intervening between two of them will become very narrow, we may achieve the result of forming walls upon their crests. Purely fluviatile erosion could not accomplish this end unless by undermining, and then only if joints of sufficient extent should enable the rocks to drop down easily. Where only such erosion can exert its influence, we will often find vertical faces produced by undermining and subsequent falling down, but the summit of the ridge will be too wide to term it a wall: it will be a bluff, or even a sloping plateau.

In the vicinity of the White River we have, in fact, a sandstone thoroughly traversed by joint-fissures. At favorable localities, the early erosion by flowing water has cut narrow, deep channels into the rock, has evidently undermined, and does to-day undermine, certain portions, causing the strata above to break. Before the tension thus produced is relieved by the absolute disruption of the strata, the joints probably open more widely, causing an apparent downward flexure of the beds. Frost, and in part vegetation, rapidly produce a still greater widening of such fissures, and subsequent falls of rock-masses will take place. Eventually, by this means, the production of a wall, several hundred feet long, one hundred to one hundred and fifty feet high, and sixty to one hundred feet thick, can be achieved. Wherever they were found, they were observed to occupy prominent points, mostly on short, narrow ridges with very steep slopes. Series of what appear to be "walls" are formed of the same sandstone, and will be discussed under architectural forms.

Gradual denudation, the widening of fissures and seams, in the course of time breaks up the wall, and isolated columns are left to mark its former course and extent. Nowhere were the walls observed to have been formed to such perfection within Colorado as in the region of the White River. Undoubtedly the sandstones there are unusually well adapted to illustrate the various results of erosion. Their peculiar composition and the position they occupy have alike been favorable to subject them to the most intense and varied erosive action. During the first visit to this locality, the impression made upon the explorer is a very lasting one. On all sides the most curiously wrought and sometimes almost mystifying forms and figures beset the traveller. Day after day he may ride along the hills, and at every turn a surprise is awaiting him. Though that which may be seen here of such objects is not by any means unique, the enormous variety and the rich stores from which to select cannot but elicit admiration. Other products of erosion, too, are plentifully represented, some of which will be alluded to below. Erosion on a grand scale may be favorably studied in this region, and the evidences of the large masses that formerly have existed there create a profound feeling of surprise regarding the vast power that must have been utilized in transporting them.

B.—Second Group.

Dikes.

In quoting dikes as "products of erosion", it becomes necessary to define the basis upon which this is done. Dikes, strictly speaking, are certainly not products of erosion. They are essentially the casts of moulds formed by sedimentary or other rocks. Injected into these moulds—fissures in this instance—they either remain hidden from sight at first, or the injected material flows over and forms hills of greater or less extent. It is by the means of erosion, however, that dikes, resembling walls in all their essential exterior features, are brought to light, and become natural walls. Until this is accomplished, they remain foreign matter placed into most intimate relations with the general country-rock. Owing to the physical character of this rock, the dikes may either remain hidden, or they may eventually acquire positions entirely isolating them for a certain distance. In this case, they appear as mural forms, and enter into consideration in connection with erosive products. They occur very numerously, and apart from their relations to erosion are subjects of absorbing interest.

REGION OF SPANISH PEAKS.

One of the most highly favored regions in Colorado for the study of dikes is that of the Spanish Peaks. Located east of the main passes of the Sangre de Cristo Range they traverse the sedimentary formations. North of West Spanish Peak two dikes extend for the distance of 8 to 10 miles unbrokenly through the Carboniferous strata. Erosion, which may have required geological ages, has removed a sufficient amount of sedimentary material to let the narrow walls project for several hundred feet above the surrounding level. While the more easily disintegrated material was carried away, the hard, unyielding rocks composing the dikes have successfully resisted the repeated attacks. Preserving to a great extent features that even comparatively slight erosive action would efface, they have remained essentially intact. From the character of the volcanic material composing them it is evident that mechanical erosion will attack them but very slowly, unless preceded or accompanied by chemical decomposition.

Dikes, projecting as walls, occupy various positions. They may be found occurring on ridges and mountain-spurs, or they may extend for long distances in a level region. In the former instance, it is their influence mainly, either directly or indirectly, that permitted the formation of ridge or spur. By metamorphosis of the adjoining sedimentary beds, these may have been rendered better able to resist erosion, or the exposure of the dike-wall may prove to be a mechanical shelter for other less resisting portions. When the dike-wall succumbs to decomposition and erosion, it ends in the same manner as the walls above described. Portions of it break down, destroying the continuity, until finally rock-pillars alone remain to mark the former course.

Throughout Colorado, dikes occur more or less frequently. They are very uniform in their behavior regarding erosion, however, and as only their wall-like appearance upon the surface here becomes of interest, it is unnecessary to allude to more of them. What has been said above will hold good for all occurrences of this nature. In geographical nomenclature, their influence upon the character of scenery and landscape has been acknowledged. Names like "Fortification Creek" and "Muralla Peak" denote the existence of the typical wall-like projections of volcanic rock.

During 1875, Mr. Holmes had occasion to explore Southwestern Colorado. From Navajo Creek, he publishes a very interesting sketch of a double dike-wall.* The volcanic material there protrudes through Lower Cretaceous strata. Subsequent erosion has removed the sedimentary material surrounding it, so that at present the double wall extends upward perfectly isolated. By the various remnants indicating the trend of the dike, Mr. Holmes found its length to be more than a mile.

Few occurrences, perhaps, can furnish us with data so reliable for

*Rep. U. S. Geol. Surv. for 1875, p. 276.

determining the quantity of erosion as the existence of these dike-walls. It may here incidentally be mentioned, that not unfrequently the casts of edges of strata may still be found upon the sides of such walls, and they certainly furnish an applicable indication as to what relative height the sedimentary beds must at one time have extended.

ARCHITECTURAL FORMS.

As in the preceding class, so here, too, we have essentially such forms which are produced directly by erosive action and such that are merely made more prominent thereby. In case of stratigraphical disturbances, hard strata may acquire positions which render them of great importance in the landscape. By the removal of certain portions, displaying more striking features, perhaps, than otherwise would have appeared, erosion certainly does its share toward increasing their characteristics. It is necessary only to quote Cathedral Rocks near Monument Park as an instance of this kind. There the strata stand on edge, rising in vertical columns for more than 400 feet. Erosive action has modified and determined detail-features, but its effect had nothing to do with the present position of the rocks. In discussing architectural forms, we can appropriately distinguish two groups: such representing either complete or ruined structures, and such simulating architectural ornamentation. Both of these are well developed in Colorado, more particularly the latter. At numerous localities are they found, and the number of varieties they present is very great.

A.—First Group.

WHITE RIVER REGION.

In this region it is again the Upper Green River sandstone that enters into consideration. The formation of eroded walls has been discussed above. Architectural forms are but a series of walls in this instance. Mainly the prevalence of joint-fissures and undermining by fluviatile erosion caused the occurrence of the remarkable forms here observed. On the north side of the river, the bluffs rise to a relative elevation of more than 2,000 feet. For a considerable distance, the highest portions of these hills are covered by products of erosion closely resembling ruins of houses and castles. Erosion here has been carried on on a grand scale. Enormous masses of sandstones have become detached by undermining and frost, and have rolled down far below their original positions. Vertical faces, often regular as though cut by hand, mark the places whence these masses came. For the purpose of indicating the effect produced by these curious conditions I quote from a letter:—"On the north side of the river a perpendicular wall rose to the height of 500 feet, and innumerable walls and turret-shaped rocks ornamented the steeply sloping summit. Seen thus by the slanting rays of a setting sun, the effect was that of a ruined city. A mighty citadel occupied the highest point, fortified on every side by vertical walls. Below all this was the bright green valley with its meandering river, which reflected the rosy hue of an evening sky."

This "ruined city" is built upon a rapidly rising slope, in terraces, resembling somewhat in its general plan Oriental arrangement. Dark shadows are cast into the narrow streets, and curious detail-erosion has peopled the city with fantastic beings. Altogether it produces the impression of a weird spot, resembling the former abode of living creatures, but now desolate, haunted scarcely even by a shy, cringing wolf. Upon closer examination, however, much of its mythical character is dispelled. Too plainly are recognized the forces that have been at work to accomplish the result we observe. What has been said about the composition and formation of mural forms will here apply. On a grander scale the agents employed have been able to perform their duties, and have built for themselves, in this ruined city, a monument most instructive and imposing.

Forms resembling castles, towers, and spires can readily be found within this sandstone area, due to the same causes operating with the same effects.

LA PIEDRA PARADA.

Near the junction of Rio Piedra and Rio Nutria, at about west longitude 107° 18′ and north latitude 37° 17′, is located a famous landmark, La Piedra Parada. On the summit of a narrow ridge stands an isolated mass of rock. It is only with difficulty that the top of it can be reached. Rising nearly vertically on all sides, this remnant of formerly extensive strata attains a height of about 400 feet from its base. It is over 600 feet long, and about 120 feet wide.* Alternating beds of shale and sandstone compose it, and heavy strata of yellow sandstone form the top. During the progress of maximum erosion in that region, enormous masses of material were swept away, but this huge block remained. Subsequent weathering and disintegration have ornamented it with small towers and turrets, so that to-day it resembles some ancient, dismantled castle. Constantly fragments, loosened by frost, are falling down. Joint-fissures, very pronounced, facilitate the wedging action of frost and growing vegetation, so that, in the course of time, this prominent feature will no longer remain a portion of the scenery.

B.—Second Group.

GUNNISON RIVER.

North of the Gunnison, in the regions examined by Dr. Peale during 1874, are large outcrops of trachytic "breccia". This material has been eroded into innumerable forms representing spires, columns, turrets, and castle-shaped masses. Its composition, here as well as elsewhere, fits it

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* Compare Report Exploring Expedition, J. N. Macomb, 1859, 1876, p. 78.

admirably for imitating forms that can readily be compared to those of Gothic architecture. The form of the spires is similar, and the numerous inclosed bowlders of varying size produce effects comparable with the ornamentation of Gothic structures. At a number of points, such conditions were noticed, often producing singularly beautiful pictures. Perhaps one of the most striking views may be obtained from the summit of Uncompahgre Peak (14,235 feet above sea-level). Looking down from there upon a vast mass of rugged mountains, we find that to the north and west the trachytic conglomerates occupy a definite horizon. Thousands of spires are clustered along the sides of mountains, rivalling, as it were, the densely studded spires of that gem of Gothic architecture, the cathredal of Milan. Situated as they are, they stand out in bold relief when viewed from below, but seen from above they produce a profound impression by their great numbers.

Primarily erosion by flowing water cut deep, narrow channels into the yielding material, forming sharp ridges, which soon were separated into detached portions. Subsequent erosion, every agent available being employed, wrought the curious and rare forms we now observe. Removal of the harder beds overlying the conglomerates affords free access to water, and though many of the spires and towers may disappear in a comparatively short space of time, the supply of fresh material is practically inexhaustible.

Other products of erosion might appropriately be placed into this group. Differences of density in rocks, more particularly parallel to the planes of bedding, will cause fluviatile as well as pluvial erosion to carve them into unique forms. Shelved and scolloped edges of plateaus and bluffs, segregation into regular and highly ornamented columns, and minute decorations thus produced, might well be employed as models for the hand of the artisan.

CAVES.

Caves that owe their formation to erosion may be formed in two different ways. They may be due to either chemical or mechanical action. By means of decomposition and by subsequent removal of the material, either mechanically or in solution, the first effect is accomplished. Many of the smaller caves in limestone, for instance, were formed by a solution of the carbonate of lime in water charged with carbonic acid gas. The second group, the one which we shall here discuss, is formed by erosive agents, which are usually recognized specifically as such. As the initiatory step toward the formation of a cave, or as the most primitive form thereof, we may regard the results produced by fluviatile action in undermining certain portions of rocks or strata. Dependent upon the local force of the water and the cohesive qualities of the overhanging material, "shelves" of considerable extent may frequently be produced. In tough shales, such as are found in some of the Tertiary groups, we may often find excavations of this kind of appreciable size. Sandstones, if massively bedded, are eroded in the same way, and retain the form of shallow caves for a considerable length of time.

FRONT RANGE.

Along the eastern border of the Front Range many of the sandstones there exposed show interesting results of erosion. Shallow caves have been worn into the yielding rocks, dependent upon their more or less firmly cemented condition. Within the region containing monuments, such caves are of frequent occurrence. They may be worn into the sandstones by flowing water, or they may be due to gradual disintegration and transportation of certain circumscribed portions. The method producing caves of this character is so simple that it scarcely requires discussion. Frost, rain, or other agents may start a shallow abrasion of the sandstones, which, in the course of time, will extend toward the interior, forming a cave-like excavation. Similar conditions occur wherever sandstones of the same composition are exposed to fluviatile or other erosion. The shape of such caves is a very simple one, being merely an arched excavation, the plan of which usually resembles either half a circle, or, if very extensive, the segment of a large circle. Modifications of this shape take place in case water finds a free passage through fissures in the rocks into the cave. Hard masses contained within the sandstones, either as impregnations or concretions, remain less disturbed than their surroundings, and form irregular projections on the cave-walls.

CAVES IN TRACHYTIC CONGLOMERATES.

Cave-like excavations are thoroughly characteristic of the trachytic conglomerates. While speaking of monuments, the composition of this deposit has been discussed. It is evident that material of such character will very readily be attacked by both fluviatile and pluvial erosion. Furthermore, the results produced will vary according to the local character of the conglomerate. Within the exposures on South River many caves were found. Sometimes they are but slight niches worn into the steep wall, and again they may extend for more than 30 feet into it. From what was there observed, it is certain that frost loosens a large portion of the material which is afterward removed. So far as could be seen, the action is essentially a mechanical one, although decomposition of various feldspars greatly facilitates it.

Along the western border of the San Juan Mountains, a large mass of conglomerate of this nature lies exposed. Even from a distance it can easily be recognized on account of the rugged and grotesque forms it assumes upon weathering. Dark spots seen before it is reached mostly prove to be more or less shallow caves. Near Piedra Falls a number of these were found. It was there noticed that the largest one, about 25 feet high, 18 feet wide, and 40 feet deep, owed its existence to the presence of slowly moving water. The opening of this cave, which is its widest part, is located in a steeply sloping, smooth wall of conglomerate. In a narrow crack, water slowly trickles down to the top of the opening. Although, in the course of ages, even this slightly wearing movement can produce a visible effect upon the rock, it is not—as a movement—the cause which led to the formation of this wide opening. At that point the conglomerate varies considerably in composition. In the immediate vicinity of the cave, it is softer, contains fewer large bowlders, and these are but loosely cemented by clay and feldspathic material. Saturation of this rock and subsequent expansion of the water upon freezing cause portions of the roof and walls to "scale off". After some of the cementing material has been removed, the bowlders, no longer held in place, drop out, thus gradually enlarging the excavation. As soon as such portions of the rock are reached that are sufficiently cohesive to resist this action, the growth of the cave will come to an end. Ample evidence was found at that point to demonstrate that this was really the method of formation. Masses of *débris* on the floor of the cave and dangerously loose bowlders overhead corroborated other evidence. Indians and wild animals have not unfrequently utilized these and other caves as places of shelter. Remnants of charcoal indicate the places where at one time fires had been built. One of the most striking examples where such caves or excavations produced by fluviatile erosion have been utilized by man may be found in the ruins of the old cliff-dwellings in Southwestern Colorado. Several of the streams there have worn long and deep recesses into the readily yielding sandstones and shales prevailing in that region. Into these, single houses and entire settlements have been placed by the shrewd aboriginal inhabitants. Although often removed a considerable distance from water, the architects of those times preferred to take advantage of the places which nature had prepared for them. Both shelter and protection from enemies were afforded them, and they adapted their style of building to the places which they chose for the purpose. In the various publications of the Survey, full accounts of these dwellings will be found.

ARCHES.

Arches, or "natural bridges", as they are frequently termed, can be formed wherever the rock containing them is sufficiently thin to be perforated by erosive action. We have here to consider mainly such arches the genesis of which is directly referable to agents of erosion. Viewing them from this standpoint, we may say that an arch is the most complete form of a cave. If the material containing the latter should be sufficiently thin to allow erosion to progress throughout its entire extent, then we will have the former as the result. It is evident that definite conditions, perhaps not often met with, must exist before we can expect an arch to be completed. Necessarily such products will show much variation in form and size, dependent upon the material through which the opening extends. In limestones not unfrequently the existence of an extensive fissure will eventually result in the formation of an arch. This is due, in a great measure, to chemical action. Instances are on record where hills are traversed by a narrow natural tunnel in limestone. Genetically considered, this is an arch, but to the popular mind does not present itself as such.

IN TRACHYTIC CONGLOMERATE.

The scenery on South River has been described in previous pages, and allusion has been made to the arches occurring there. It will be remembered that high, narrow walls of conglomeritic material are projected toward the stream from the ridge east of it. In these walls, niches and arches are found, some of them of surprising regularity. While making our observations there, we counted altogether eleven complete arches, although more may have been hidden out of our sight. Mr. Rhoda was the first one of the party who successfully ran the risk of climbing along ledges on the wall in order to get into one of the arches. To him, therefore, has been dedicated the one represented by an illustration in the Annual Report for 1875 (Plate XX, page 158). A description of this one will answer entirely for all others there observed, as in general shape and method of formation they are very nearly alike. Rhoda's arch is probably the most regular one in outline. A slight leaning toward the eastward somewhat disturbs its symmetry. Located in a high wall, this arch shows ample dimensions. It is about 180 feet high, 150 wide, and the wall containing it has a thickness of 60 to 80 feet. Surrounded by monuments, some of which reach a height of more than 200 feet, the entire view from the point where the sketch was made is one of rare beauty. Pine-trees, 30 feet high, at the base of monuments, appear like pigmies by the side of these towering forms.

Some of the niches or arches at this locality were comparatively accessible, and it was found that they were eroded into loosely cemented material. Considering that these conglomerates have been deposited by water, we should expect homogenousness laterally, although variations would probably occur vertically. We have, however, in this instance a case analogous to that of the sandstones near White River. By a slow process of infiltration, the large mass has either been rendered more compact, or—reversing the proposition—a process of leaching has rendered certain portions very weak. Either of these suggestions may contain the statement of what has really occurred, because, so far as our observations extend, we find that the physical constitution of the material in which niches and arches occur is such as to render it more easily yielding to erosive action. Taking into consideration the method of deposition of the conglomerates, it seems illogical to assume that this state of affairs existed ever since the time of its formation: we must therefore seek for a cause to explain the phenomenon.

What has been said of the formation of caves within the conglomerates applies perfectly to the arches. They are, in reality, nothing but caves which extend entirely through the walls. It is probable that both sides were simultaneously attacked. This would account in a measure for the regularity of outline. Whichever portion of the wall was exposed to the "weather side" was cut away more rapidly than the other.

In connection with this subject it may be stated that not unfrequently compact trachytes contain inclusions, of greater or less extent, composed of soft "ashy" material. These, in the course of time, will weather out, forming caves and sometimes arches of varying extent. Wherever we observed occurrences of such character in Colorado, they were so situated as to afford ample opportunity for the removal and ultimate transportation of detritus, excepting a very few cases. These latter were such where the fall of loosened material had evidently been a sudden one, and of considerable quantity.

On the eastern slope of the Sangre de Cristo Range, near Indian Pass, a small "gateway" was observed occurring in red Carboniferous sandstone.* Standing perfectly isolated near the crest of a small ridge was a block of sandstone about 10 to 12 feet high. Near the centre were two openings; the upper one small, the lower one large enough to admit the passage of a man. At first sight, this peculiar position for an arch seemed rather inexplicable. Upon examination, however, it was found that five different strata composed the block. Counting from above, the first, third, and fifth strata were hard, the second and fourth soft. A vertical crack runs through the entire distance of the block. Water collecting in the crack saturated the soft strata and eventually accomplished their disintegration. Aided by frost and sand-blasts, the crumbling sandstone soon fell away, producing the openings we observed. This instance is one where only atmospheric agents could reasonably be supposed to have exerted any influence. Although this is an unusually clear case, it points out a method whereby excavations of some extent may be produced at places where they can by no means be so readily explained.

At various localities along the Front Range, arches occur in the sandstones. Besides the causes above mentioned as facilitating the formation of such products of erosion, still another may be mentioned. In case flowing water undermines a certain stratum or series of strata, and continues this process for a long time without the overhanging portions caving in, the entire width of the dividing portion may be cut. Thus a subterranean passage of varying dimensions will be formed. This form of arch is usually designated as a "tunnel", limiting the former term to such occurrences where but a narrow wall of rock is perforated. The ingenuity of man has likened these products to various other objects dependent upon their form and dimensions. Many of them are compared directly to the works of man. In Europe, wide and deep arches are

* Compare Annual Report for 1875, Plate XX.

often called "barns". Such appellations as "natural bridge", "gate", "gateway", "tunnel", and others, designate each a definite class of forms. They are too generally understood to require any discussion as to etymology and comparative applicability. Occurrences of this character have always been invested by man with more or less mythical interest, and many a legend is told which stands in the most intimate connection therewith.

ISOLATED FORMS.

As "isolated forms" we may regard such that vary in their distribution and mode of occurrence from the classes above enumerated. Taking for instance the trachytic conglomerates: we may regard the occurrence of grotesque forms within that group as a characteristic thereof. It is an essential feature, and one that may readily be employed in determining this recognition. In contradistinction thereto, isolated products of erosion are such that occur only sporadically in geognostic groups or formations where they would not be expected. Some peculiar circumstances may combine to produce such results, and in vain may similar forms be looked for at other localities within the same horizons. From the nature of the case, it is evident that the isolated monumental products will occur comparatively rarely, and that they will show a great diversity of composition and shape. Only a few such instances will be mentioned from Colorado as comprising the most prominent representatives of this class. Extensive erosion within certain regions will necessarily result in the formation of objects that would appropriately be placed under this head, but for our purposes it will be entirely sufficient to refer to but a few of them.

LIZARD'S HEAD.

The Mount Wilson group is located a short distance west of San Miguel Lake, in west longitude 107° 59′ and north latitude 37° 50′ Descending by the Bear Creek trail from the divide between Rio Animas and San Miguel drainage, we see before us a steep, downward slope which abruptly terminates in the valley of the last-named river. Two thousand feet below us lies the placid sheet of water which receives its name from the river. Looking beyond it toward the northwest, we see the mountain mass of the Wilson group rising high up in bold relief. An elevation of 14,280 feet is reached by the main peak, the summit being nearly a mile higher than the lake. Prominent in the mountain group we notice a "needle" standing near its eastern edge.* From a distance it appears insignificant, but we can easily determine that it must be of large proportions in order to be seen at all. As we approach closer, we find that a comparatively regular pedestal has been formed, supporting an enormous monolith. Steep slopes lead up to its base, broken often by vertical walls. From this base rises a gigantic rock-

*Compare Annual Report for 1874, fig. 2, page 207.

column, 290 feet in height, while its diameter amounts to from 60 to 80 feet. Its isolated position permits it to be seen for a long distance, and its elevation—13,160 feet above sea-level at the summit of shaft—renders it an excellent landmark for all the lower country adjoining.

Both the rocks composing the Wilson group and those which the monolith—Lizard's Head—exhibits, are of volcanic origin. In former geological periods enormous masses of sedimentary and volcanic material have been eroded and transported from that region. It seems possible that a former connection existed between the ridge now supporting Lizard's Head and the main volcanic group farther east. No surface connection exists at present, however. All that remains in the immediate vicinity of them is the huge monolith. During the period of the great erosion, valleys were cut into the rocks and ridges were gradually carved away so as to become narrower and shorter. Probably the disturbances produced by eruptions of volcanic material, and, more particularly, the phenomena accompanying them, rendered the rocks of that region less capable of resisting such powerful agents of demolition as were then employed. It may be observed that the trachytes composing Lizard's Head show a certain development of columnar structure. This structure is almost invariably accompanied by basal fracture-planes. By this means, erosion will be enabled to attack such portions more successfully. A process of undermining will result in the falling of overhanging portions. Owing to the columnar arrangement of the integral parts composing a hill or bluff, the faces produced by such falling will be quite or nearly vertical. In this manner, fluviatile erosion can produce, from such material, a type of form which is represented by Lizard's Head. Had the erosion continued on at the same level, the entire mass must have succumbed. Increasing width and depth of the excavated valleys, however, caused the waters to sink. Thereby the same species of erosion was produced along the sides of that portion which now forms the "pedestal", but the column remained intact. This appears to be the only way of accounting for the existence of Lizard's Head. It is not a dike or intruded volcanic product, subsequent to the main eruptions, but a portion of the regular flows, large masses of which are still preserved not far distant.

Similar in shape are the forms resulting from a partial breaking-down of mural products of erosion. Their arrangement, however, and the character of the rocks composing them, will admit of their ready identification.

Another important group of isolated forms of erosion comprises such that are produced by local inclusions of essentially foreign material. Concretions may be contained quite frequently in shales and sandstones. Those to which we have special reference here are harder, resisting erosion and disintegration more effectually than the rocks containing them. Forms similar to those of the monuments may be produced by a gradual wearing-away of the portions adjacent to concretions. Among the Upper Cretaceous sandstones, and among those belonging to the lignitic series, this is especially noticeable. Although occurring comparatively frequently, the phenomenon cannot be regarded as a characteristic of either of these groups. In a general way, this feature is comparable to the irregular density of the sandstones of the White River region. As soon, however, as this irregularity assumes the extreme form of concretions, we can no longer expect that great variety of fantastic figures there exhibited, because concretionary inclusions are usually shaped after the same general type.

Before closing the discussion of erosive products, I desire to point out one feature of fluviatile and pluvial erosion that is as instructive as it is beautiful, the carving of uniformly homogeneous deposits. In Colorado, ample opportunity is afforded to study this interesting phenomenon. More, perhaps, than by any other geological group, it is exhibited by the soft shales, comparatively free from sand, of the Cretaceous formation. Frequently may be found bluffs or ridges the sides of which present a most typical miniature arrangement of hills, valleys, mountains, and cañons. What is here accomplished in a comparatively short time on so small a scale, nature's power has successfully completed in successive ages on a scale incomparably greater. Time and the never-ceasing activity of erosive influence produce results that at present fill us with astonishment and admiration. Changing from day to day, in a degree imperceptibly small to us, geological periods have been required to produce what we now see. Nothing, perhaps, expresses more aptly the lesson taught by observing the effects of erosion than the old Roman verse:

"Gutta cavat lapidem non vi,
Sed sæpe cadendo."

ART. XXXVI.—PALEONTOLOGICAL PAPERS NO. 8: REMARKS UPON THE LARAMIE GROUP.

BY C. A. WHITE, M. D.

In other writings* I have shown that all the principal brackish-water deposits of the Western Territories are properly referable to one great group of strata which represents a period of time whose importance in the geological history of the North American continent increases with our knowledge concerning it. The members of the Laramie Group as now understood are the Judith River and Fort Union beds of the Upper Missouri River region; the Lignitic Series east of the Rocky Mountains in Colorado; the Bitter Creek Series of Southern Wyoming and adjacent parts of Northwestern Colorado, and the "Bear River Estuary Beds", together with the Evanston Coal Series† in Bear River Valley and their equivalents in adjacent parts of Wyoming and Utah. These, at least, are the best-known members of the Laramie Group; but it has a much wider geographical extent than even the widely separated localities just referred to would indicate. Some of the known portions of this great group doubtless represent different stages of the Laramie period, but the members just designated are, as a rule, understood to represent different geographical developments of its strata with modifications of its fauna, rather than separate successive epochs of time in the geological period which is represented by the whole great group. The proof of the identity of these widely separated portions of the Laramie Group consists in the recognition of various species of fossil mollusks in all of them that are also found in some one or more of the others, thus connecting the whole by faunal continuity. Similar proof has also been obtained by Professor Cope in the discovery of certain species of vertebrate fossils in more than one of these geographical members of the Laramie Group.

The entire geographical limits of the Laramie Group are not yet fully known, but its present ascertained extent may be stated in general terms as from Southern Colorado and Utah, northward into the British Possessions; and from the meridian of the Wasatch Range, eastward, far out on to the great plains. Its extent north and south is thus known to

*See Bull. U. S. Geol. and Geog. Surv. Terr. Vol. IV, Art XXIX, and An. Rep. U. S. Geol. and Geog. Surv. Terr. for 1877.

† Sometimes called the "Almy Mines", from the name of the small mining hamlet where the mines are located.

be about 1,000 miles, and east and west a maximum of not less than 500 miles. The full length of the area once occupied by the group is probably considerably greater than here indicated, and we may safely estimate that it originally comprised not less than 50,000 square miles. The present range of the Rocky Mountains traverses this great area, against both flanks of which, as well as those of the Black Hills, the Laramie strata are upturned. These mountains, therefore, did not exist during the Laramie period, and the continuity of the waters of the Laramie Sea over their present site is also shown by the specific identity of aqueous molluscan fossils in its strata on both sides of those mountains.

The prevailing material of the strata, especially those of Mesozoic and Cenozoic age, in all the Western Territories, whether of marine, brackish-, or fresh-water origin, is sand; and consequently those of most of the groups have certain characteristics in common.

Not only in this general way, but in other respects also, the lithological characteristics of the Laramie Group are similar to those of the Fox Hills Group of the Cretaceous Series, upon which the former group rests, and with which, so far as is now known, it is everywhere apparently conformable;* that is, it has the appearance of a widespread marine formation, consisting mainly of sandstones and sandy shales; but that it was not, like the Fox Hills Group, an open-sea deposit, is shown by its fossils. Its resemblance to the Fox Hills Group is still further increased by the presence in the latter, as well as the former, of many important beds of coal. It is true that no coal has been found in the Fox Hills Group in the Upper Missouri River region, nor in Eastern Colorado, but it is not uncommon among the strata of that group in Wyoming, Utah, and Western Colorado.

Although there is sufficient evidence that the Fox Hills Group, which immediately preceded the Laramie, was deposited in a comparatively shallow sea, the bottom of which was slowly but constantly subsiding, its waters seem to have been everywhere truly marine except in a few estuaries;† and the whole area occupied by the group where it has been studied seems also to have been always and entirely submerged, except, perhaps, those surfaces upon which the coal-plants grew, and these could have been above the water-level only during the growth of that vegetation and the accumulation of its carbonized remains. The Laramie Group seems also to have been deposited in waters that were constantly shallow, and as the group has a maximum thickness of not less than 4,000 feet, the bottom must have been constantly subsiding.‡

*There must necessarily be some unconformity between these two groups in the peripheral portions of the Laramie, because, as will be shown further on, the area upon which its waters rested was cut off from the great open sea by the elevation of portions of the bottom upon which the Fox Hills deposits were made.

†An interesting assemblage of fossils from a deposit of one of these estuaries has been obtained near Coalville, Utah.

‡Similar remarks may be made concerning all the other groups of the Western formations from the Jura Trias to the Bridger Group inclusive, as will appear further on.

In all places where the group is known, and from its base to the top, the majority of its invertebrate fossils are brackish-water forms, and yet in the same places and throughout the same vertical extent, a greater or less number of molluscan species occur that are referable to either a fresh-water or land habitat. In many instances, the fresh-water species occupy separate layers from those which contain the brackish-water forms, and alternate with them, but it is very commonly the case that both fresh- and brackish-water types are found to occupy the same layers, the condition of the specimens of both categories being such as to forbid the supposition that either of them was drifted from elsewhere to their present places of deposit and association. For example, numerous specimens of *Unio*, of many species, have been found associated with equally numerous specimens of *Corbula* and *Corbicula*, a large proportion of all of which still retain both valves together in their natural position. Associated with these, and in a similarly unmutilated condition, there are other molluscan remains, the living representatives of which are respectively of fresh- and brackish-water habitat; and all of them are in such condition as to force the conclusion that they all lived together. The general prevalence of brackish-water types throughout the group, including *Ostrea* in abundance, *Anomia* quite plentiful, with occasional examples of *Nuculana* and *Membranacea* (or a closely related polyzoan), leaves no room for reasonable doubt that the prevailing condition of the Laramie Sea was saline; but the absence of true marine species proves that its waters were cut off from the open ocean. The conditions and association of species just explained show also that there must have been in certain places and at different times an alternation of greater and less saltness of its waters.

It is well known that some species at least of certain genera of mollusks are capable of living in both brackish and fresh waters, but the evidence seems conclusive that certain forms found in the Laramie Group, the living representatives of which are respectively confined to either a fresh- or brackish-water habitat, then not only lived but thrived together in the same waters; and also that those waters were in some degree saline. This commingling of brackish- and fresh-water types is not exceptional in the Laramie Group, but quite common, yet there are layers in some places, as for example near Black Buttes, in which all, or nearly all, the *Mollusca* are of fresh-water type. A statement of these facts naturally suggests that this commingling of brackish- and fresh-water forms took place in estuary waters, and that the strata containing them are estuary deposits. But the character and condition of the strata show that this is not the fact, or if so in any cases, they are rare and at present unknown exceptions to the rule. While there were necessarily tributary streams flowing into the Laramie Sea, and true estuaries at the mouths of at least a part of them, I do not know of a single deposit or part of one in any district or in any of the divisions of the great Laramie Group that presents the stratigraphical characteristics of an estuary deposit.

Judging from the characteristics of existing land-locked seas, it is difficult to understand clearly how fresh and brackish waters could have existed in one and the same sea in the absence of, or at a distance from, the mouths of tributary rivers; but the character of the deposits of the Laramie Sea, as well as its molluscan fauna, warrants the suggestion that many comparatively large portions of its area were, at different times and in different places, in the condition of marshes, which were only slightly raised above the general water-level, upon which fresh waters from rains accumulated, and gave congenial habitat to such members of the molluscan fauna of the period as would preferably avoid the brackish waters. This view is supported by the occasional presence of land-shells among those of branchiferous mollusks, the more common occurrence of palustral shells, the occurrence of deciduous leaves, and other fragments of vegetation, all in the same or associated strata; and also the presence of numerous beds of lignite throughout the group. It is also supported by the fact that the fossil *Mollusca* are found, not uniformly distributed throughout the group, either vertically or geographically, but to occupy small, distantly separated areas, which are not only locally restricted, but within which locally restricted areas the vertical range of the different species is limited. Admitting that such conditions prevailed, it is easy to understand how it may have happened that certain layers containing the remains of *Mollusca*, which could have flourished only in salt or brackish waters, as, for example, *Ostrea* and *Anomia*, are found to alternate in close succession with those containing an abundance of fresh-water species, and also with those containing a commingling of types. The conditions thus indicated would have brought the brackish- and fresh-water habitats of those *Mollusca* into such juxtaposition that they must have frequently encroached upon each other. This frequent encroachment, or mingling of habitats, and, no doubt, the frequent impracticability of retreat, would have had a tendency to inure at least a portion of the mollusks of each to an existence in the other. It is evident that many of the Laramie species were capable of such an interchange of habitat without disadvantage, and that among these were certain species of the *Unionidæ*, *Ceriphasiidæ*, and allied families.

In expressing the belief that, with the exceptions referred to, the Laramie Sea was a great body of brackish water, I have not lost sight of the fact that some living mollusks belonging to families that are regarded as of distinctively marine habitat are known to inhabit fresh waters; nor of the fact that some others which are regarded as of fresh-water types are occasionally found in brackish waters. It seems impossible, however, to account for the commingling of types which we find in the Laramie strata, except by assuming that they all lived and thrived together in the same waters, as before stated.

Before leaving the discussion of the general characteristics of the Laramie Group, the existence in it of a remarkable local or regional molluscan fauna should be noticed. All the branchiferous species of *Mollusca* of the lower or brackish-water beds of the Laramie Group of Bear River Valley and the adjacent region are different from any of those yet found in any other part of the Laramie Group. Besides this, there are two or three generic or subgeneric types among those mollusks that have never been discovered elsewhere. This statement applies only to those beds that have been so often called the "Bear River Estuary Beds", and not to the upper or coal-bearing beds of Bear River Valley, as developed near Evanston, Wyo.; for, in the latter, a few species have been recognized as identical with some that are found in other and distant parts of the group.* Because of the general character of these Bear River brackish-water strata, and their relation to those both above and beneath them, no reasonable doubt can be entertained that they form an integral part of the great Laramie Group, notwithstanding the unique character of a large part of their fossils. The existence of that remarkable local fauna in the Laramie Group has a parallel in the similarly restricted and unique fauna that is found in the Cretaceous series of Coalville, Utah, and the region adjacent, extending as far northward as the valley of Bear River, where the Laramie beds before referred to are exposed. The faunal differences in both cases were probably due to a similar general cause, and that cause probably had relation to the proximity of a then existing western continental coast.

Having briefly considered the distinguishing characteristics of the Laramie Group, its relation to the other groups will be better understood by a brief review of the physical conditions of that portion of the North American continent which it occupies, together with the portions adjacent. Much remains to be known upon this important subject, but the facts hitherto ascertained seem to warrant the following statements and conclusions :—

East of west longitude 95°, North America is mainly occupied by Paleozoic and Archæan rocks; as is also a large area which extends northward and southward through Western North America; the eastern border of the latter area being adjacent to the region here discussed and not far from the one hundred and thirteenth meridian of west longitude. These two great areas are taken to represent approximately the outline and extent of the principal portions of the North American continent that were above the level of the sea at the beginning of the Mesozoic time. A broad expanse of Mesozoic sea then stretched between these two continental factors, which were finally united by a general continental elevation, and the consequent recedence of the sea. This elevation was not, properly speaking, catastrophal, but gradual and oscillatory. That intercontinental Mesozoic sea was narrower during the Jura-Trias period than it was in the next epoch afterward, but it was always shallow, as is shown by the lithological character of the strata of all the Mesozoic

* In consequence of a misplaced label, I erroneously referred *Macrocyclis spatiosa* Meek, to the Judith River beds, in the table on p. 722, Bull. U. S. Geol. and Geog. Surv. Terr. vol. iv.

formations; and as these aggregate a great thickness, there was, of course, for a long time, and over a very large part of the space which it occupied, a gradual subsidence of the bottom which allowed the successive deposition of shallow-water formations. The following facts prove the occurrence of oscillations of land-surface and sea-bottom by which from time to time the eastern border of the Mesozoic sea was shifted, and the whole finally displaced.

In Western Iowa, Eastern Nebraska, and Eastern Kansas, the Cretaceous strata are known to rest directly upon the Carboniferous strata, the Jura Trias being absent. These last-named strata, however, are in full force where the Mesozoic rocks are turned up against the eastern flanks of the Rocky Mountains and Black Hills, as well as farther westward. Their eastern border is certainly somewhere in the great plains beneath later Mesozoic formations and the prevailing surface *débris*, but its location is not even approximately known. Cretaceous strata continuous with those of the West are known to have been deposited as far eastward as within 50 or 60 miles of the Mississippi River in Northern Iowa and Southern Minnesota; southward from which region their eastern border gradually recedes to the westward nearly as far as Central Kansas. In the northeastern region just named, it is the attenuated strata of the Fort Benton and Niobrara Groups that are found, and these rest directly upon the Paleozoic rocks, the Dakota Group being absent there. In Western Iowa and Eastern Nebraska, the strata of the Dakota Group are found to rest upon the Paleozoic rocks, the former extending farther eastward there than any other Cretaceous strata; but the eastern borders of the Fort Benton and Niobrara Groups are not there very far to the westward. The eastern border of the Fort Pierre and Fox Hills Groups, or the Later Cretaceous, is still farther westward, but its position is hidden by the later formations and the prevailing *débris* of the plains.

From the foregoing facts, the following inferences may be legitimately drawn:—During the period represented by those Western rocks which have received the designation of Jura Trias (and apparently during a portion of the Permian period also), the western shore-line of the eastern or principal continental factor was extended so far westward that the eastern border of the deposits of the period referred to reached no farther eastward than along some line now far out on the great plains, but the location of which is not known. It is now covered from possible discovery by superimposed Mesozoic strata and the prevailing surface *débris*. At the close of the Jurassic period, a subsidence took place, which carried the deposits of the Dakota Group nearly as far eastward as Central Iowa. Still later, continued subsidence, but of more limited extent to the southeastward, caused the deposition of Fort Benton and Niobrara strata still farther eastward, in Northern Iowa and Southern Minnesota. At or before the close of the Niobrara epoch, the elevation of the western portion of the eastern or principal continental factor was resumed and apparently continued without further interruption by any other subsidence sufficient to carry any of the recovered or added land-surface again beneath the level of the sea; although portions of the area which the intercontinental Mesozoic sea had covered were afterward occupied by great bodies of both brackish and fresh waters. The eastern border of the later Cretaceous deposits was thus carried westward, where its place is now covered like that of the border of the earlier Jura-Trias deposits, but not so deeply.

The eastern border of the Laramie Group is hidden in the same manner, but there is yet no evidence that it is anywhere overlapped by any subsequent *marine* deposit; although it is known to have received upon it in several places different groups of fresh-water strata. Perhaps no fact in the physical history of North America is better established than that the elevation of the Rocky Mountains as such are of later date than the Laramie Group, but the foregoing facts show that both oscillatory movements and general continental elevation took place before the beginning of the movements which resulted in the elevation of those mountains. Besides the oscillations of surface which have already been mentioned, there are indications that other similar movements occurred elsewhere within the same limits of time; such, for example, as the unconformity of the Laramie strata upon those of the Fox Hills Group in Middle Park, reported by Mr. Marvine; the unconformity in some places of the Jura Trias upon rocks older than the Carboniferous, &c.

But leaving now the subject of the elevation and subsidence of land-surface to be briefly resumed further on, a few facts concerning the former physical conditions of what is now the western part of North America may now be considered. No fresh-water deposits of any kind or extent have yet been discovered in any of the Paleozoic rocks of North America, unless the coal of Carboniferous age may be regarded as such; but even in that case the elevation of the land upon which it was formed could have been only barely above the sea-level; for the conformity of the coal-beds with the strata immediately above and below them is never broken, and the latter strata contain marine fossils. Therefore, for our present purpose, all the Paleozoic strata may be regarded as of marine origin. As a rule, also, all the Mesozoic strata, from the Jura Trias to the Fox Hills Group inclusive, are, by the character of their fossils, known to be of marine origin, although at a few localities in some of the strata of each period fresh-water *Mollusca* have been discovered. These exceptions no doubt indicate the proximity of then existing shores rather than the prevalence of any such bodies of either brackish or fresh water as afterward covered wide areas in the same region.

Resting directly upon the strata of the Fox Hills Group are those of the Laramie, sedimentation having evidently been continuous from the former, notwithstanding the fact that there was such a radical change in the fauna upon the ushering-in of the Laramie period. The geographical extent of the great Laramie Group has already been referred to, as well as its great thickness, the maximum being about 4,000 feet.

Its general lithological characteristics are similar to those of the Fox Hills Group, a known marine formation, but its fauna, as has been shown, is mainly of brackish-, but partly of fresh-water origin, and not marine. Furthermore, the brackish-water species are distributed throughout its entire thickness and its whole geographical extent. These facts, together with the absence from all the strata yet examined of any true estuary characters, show that the Laramie Group was deposited in a great brackish-water sea. This being the case, it must have received its peculiar character as well as its boundaries by having been separated from the great open sea by an encircling elevation of land. The final act of the inclosing movements was the elevation of land at both the northern and southern end of the intercontinental Mesozoic sea, which connected the two great continental factors, so that that sea became a land-locked one, without material change of its status in its principal portion as regards the continued accumulation of sediments upon its bottom.

Whether the brackish saltness of the Laramie Sea was sustained throughout the period by limited communication of its waters with those of the great open sea, or whether such communication was entirely cut off and the supply of salt, above that which was retained of its original marine saltness, came by adjacent continental drainage in amount sufficient to balance the waste by overflow, can probably never be known, but the latter seems probable. If the former condition existed, one of the places of communication was no doubt at the southeastern border of the Laramie Sea, and some fortunate exposure of strata* in the region between Western Kansas and the Gulf of Mexico may yet reveal the true relations of the Laramie Group with the Cretaceous and Eocene deposits of the Gulf border. If tide-level communication between the Laramie Sea and the open ocean was entirely cut off, as there is much reason to believe it was, the question of such relationship or contemporaneousness of deposition must ever remain an open one.

It is evident that the movements which caused the inclosure of the Laramie Sea did not materially interrupt the continuity of sedimentation within at least a very large part of its area, although the effects of those physical changes were such as to cause a total change in at least the molluscan fauna. The wide geographical distribution and great vertical range of many of the molluscan species of the Laramie Group, and the great uniformity of its lithological characters, show that the period was one of comparative quiet within the region which was occupied by its waters. There were, however, some comparatively slight

* In Professor Powell's Report on the Geology of the Uinta Mountains, and in the American Journal of Science, vol. xi, 3d series, p. 161, I announced, on the authority of Professor Powell, the existence of marine Tertiary fossils in the strata of the valley of Bijou Creek, 40 miles east of Denver, Colo. A personal examination of that region in 1877 failed to confirm that reported discovery, as I have shown in my report for that year. See An. Rep. U. S. Geol. Surv. Terr. for 1877.

oscillations of surface or sea-bottom, which caused local unconformity of strata, but these are so limited in extent, so far as they are known, that, at no great distance away from each, the strata, which evidently correspond with the displaced ones, show no evidence of disturbance. An example of such local unconformity exists in the Bitter Creek Series, near its top, in the vicinity of Point of Rocks Station.

Although the disturbances at or near the close of the Laramie period were greatest in the region of the western border of the Laramie Sea, there were necessarily minor disturbances over a large part of the area which it occupied, because it was no doubt a continuation of continental elevation that narrowed the area of the Laramie Sea and fixed the boundaries of the freshened waters that continued to cover a large part of its former site. The evidence seems conclusive, however, that while there was then at least a slight elevation of that part of the continent, and a freshening of the remaining great body of land-locked waters, sedimentation was not interrupted thereby over a large part of the area occupied by those freshened waters. It is not claimed that the disturbances of strata which marked the change from the Fox Hills Group to the Laramie approached in extent or degree those which occurred at or near the close of the Laramie Group, although there was a radical change in at least the molluscan fauna in both cases; but the facts seem to prove that we have in these western strata, including the great fresh-water deposits, an unbroken geological record, extending at least from the earlier Mesozoic far into Tertiary time. The apparent paleontological breaks in that record are regarded as only faunal displacements and restrictions which were caused by radical changes of environment that were consequent upon the different physical changes which took place in the progress of the evolution of the continent.

The already accumulated geological facts show that the general continental elevation was continued after the Laramie period, much in the same manner that it progressed up to that time (for the Rocky Mountains were not yet elevated); still inclosing large bodies of water, but which were no longer salt. The surface of the Laramie Sea was doubtless only slightly, if at all, elevated above the level of the great open sea; but the elevation of its former bed was no doubt considerably increased during its successive occupancy in part by the Wasatch, Green River, and Bridger Lakes. There must, however, have been a subsidence of the bottom of each of these great bodies of fresh water during their existence, which permitted the accumulation of the immense thickness of their strata which now remain, besides that which has been removed by erosion. Free drainage of overflow into the open sea must also have been maintained during these later epochs, which kept their waters fresh, but which evidently did not exist during the Laramie period; but the present discussions are necessarily confined mainly to the last-named period.

In the foregoing discussion of the paleontological characteristics of the

Laramie Group I have had reference almost entirely to the invertebrate fauna, which consists, so far as the discussions are concerned, entirely of the *Mollusca*. This was not because the investigation of those subjects is more in the line of my special studies, but because being inhabitants of the waters in which the formations were deposited, they had a more direct bearing than any others upon the physical phases of the western portion of North America during the period that has been discussed, and, also, because neither the then existing vegetation nor the most important part of the vertebrate fauna was necessarily affected by at least those physical changes which caused an entire change of the whole molluscan fauna, both at the beginning and close of the Laramie period. The reptilian fauna of the Laramie period, however, assumes especial interest, because certain of its types, which extend throughout the whole vertical range of the group, are regarded as characteristic of Cretaceous age.

Notwithstanding the positive opinions that have been expressed by others upon the subject of the geological age of the Laramie Group, I regard it as still an open question. All paleontologists agree that the Cretaceous period extended at least to the close of the Fox Hills epoch; and the question is whether the Cretaceous period closed with the close of the Fox Hills epoch or with that of the Laramie period. The question might be extended so as to embrace the inquiry whether the true chronological division between the Cretaceous and Tertiary did not really occur within the Laramie period; but this, while not unreasonable, would perhaps be inconvenient and unprofitable. That, according to European standards, the *Dinosauria* which are found even in the uppermost strata of the Laramie Group are of Cretaceous types is doubtless indisputable, and there also appears to be no occasion to question the reference that has been made of fossil plants which have been obtained from even the lowest Laramie strata, to Tertiary types. The invertebrate fossils, of the Laramie Group itself, as I have shown in other writings, are silent as to its geological age, because the types are either unique, are known to exist in both Mesozoic and Tertiary strata, or pertain to living as well as fossil forms.* Every species found in the Laramie Group is no doubt extinct, but the molluscan types have collectively an aspect so modern that one almost instinctively regards them as Tertiary; and yet some of these types are now known to have existed in the Cretaceous, and even in the Jurassic period. In view of these facts, together with those presented in the foregoing discussions, the following suggestions concerning the geological age of the Laramie Group are offered.

It is a well-known fact that we have in North America no strata which are, according to European standards, equivalent with any part

* It is a fact worthy of consideration in this connection that a large proportion of the molluscan types of the extensive fresh-water deposits of Southeastern Europe are practically identical with some of those of the Laramie Group, and that European geologists regard those deposits as of Eocene Tertiary age.

of the Lower Cretaceous of Europe, but that all North American strata of the Cretaceous period are equivalent with certain portions of those of the Upper Cretaceous of that part of the world. That the Fox Hills Group is of Upper Cretaceous age no one disputes, the only question being as to its place in the series. A comparison of its fossil invertebrate types with those of the European Cretaceous rocks indicates that it is at least as late as, if not later than, the latest known Cretaceous strata of Europe. If, therefore, that parallelism is correctly drawn, and the Laramie Group is really of Cretaceous age, we have a great and important division of the Cretaceous represented in America which is yet unknown in any other part of the world. It is in view of these facts that, for purposes of general grouping of the strata of the Western Territories, the provisional designation of "Post-Cretaceous" has been adopted for the Laramie Group in the reports of this Survey.

It is well known that able American paleontologists regard the Laramie Group as of Cretaceous age, and this opinion is understood to be based upon the persistence of some vertebrate Cretaceous types up to the close of the Laramie period and the first known appearance of Tertiary types of mammals in North America, in the immediately superimposed Wasatch strata. It is not to be denied that these are important considerations, but the following, as well as other relevant facts already mentioned, ought to be duly considered in that connection.

With rare and obscure exceptions, no mammalian remains are known in North American strata of earlier date than those of the Wasatch Group that were deposited immediately after the close of the Laramie period. Immediately from and after the close of that period, as shown by abundant remains in the fresh-water Tertiaries of the West, highly organized mammals existed in great variety and abundance. There is nothing to forbid the supposition that all of these were constituents of a Tertiary fauna, and many of them are, by accepted standards, of distinctively Tertiary types. If the presence of these forms in the strata referred to, and their absence from the Laramie strata immediately beneath them, together with the presence of Dinosaurians there, be held to prove the Tertiary age of the former strata, then was the Tertiary period ushered in with most unnatural suddenness. Sedimentation was, at least in part, unbroken between the Laramie Group and the strata which contain the mammalian remains referred to, so that the local conditions of the origin of all of them were substantially the same, and yet, so far as any accumulated evidence shows, those mammalia were not preceded in the Laramie period by any related forms. Such suddenness of introduction makes it almost certain that it was caused by the removal of some physical barrier, so that the ground which was before potentially Tertiary, became so, of paleontological record, by actual faunal occupancy. In other words, it seems certain that those Tertiary mammalian types were evolved in some other region before the close of the Laramie period, where they existed contemporaneously with at least the later Dinosaurians, and that the barrier which separated those faunæ was removed by some one of the various surface movements connected with the evolution of the continent. The climate and other physical conditions which were essential to the existence of the Dinosaurians of the Laramie period having evidently been continued into the Tertiary epochs that are represented by the Wasatch, Green River, and Bridger Groups, they might, doubtless, have continued their existence through those epochs as well as through the Laramie period but for the irruption of the mammalian hordes to which they probably soon succumbed in an unequal struggle for existence.

According to the facts which I have here and elsewhere shown, we have in the strata of the Western Territories an unbroken record from the earlier Mesozoic far into Tertiary time, and consequently no complete line or plane of demarkation between them exists. Therefore the designation of any precise boundary between the Cretaceous and Tertiary of that region must be a matter of conventional convenience rather than of natural requirement.

ART. XXXVII.—SYNONYMATIC LIST OF THE AMERICAN SCIURI, OR ARBOREAL SQUIRRELS.

By J. A. Allen.

Since the publication last year of my revision of the American *Sciuri*,* the "Neotropical" species of the group have been ably reviewed by Mr. E. R. Alston,† under unusually favorable circumstances. With his accustomed thoroughness, he has taken the trouble to seek out the types, so far as they are extant or accessible in several of the principal museums of Europe, of most of the species of former authors, and has thus been able to determine the character of many species so inadequately described, that in no other way could their proper allocation be satisfactorily determined. His careful elucidation of this obscure and perplexing group has not only placed his fellow-workers in the same field under lasting obligations to him, but must mark an era in the history of the subject. Of the fifty-nine nominal species of this group described by different authors, he informs us that he has examined the types of no less than forty-one! With the rich material of the British Museum at his command, he has been able to tell us exactly what the late Dr. Gray had for the basis of his *nineteen* "new species", described in a single paper in 1867, some of them so vaguely or inaccurately that the descriptions are sometimes misleading, and often inadequate indices of what he actually had before him. Mr. Alston has also been able to allocate the species described previously by the same author, and by Richardson, Bennett, Ogilby, and other British writers. In the Paris Museum, he found still extant the types of most of the species described many years since by Is. Geoffroy, Lesson, F. Cuvier, and Pucheran, and in the Berlin Museum types of the species described by Dr. Peters; so that the only important ones not seen by him are those of Brandt, Wagner, and Natterer. To assist him in collating my own work, I had the pleasure of sending him examples of the greater part of the species recognized by me in my recent monograph of the American *Sciuridæ*. As I had not access to the types of the species described by foreign authors, I made, in some instances, my allocations of synonymy with doubt, and, in other cases, only provisionally, feeling conscious of the uncertainty with which refer-

* Coues and Allen's "Monographs of North American Rodentia", pp. 666-797, August, 1877.

† "On the Squirrels of the Neotropical Region", Proc. Zoöl. Soc. Lond. 1878, pp. 656-670, pl. xli. This highly important memoir gives excellent diagnoses of the species, with their synonymy in full, and a critical commentary on the species of previous authors.

ences to many of the species must necessarily, under the circumstances, be made. Although Mr. Alston has shown the incorrectness of some of my identifications, and the necessity of substituting, in two instances, names other than those I was led to adopt, I feel, on the whole, no small degree of satisfaction in the confirmation of so large a portion of my synonymic work by the trying ordeal to which it has been submitted; especially as Mr. Alston has done me the kindness to state, in several instances, that I was led into mistakes by descriptions that did not properly represent the objects described. The purpose of the present paper is to correct these errors, so far as they have been satisfactorily shown, and to present a nomenclature that fairly reflects the present state of the subject.

In my former revision of the *Sciuri* of Tropical America, I felt authorized in reducing fully four-fifths of the previously described species to synonyms, and stated it as my belief that I had still recognized too many rather than too few. Mr. Alston, with far more—and mainly historic—material at his command, has, in one or two instances, carried the reduction still further, but, on the other hand, has added one or two species unrepresented in the material I had before me. While I recognized ten species and two subspecies, he has raised the number of the former to twelve. The changes, so far as species are concerned, consist in his elevating one of my subspecies to full specific rank; in treating as a species a form I regarded as the young of another species; in uniting, in two instances, two of my species into one; and in restoring two species I treated as nominal. These changes, as well as those of nomenclature and synonymy, will be fully noted in the following pages.

For the purpose mainly of presenting a connected view of the American *Sciuri*, but partly to correct one or two errors of synonymy, I include the North American species in the subjoined enumeration, although I have no changes to make in the nomenclature adopted in "Monographs of North American Rodentia". In order to distinguish readily those that are represented in the North American fauna, I divide the species, as before, into two geographical series. Gray's species are assigned in accordance with Mr. Alston's determinations, based on an examination of the types, as are also those of Peters, Pucheran, Cuvier, Geoffroy, Bennett, and Richardson. Consequently the synonymatic tables here presented are substantially the same as Mr. Alston's.

A.—NORTH AMERICAN SPECIES.

I.—SCIURUS HUDSONIUS, Pallas.

1.—Var. hudsonius.

Sciurus vulgaris, FORSTER, Phil. Trans. lxii, 1772, 378.
Sciurus vulgaris, *ε*, *hudsonicus*, ERXLEBEN, Syst. Anim. 1777, 416.
Sciurus hudsonius, PALLAS, Nov. Spec. Glires, 1778, 376.
Sciurus carolinus, ORD, "Guthrie's Geogr. (2d Am. ed.) ii, 1815, 292."
Sciurus rubrolineatus, DESMAREST, Mam. ii, 1822, 333.

2.—Var. richardsoni.

Sciurus richardsoni, BACHMAN, Proc. Zoöl. Soc. Lond. vi, 1838, 100.

3.—Var. douglassi.

Sciurus hudsonius, var. β, RICHARDSON, Faun. Bor.-Am. i, 1829, 190.
Sciurus douglassi, GRAY, Proc. Zoöl. Soc. Lond. 1836, 88 (no description).—BACHMAN, Proc. Zoöl. Soc. Lond. 1838, 99.
Sciurus townsendi, BACHMAN, Journ. Acad. Nat. Sci. Phila. viii, 1839, 63 (MS. name).
Sciurus lanuginosus, BACHMAN, Proc. Zoöl. Soc. Lond. 1838, 101.
Sciurus mollipilosus, AUDUBON & BACHMAN, Proc. Acad. Nat. Sci. Phila. i, 1842, 102.
Sciurus belcheri, GRAY, Ann. and Mag. Nat. Hist. x, 1842, 263.
Sciurus suckleyi, BAIRD, Proc. Acad. Nat Sci. Phila. vii, 1855, 333.

4.—Var. fremonti.

Sciurus fremonti, AUDUBON & BACHMAN, Quad. N. Amer. iii, 1853, 237, pl. cvlix, fig. 1.

II.—SCIURUS CAROLINENSIS, Gmelin.

1.—Var. leucotis.

Sciurus cinereus, SCHREBER, Säuget. iv, 1792, 706, pl. ccxii (*nec* Linné, 1758).
Sciurus pennsylvanicus, ORD, "Guthrie's Geog. (2d Am. ed.) ii, 1815, 292" (melanistic).
Sciurus niger, GODMAN, Am. Nat. Hist. ii, 1826, 133 (melanistic; *nec* Linné, 1758).
Sciurus carolinensis, GODMAN, Am. Nat. Hist. ii, 1826, 131.
Sciurus leucotis, GAPPER, Zoöl. Journ. v, 1830, 206, pl. xi.
Sciurus vulpinus, DEKAY, N. Y. Zoöl. i, 1842, 59.
Sciurus migratorius, AUDUBON & BACHMAN, Quad. N. Amer. i, 1849, 265, pl. xxxv.

2.—Var. carolinensis.

Sciurus carolinensis, GMELIN, Syst. Nat. i, 1788, 148.
Sciurus fuliginosus, BACHMAN, Proc. Zoöl. Soc. Lond. 1838, 96.

3.—Var. yucatanensis.

Sciurus carolinensis var. *yucatanensis*, ALLEN, Mon. N. Am. Rod. 1877, 705.

NOTE.—In "Monographs of the North American Rodentia", p. 701, exclude from synonyms of var. *leucotis*, "*? Macroxus melania*, Gray", and from synonyms of var. *carolinensis* exclude "*? Sciurus deppei*", respecting which see *infrà*, pp. 881, 885. Variety *yucatanensis* seems to be a rare form in collections, Mr. Alston stating that the only specimen he has seen being the one I sent him.

III.—SCIURUS NIGER, Linné.

1.—Var. niger.

Sciurus niger, Linné, Syst. Nat. i, 1758, 64.
Sciurus variegatus, ERXLEBEN, Syst. Anim. 1777, 421 (in part).
Sciurus vulpinus, GMELIN, Syst. Nat. i, 1788, 147.
Sciurus capistratus, BOSC, Ann. du Mus. i, 1802, 281.
Sciurus rufiventris, M'MURTRIE, Cuvier's An. King. (Am. ed.) i, 1831, 433.
Sciurus texianus, BACHMAN, Proc. Zoöl. Soc. Lond. 1838, 86.

2.—Var. cinereus.

Sciurus cinereus, LINNÉ, Syst. Nat. i, 1758, 64.
Sciurus vulpinus, SCHREBER, Säuget. iv, 1792, 772, pl. ccxv, B.

? *Sciurus hyemalis*, ORD, "Guthrie's Geog. (2d Am. ed.) ii, 1815, 293, 304."
?? *Macroxus neglectus*, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 425 (locality unknown).

3.—Var. ludovicianus.

Sciurus ludovicianus, CUSTIS, Barton's Med. and Phys. Journ. ii, 1806, 43.
Sciurus ludovicianus var. *atroventris*, ENGELMANN, Trans. Acad. Sci. St. Louis, i, 1859, 329.
Sciurus macroura, SAY, Long's Exp. R. Mts. i, 1823, 115.
Sciurus macroureus, GODMAN, Am. Nat. Hist. ii, 1826, 134.
Sciurus magnicaudatus, HARLAN, Faun. Am. 1825, 178.
Sciurus subauratus, BACHMAN, Proc. Zoöl. Soc. Lond. 1838, 87.
Sciurus auduboni, BACHMAN, Proc. Zoöl. Soc. Lond. 1838, 97.
Sciurus occidentalis, AUDUBON & BACHMAN, Journ. Acad. Nat. Sci. Phila. viii, 1842, 317.
Sciurus rubicaudatus, AUDUBON & BACHMAN, Quad. N. Am. ii, 1851, 30, pl. lv.
Sciurus sayi, AUDUBON & BACHMAN, Quad. N. Am. ii, 1851, 274, pl. lxxxix.
Sciurus limitis, BAIRD, Proc. Acad. Nat. Sci. Phila. vii, 1855, 331.

NOTE.—Under Var. *ludovicianus*, Mon. N. Am. Rod. p. 718, exclude "? TOMES, Proc. Zoöl. Soc. Lond. 1861, 281 (Costa Rica [*lege* Guatemala])".

IV.—SCIURUS FOSSOR, Peale.

Sciurus fossor, PEALE, Mam. and Birds U. S. Expl. Exp. 1848, 55.
Sciurus heermanni, LECONTE, Proc. Acad. Nat. Sci. Phila. vi, 1852, 149.

V.—SCIURUS ABERTI, Woodh.

Sciurus dorsalis, WOODHOUSE, Proc. Acad. Nat. Sci. Phila. vi, 1852, 110 (*nec* Gray, 1848).
Sciurus aberti, WOODHOUSE, Proc. Acad. Nat. Sci. Phila. vi, 1852, 220.
Sciurus castanotus, BAIRD, Proc. Acad. Nat. Sci. Phila. vii, 1855, 332 (typ. error for *castanonotus*).

VI.—SCIURUS ARIZONENSIS, Coues.

Sciurus arizonensis, COUES, Amer. Nat. i, 1867, 357.
Sciurus colliæi, ALLEN, Mon. N. Am. Rod. 1877, 738 (exclusive of synonyms, which all belong to the next species, except "? *S. leporinus*, AUD. & BACH.", which is indeterminable).

NOTE.—"Misled by imperfect descriptions and a bad figure of Richardson's type, Mr. Allen has referred the Arizona Squirrel of Dr. Coues to Richardson's *S. colliæi*. He has since kindly intrusted me with a typical example of *S. arizonensis*; and I find that it is quite distinct from *S. colliæi* (which is Mr. Allen's *S. boothiæ*), being much more nearly allied to *S. carolinensis*, from which, however, both Dr. Coues and Mr. Allen consider that it is 'thoroughly distinct'."—ALSTON, *l. c.* p. 659.

B.—SPECIES OF MEXICO AND CENTRAL AND SOUTH AMERICA.

VII.—SCIURUS GRISEOFLAVUS, (Gray) Alston.

Macroxus griseoflavus, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1877, 427.
Sciurus griseoflavus, ALSTON, Proc. Zoöl. Soc. Lond. 1878, 660.
? *Sciurus ludovicianus*, TOMES, Proc. Zoöl. Soc. Lond. 1861, 281 (according to Alston, *l. c.* p. 660).

NOTE.—Referred by me to my *S. leucops*. Considered by Mr. Alston to be "closely allied" to *S. arizonensis*, of which he suspects "it will eventually prove to be a southern race. More specimens, however, are required before they can be united; and provisionally I therefore accept *S. griseoflavus* as a distinct species." My own inclination, in view of Mr. Alston's diagnosis of *S. griseoflavus*, is to unite them, but I refrain from doing so at present.

Mr. Alston further remarks:—"Mr. Allen considers Gray's *M. griseoflavus* to be specifically identical with his [Allen's] *M. leucops*; and the original diagnosis certainly seems to give countenance to such a view. The typical specimens (five in number), however, are very different. . . ." In consequence of my referring Gray's *Macroxus griseoflavus* to my *S. leucops*, he quotes the latter as a synonym of *S. griseoflavus*, Alston, but the specimens I referred to my *S. leucops* represent his *S. variegatus* var. *leucops*.

VIII.—SCIURUS HYPOPYRRHUS, Wagler.

? *Sciurus variegatus*, ERXLEBEN, Syst. Anim. 1777, 421 (in part).
Sciurus hypopyrrhus, WAGLER, Isis, 1831, 610.
Sciurus nigrescens, BENNETT, Proc. Zoöl. Soc. Lond. 1833, 41 (melanistic).
Sciurus colliæi, RICHARDSON, Zoöl. Voy. Blossom, 1839, 8, pl. i.
Sciurus variegatoides, OGILBY, Proc. Zoöl. Soc. Lond. 1839, 117.
Sciurus richardsoni, GRAY, Ann. and Mag. Nat. Hist. x, 1842, 264 (*nec* Bachman, 1838).
Sciurus boothiæ, GRAY, List Mam. Brit. Mus. 1843, 139 (=*S. richardsoni*, Gray).
Sciurus griseocaudatus, GRAY, Zoöl. Voy. Sulphur, 1844, 34, pl. xiii, fig. 2 (animal), pl. xviii, figs. 7–12 (skull and teeth).
Sciurus fuscovariegatus, SCHINZ, Synop. Mam. 1845, 15 (= *S. richardsoni*, Gray).
Sciurus adolphei, LESSON, Descrip. de Mam. et d'Ois. 1847, 141.
Sciurus pyladei, LESSON, Descrip. de Mam. et d'Ois. 1847, 142.
Sciurus dorsalis, GRAY, Proc. Zoöl. Soc. Lond. 1848, 138, pl. vii.
Sciurus rigidus, PETERS, Monatsb. Köngl. Preuss. Akad. Wissensch. zu Berlin, 1863, (1864), 652.
Sciurus oculatus, PETERS, Monatsb. Köngl. Preuss. Akad. Wissensch. zu Berlin, 1863, (1864), 653 (formerly referred by me to my "*S. colliæi*" =*S. arizonensis*, Coues).
Sciurus intermedius, "VERREAUX", GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 421.
Sciurus nicoyana, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 423.
Sciurus melania, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 425 (formerly referred by me, with a query, to *S. carolinensis*).
Sciurus colliæi, ALLEN, Mon. N. Am. Rod. 1877, 738 (the synonyms, except *S. arizonensis*, Coues, but not the specimens, nor the descriptive text).
Sciurus boothiæ, ALLEN, Mon. N. Amer. Rod. 1877, 741 (synonyms, text, and specimens).
Sciurus hypopyrrhus, ALLEN, Mon. N. Amer. Rod. 1877, 746 (synonyms,—except *Macroxus maurus*, Gray,—text, and specimens, except the series from Guayaquil and the text relating to them).

NOTE.—This species, as at present defined, includes both my *S. boothiæ* and *S. hypopyrrhus*, except certain specimens from Guayaquil described by me under the latter name, which represent, according to Mr. Alston's determination of them, *S. stramineus*. In uniting my *S. boothiæ* and *S. hypopyrrhus*, Mr. Alston confirms a suspicion I had already expressed of their possibly proving identical. I kept them apart mainly from the impression made upon me by the Guayaquil specimens, which I felt pretty sure were specifically different from those I referred to *S.*

boothiæ, and which were really the basis of what I recognized as *S. hypopyrrhus*. I associated with them, however, specimens representing the *S. dorsalis* of Gray, from their apparently slenderer form and relatively longer ears and tail. Although Mr. Alston has not seen the types of either Wagler's *S. hypopyrrhus* or of *S. stramineus*, I defer for the present to his judgment in adopting *hypopyrrhus* as the name of this highly polymorphic group.

Under *S. hypopyrrhus*, Mr. Alston recognizes five "types", namely:— 1. "The *hypopyrrhus* type", to which he refers *S. nigrescens*, Bennett, and *Macroxus boothiæ*, Gray, 1867. 2. "The *rigidus* type", to which he refers *S. rigidus*, Peters, *S. intermedius*, Verreaux, and *S. nicoyanus*, Gray. 3. "The *dorsalis* type." 4. "The *colliæi* type", to which he refers *S. colliæi*, Richardson, *S. adolphei* and *S. pyladei*, Lesson, *S. variegatoides*, Ogilby, *S. oculatus*, Peters, and *S. griseocaudatus*, Gray. 5. "The *melania* type."

"With regard to the synonymy," Mr. Alston writes, "I may observe that I have been able to examine the types of all the 'species' here united, excepting that of *S. hypopyrrhus*, which, however, has been well described by Wagler and Wagner; it appears to be a dark variety without the usual wash of white on the tail. . . ."

"Of the geographical distribution of the races," he says, "we can only judge from the comparatively few specimens of which the exact localities have been noted. The *hypopyrrhus* phase appears to be the most northern, the *colliæi* to obtain principally along the Pacific slopes, and the *dorsalis* to be the most southern. Each, however, appears to be found along with the others in some parts. Thus, I have seen specimens of the *hypopyrrhus* type from Mexico, Honduras, and Guatemala, of *rigidus* from Guatemala, Nicaragua, and Costa Rica, of *dorsalis* from Nicaragua, Costa Rica, Veragua, and Panama, and of *colliæi* from the west coast of Mexico and Guatemala, Nicaragua, and Costa Rica. The only localities which I know for *S. melania* are Nicaragua and Veragua."* In all probability, these five types will prove to be entitled to varietal rank.

IX.—Sciurus aureigaster, F. Cuvier.

Sciurus aureogaster, F. Cuvier, Hist. des Mam. iii, livr. lix, 1829.

Sciurus leucogaster, F. Cuvier, Suppl. de Buff. i, Mam. 1831, 300.

Sciurus albipes, Wagner, Abh. Bayer. Ak. ii, 1837, 501 (according to Alston; formerly referred by me, with a ?, to the preceding species).

Sciurus socialis, Wagner, Abh. Bayer. Ak. ii, 1837, 504, pl. v (according to Alston).

Sciurus ferruginiventris, Audubon & Bachman, Proc. Acad. Nat. Sci. Phila. 1841, 101, Quad. N. Am. pl. xxxviii.

Sciurus varius, Wagner, Suppl. Schreber's Säuget. iii, 1843, 168, pl. cccxiii D ("*S. albipes*" on plate; = *S. albipes*, Wagner, 1837).

Macroxus morio, Gray, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 424.

Macroxus maurus, Gray, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 425 (formerly referred by me to the preceding species).

Macroxus leucops, Gray, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 427.

Sciurus aureigaster and *S. leucops*, Allen, Mon. N. Am. Rod. 1877, 750, 753.

Sciurus variegatus, Alston, Proc. Zoöl. Soc. Lond. 1878, 660 (*ex* Erxleben).

* *Loc cit.* pp. 663, 664.

NOTE.—"Under this name I feel myself obliged to bring together two Mexican Squirrels of which typical specimens are very different in appearance. Mr. Allen has kept them separate under the names of *S. aureigaster* and *S. leucops*, remarking that the difference in coloration leaves little doubt of their distinctness, but adding that 'more abundant material may show that they are not specifically separable' (*op. cit.* p. 755). The color-variation is not nearly so great as we shall find it to be in the next species [*i. e. S. hypopyrrhus*]; and after a careful examination of a great number of specimens, especially of the fine series in the Paris Museum, I have been unable to find a single distinctive character which is constant."—ALSTON, *l. c.* p. 661.

Of this species Mr. Alston recognizes two forms, denominated respectively "1, the *aureogaster* type", and "2, the *leucops* type".

Unfortunately, as it seems to me, Mr. Alston has selected for this species Erxleben's name *variegatus*, remarking that it is "primarily founded" on the "Coztiocotequallin" of Hernandez, and that Buffon's "Coquallin" is quoted only as a synonym; and adds, "Erxleben's diagnosis and description appear to me to be quite characteristic of the *leucops* form of the present species. By retaining this appropriate name," he continues, "we are enabled to escape from F. Cuvier's barbarous term *aureogaster*, under which this beautiful species has labored in so many works" (*l. c.* pp. 661, 662). However pleasant it might be to escape Cuvier's barbarous name, this to me is not so clearly the way to do it. Erxleben's species is admittedly a composite one, and neither his diagnosis nor Hernandez's account of the "Coztiocotequallin" helps the matter, since the best that can be made out is that Erxleben's species was black above, varied with white and brown, and yellow below, twice the size of the European Squirrel, and with the ears not tufted; a characterization broad enough to apply to the dusky phase of any of the larger Mexican Squirrels. F. Cuvier's excellent figure and detailed description, on the other hand, leave nothing to be guessed at in respect to just what his *aureogaster* was, the types of which, it appears also, are still preserved.

X.—SCIURUS STRAMINEUS, Eyd. & Soul.

Sciurus stramineus, EYDOUX & SOULEYET, Voy. de la Bonite, Zool. i, 1844, 37, pl. ix.
Sciurus nebouxii, IS. GEOFFROY, Voy. de La Vénus, Zool. 1855, 163, pl. xii.
Macroxus fraseri, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 430.
Sciurus hypopyrrhus, ALLEN, Mon. N. Am. Rod. 1877, 747 (in part).

NOTE.—As already stated, this species was embraced under my *S. hypopyrrhus*. The *S. stramineus* I included among the synonyms of *S. variabilis*. The *S. nebouxii* I was unable to identify, and gave it among my undetermined species. The *Macroxus fraseri* I referred doubtfully to *S. tephrogaster*.* Mr. Alston has examined the types of *S. nebouxii* and

* "It is only fair to Mr. Allen to add, that Gray's description of *M. fraseri* is so imperfect that it is not surprising that the American zoölogist should have doubtfully referred it to *S. tephrogaster*."—ALSTON, *l. c.* p. 665.

S. fraseri, and their allocation here is on his authority. It turns out that the Guyaquil specimens of my *S. hypopyrrhus* series (one of which Mr. Alston has seen) represent this species. Mr. Alston states that this species is rare in collections, and appears to be the only representative of the genus in Western Peru. He further says :—"A remarkable peculiarity of this species is its tendency to the development of irregular tufts of pure white hairs, rather longer than the rest of the fur, and sometimes uniting in large patches. These asymmetrical markings are present in the majority of the individuals examined." This peculiarity in the texture and color of the pelage I looked upon as abnormal and as indicating a tendency to albinism, and am surprised that it should prove of such general occurrence.

XI.—SCIURUS VARIABILIS, Is. Geoffroy.

Sciurus variabilis, IS. GEOFFROY, Mag. de Zool. 1832, i, pl. iv.

Sciurus langsdorffi, BRANDT, Mém. Acad. de St. Pétersb. 6e sér. Math. Phys. et Nat. iii, 2e pt. 1835, 425, pl. xi.

Sciurus igniventris, "NATTERER", WAGNER, Wiegm. Arch. für Naturg. 1842, i, 360.

Sciurus pyrrhonotus, "NATTERER", WAGNER, Wiegm. Arch. für Naturg. 1842, i, 360.

Sciurus tricolor, "PÖPPIG", TSCHUDI, Faun. Peruan. 1844–46, 156, pl. xi.

Sciurus morio, WAGNER, Abh. Bayer. Ak. v, 1·50, 275.

Macroxus gerrardi, GRAY, Proc. Zoöl. Soc. Lond. 1861, 92, pl. xvi.

Sciurus brunneo-niger, "CASTLENAU", GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 429.

Sciurus fumigatus, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 428.

Sciurus variabilis and *S. gerrardi*, ALLEN, Mon. N. Am. Rod. 1877, 768, 766.

NOTE.—Mr. Alston extends this species to cover my *S. gerrardi*, which I separated mainly on the ground of smaller size. He says :—" Here, again, the greater amount of material compels me to go beyond Mr. Allen in the identification of nominal species. Most of the above synonyms were brought together by him under the name of *S. variabilis* ; but *S. gerrardi* and *S. rufo-niger* [*lege brunneo-niger*] were kept separate under the former title. The principal points on which he rested were the smaller size and shorter ears of *S. gerrardi;* but on examination of a sufficient series, I have not been able to find any constancy in the proportions of the ears, while the difference in size totally disappears. . . . The smaller specimens (*S. variabilis*, *S. gerrardi*, etc.) appear to prevail towards the north ; but this is not constant. . . . Nor is it constantly connected with any of the numerous varieties of coloration—rufous, grizzled, and melanistic specimens occurring of all sizes." These color-variations, he says, seem to resolve themselves into three primary groups, namely :—"1, the *morio* type", melanistic ; " 2, the *variabilis* type", red, varied with black ; " 3, the *langsdorffi* type", reddish- or yellowish-grizzled. Each of these types seems to prevail in certain localities, but there is no regularity in their distribution, the red and grizzled often occurring together.

Our synonymy of this variable group agrees, except that I included *S. stramineus* under *variabilis*, and Gray's *Macroxus xanthotus* under *S. gerrardi*, which latter Mr. Alston refers to *S. griseogenys* (= *Sciurus* *æstuans* var. *rufo-niger*, Allen), with the remark, "By some curious error Gray's account of this last (*Macroxus xanthotus*) has been printed after that of *M. brunneo-niger*, instead of after *M. griseogena;* so that the remark, 'very like the former', etc., naturally led Mr. Allen to refer the synonym to *S. gerrardi*" (*l. c.* p. 667).

XII.—SCIURUS DEPPEI, Peters.

Sciurus deppei, PETERS, Monatsb. K.-P. Ak. Wissen. Berlin, 1863, (1864), 654 (formerly referred by me, with a ?, to *S. carolinensis*).
Macroxus tephrogaster, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 408.
Macroxus middellinensis, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 408.
Macroxus tæniurus, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 431.
Sciurus tephrogaster, ALLEN, Mon. N. Am. Rod. 1877, 763 (excluding "*?Macroxus fraseri*, Gray").

NOTE.—The examination of the type of *S. deppei*, Peters, by Mr. Alston, shows it to be identical with Gray's *M. tephrogaster*, over which it has three years' priority. "As already observed," says Mr. Alston, "*M. fraseri*, Gray, was so insufficiently described that Mr. Allen was led to identify it with the present species, which is about half its size and totally different in coloration" (*l. c.* p. 669).

XIII.—SCIURUS ÆSTUANS, Linné.

Sciurus æstuans, LINNÉ, Syst. Nat. i, 1766, 88.
Sciurus æstuans var. *guanensis* PETERS, Monatsb. K.-P. Akad. Wissens. Berlin, 1863, (1864), 655.
Myoxus guerlingus, SHAW, Gen. Zoöl. ii, 1801, 171, pl. clvi.
Sciurus gilvigularis, "NATTERER", WAGNER, Wiegm. Arch. für Naturg. 1843, ii, 43; *ib.* 1845, i, 148.
Macroxus leucogaster, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 430.
Macroxus irroratus, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 431.
Macroxus flaviventer, "CASTELNAU", GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 432.
Sciurus æstuans var. *æstuans*, ALLEN, Mon. N. Am. Rod. 1877, 756 (exclusive of "*? S. pusillus*, Geoffroy", and "*M. kuhli*, Gray", and inclusive of "*M. irroratus*, Gray", referred to var. *rufoniger*).

NOTE.—"*M. irroratus* must also be placed here, although the original description is such that Mr. Allen unhesitatingly referred it to the last species [*S. griseogenys*]."—ALSTON, *l. c.* p. 668.

XIV.—SCIURUS HOFFMANNI, Peters.

Sciurus æstuans var. *hoffmanni*, PETERS, Monatsb. K.-P. Ak. Wiss. Berlin, 1863, (1864), 654.
Sciurus hyporrhodus, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 419.
Macroxus xanthotus, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 429.
Macroxus griseogena, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 429.
Sciurus griseogenys, ALSTON, Proc. Zoöl. Soc. Lond. 1878, 667.
Sciurus æstuans var. *rufoniger*, ALLEN, Mon. N. Am. Rod. 1877, 757 (excluding *S. rufoniger* and *S. chrysosurus*, Pucheran, and adding *M. xanthotus*, Gray, formerly referred to *S. gerrardi*).

NOTE.—"Mr. Allen, in his monograph, regards this Squirrel as a 'variety' or geographical race of the next species [*i. e. S. æstuans*], differing in its uniformly larger size and strikingly in the coloration of its tail. In a subsequent letter to me he says:—'It would perhaps be just as well to recognize it as entitled to specific rank, although I still feel sure of their intergradation.' That such connecting links may yet be found seems very probable; but I have not been able to find such in the very large series which I have examined, and am consequently compelled to keep them provisionally distinct. Unfortunately Mr. Allen has identified this species with Pucheran's *S. rufo niger*, which, as will be seen presently, is a much smaller and quite distinct species. Dr. Peters described it only as a variety of *S. æstuans;* and though specimens in the Berlin Museum are labelled '*Sciurus hoffmanni*', the name remains a manuscript one. Of Gray's three titles I have adopted *griseogena* (more correctly *griseogenys*) as being simultaneous in date with the others, and as indicating the typical form."—ALSTON, *l. c.* p. 667.

Accepting provisionally this Squirrel as specifically distinct from *S. æstuans*, I dissent from the foregoing only respecting its proper title. Although the name *hoffmanni* may remain a manuscript one as applied in a specific sense, its publication as a varietal name for this form, three years prior to the publication of Gray's names, appears to me to warrant its use as a specific designation for the same form. Such a procedure has certainly the sanction of numerous precedents.

XV.—SCIURUS RUFONIGER, Pucheran.

Sciurus rufoniger, PUCHERAN, Rev. de Zoöl. 1845, 336.—ALSTON, Proc. Zoöl. Soc. Lond. 1868, 669.

Sciurus chrysurus, PUCHERAN, Rev. de Zool. 1845, 337.

"*Macroxus tephrogaster minor*, GRAY, MSS." *apud* Alston.

NOTE.—This species I introduce entirely on the authority of Mr. Alston, who has examined the types. I referred both of Pucheran's species unhesitatingly to the preceding species, but the presence of two upper premolars in *S. rufoniger* would seem to render it unquestionably distinct from *S. hoffmanni*, and to ally it with *S. deppei* (as perhaps the young of that species).

Respecting this species, Mr. Alston remarks as follows:—"On examining the type of Pucheran's *S. rufo-niger* in the Paris Museum, I found that it was not identical with *S. griseogenys* [*S. æstuans* var. *rufoniger*, Allen, Mon. N. Am. Rod.], as Mr. Allen supposed, but rather allied to *S. deppei* [*S. tephrogaster*, Allen, *l. c.*]; and I soon recognized in it a small Squirrel from Panama, and which I had begun to fear would require a new name. These examples prove to agree further with *S. deppei* in having two upper premolars, but differ in being more than one third smaller, in the color of the lower parts (which are only paler than the upper, save on the breast), and in the tail being nearly uniform in color with the back (the hairs having only very minute white or yellow tips). Specimens in the British Museum are labelled *M. tephrogaster minor;* but I cannot doubt the distinctness of the form. The type of *S. rufo-*

niger has the middle of the back nearly black; while that of *M chrysosurus* appears to be a variety, merely differing in the tail being more rufous" (*l. c.* p. 669). There is nothing in Pucheran's description of the last-named species to indicate it is not the young of *S. hoffmanni.*

Judging from what I have seen in other species, the darker color of the lower surface in Alston's *S. rufoniger* as compared with *S. deppei* might result from immaturity; but in deference to Mr. Alston's opinion, grounded on excellent opportunities for deciding, I give the species provisional recognition.

XVI.—SCIURUS PUSILLUS, Geoffroy.

Sciurus pusillus, "IS. GEOFFROY", DESMAREST, Dict. d'Hist. Nat. x, 1817, 109; Mam. 1822, 337, pl. lxxvii, fig. 2.—ALSTON, Proc. Zoöl. Soc. Lond. 1878, 670 pl. xli.
Macroxus kuhli, GRAY, Ann. and Mag. Nat. Hist. 3d ser. xx, 1867, 433.

NOTE.—These names—the first with a query, the second unhesitatingly—I referred in my monograph to *S. æstuans*, influenced mainly by the strong aspect of immaturity presented by a specimen in the Museum of Comparative Zoölogy, which undoubtedly represents this species, notwithstanding the statement by Buffon, quoted by me, that the type of the species was shown by the sexual organs to be adult. Although Mr. Alston was unable to find the type of Geoffroy's *S. pusillus*, he seems to have established its distinctness from *S. æstuans* by finding two upper premolars in the British Museum specimens bearing that name. He considers Gray's *M. kuhli* (which I treated also as the young of *S. æstuans*) as unquestionably identical with *S. pusillus*. This is apparently a very rare species, as I have met with references to not more than half a dozen specimens in all. It is by far the smallest American species of *Sciurus*.

The subjoined summary indicates the changes in nomenclature here made from that adopted in "Monographs of North American Rodents", and also that employed by Mr. Alston in his recent paper "On the Squirrels of the Neotropical Region":—

Allen, November, 1878.	Alston, October, 1878.	Allen, August, 1877.
S. arizonensis	S. arizonensis	S. colliæi.
S. griseoflavus	S. griseoflavus	———
S. hypopyrrhus	S. hypopyrrhus	S. hypopyrrhus. S. boothiæ.
S. aureigaster	*S. variegatus*	S. aureigaster. S. leucops.
S. stramineus	S. stramineus	S. hypopyrrhus.
S. variabilis	S. variabilis	S. variabilis. S. gerrardi.
S. deppei	S. deppei	S. tephrogaster.
S. æstuans	S. æstuans	S. æstuans var. æstuans.
S. hoffmanni	*S. griseogenys*	S. æstuans var. rufoniger.
S. rufoniger	S. rufoniger	———
S. pusillus	S. pusillus	S. æstuans.

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INDEX TO VOL. IV.

*P. S.—SCIURUS RUFONIGER, *Pucheran*.—Since the paper on *Sciuri* passed out of my hands I have received, through the kindness of Mr. E. R. Alston, one of the types of his *Sciurus rufoniger*, endorsed on the label, "Compared with Pucheran's type in Paris Museum. E. R. A. April, 1878." This specimen, as shown by the sexual organs, is a fully adult male, though scarcely five and a half inches long, and hence cannot be regarded as an immature example of *S. deppei*, the possibility of which is above suggested. In coloration it differs little from frequent examples of *S. hoffmanni*. The tail, however, is relatively much shorter, the size nearly one-half less, and it has two upper premolars (Alston) instead of one. In this last feature, as well as in size, proportions, and coloration, it finds a near affine in *S. pusillus*.—J. A. A., Nov. 23, 1878.

[*NOTE.—The above was received too late for insertion in its proper place, the Bulletin having been worked to p. 887.—ED.]