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Art. 1.—Notes on the Aphididæ of the United States, with descriptions of species occurring West of the Mississippi.

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PART I.

BIOLOGICAL NOTES ON THE PEMPHIGINÆ, WITH DESCRIPTIONS OF NEW SPECIES.—C. V. RILEY, Ph. D.

The object of the present paper is to set forth some interesting biological facts relating to the gall-making *Pemphiginæ*,* and which were presented in abstract at the late meeting of the American Association for the Advancement of Science. These facts have a special interest just at this time on account of the close relationship between the insects of the sub-family in question and the notorious Grape-vine Phylloxera (*Phylloxera vastatrix*).

The life-history and agamic multiplication of the Plant-lice (*Aphididæ*) have always excited the interest of entomologists, and even of anatomists and embryologists not especially given to the study of insects. The life-history, however, of the gall-making species belonging to the *Pemphiginæ* has baffled the skill of observers more than that of any other group. All of the older writers, in treating of the different gall-producing *Pemphiginæ* of Europe, have invariably failed to trace the life-history of any of the species after the winged females leave the galls, and, with few exceptions, have erroneously inferred that the direct issue from the winged females hibernates somewhere. The most recent production on the subject is a paper published the present year in Cassel, Germany, by Dr. H. F. Kessler, on the life-history of the gall-making Plant-lice

* This term is used in the sub-family sense, in accordance with most common usage, and not in the tribal sense, as employed by Buckton in his Monograph of British Aphides, 1875.

affecting *Ulmus campestris*.* This author, by a series of ingenious experiments, rightly came to the conclusion that the insects hibernate on the trunk; but he failed to discover in what condition they so hibernate.

M. J. Lichtenstein of Montpellier, France, who has paid much attention to these insects, was led to the belief, announced in various publications† during the year 1877, that the European species inhabiting Elm and Poplar migrated to the roots of grasses and there hibernated. He was doubtless misled by the great general resemblance between all the species of this sub-family in the immature and apterous stages. In a letter dated December 25, 1877, I informed him that I had discovered that the sexed individuals of our Elm species inhabited the bark, to which the female consigned her single winter egg, and that his theory was altogether inconsistent with this fact and with what Derbès had discovered of *Pemphigus cornicularius* affecting Firs.‡ With this clue my friend has done good service the past season, by correctly tracing the life-history of several species, and showing that there are no such migrations as he assumed, from the trees in question. Indeed, nothing but the most thorough and absolute proof can establish the fact of any such migration. Species of the same genus often so closely resemble each other that they are more readily distinguished by their mode of life, or by the galls they produce, than by structural or describable differences; and this holds particularly true of the immature or apterous stages. This fact, taken in connection with what is here recorded and what is already known of the habits of the sub-family, renders it extremely improbable that any of the species subsist at one time on one plant and habitually change, by migration, to another of a totally different nature. Stranger things happen in nature; but until M. Lichtenstein experimentally proves the accuracy of his conclusions, I must reject his theory.

Led by previous investigations into the habits of the Grape Phylloxera, I discovered, in 1875, that some of our Elm-feeding species of *Pemphiginæ* produce wingless and mouthless males and females, and that the female lays but one solitary impregnated egg, just as in the case of Phylloxera. Continuing my investigations, especially during the present summer (1878), I have been able to trace the life-history of those species producing galls on our own Elms, and to show that they all agree in this respect, and that the impregnated egg produced by the female is consigned to the sheltered portions of the trunk of the tree, and there hibernates—the issue therefrom being the stem-mother,§ which founds the gall-inhabiting colony the ensuing spring. Thus the question as to what becomes of the winged insects after they leave the galls is no longer an

* DieLebensgeschichte der auf Ulmus campestris vorkommenden Aphiden-Arten.

† Stettiner Ent. Zeit. 1877, p. 489, &c.

‡ Ann. d. Sc. Nat. Paris, October, 1871.

§ I adopt this term as a literal translation of the German "Stamm-mutter," and as meaning the ancestress or progenitor of all succeeding generations until the impregnated egg is produced and another cycle commences.

open one. They instinctively seek the bark of the tree, and there give birth to the sexual individuals, either directly or through intervening generations.

It is my purpose in a subsequent paper to go more fully into a consideration of the habits and classification of this interesting family of Plant-lice; but my present object will best be accomplished by giving a full account of the two commoner gall-making species found upon the American Elm, with less complete accounts of some other species. It will be seen by the facts recorded, and by the descriptions, how futile all attempts must be to establish anything like a natural system of classification, whether the number of antennal joints, the character of wing-venation, or the habits be considered; and the lesson I would draw from the study of these minute insects is the same that must be drawn by all naturalists who thoroughly study any one group, viz., that any system of classification will be unsatisfactory, except on the hypothesis that it is purely a matter of convenience. We find extreme variation in the number and proportions of antennal joints in the different stages of the same species. We find a great tendency to variation even in the pterogostic characters; and, finally, there is not even unity of habit in the species of the same genus. The deflexed or horizontal position of the wings has no value in this sub-family, because most of the species carry their wings horizontal while yet in their galls or for some time after issuing from the pupa. That all of the insects of this sub-family possess, however, at least one feature in common with the species of Phylloxera so far known, namely, the mouthless, wingless, and generally degradational nature of the sexual individuals, and the production by the female of a solitary, impregnated egg, there can be little doubt, since I have traced these sexual individuals and this impregnated egg, not only in the cases indicated in this paper, but further in *Schizoneura Rileyi* (Thos.) and *Schizoneura lanigera* (Hausm.); while M. J. Lichtenstein, as already stated, has discovered them in several of the European species of this sub-family. Another feature common to the whole sub-family, though by no means peculiar to it, is the flocculent exudation from the body and the absence of bright coloration, the winged females having, all of them, a dull, dark ground-color of head and thorax. The front wings have invariably a fold or thickening of the posterior marginal vein in the region of the first discoidal; and the hind wings are correspondingly produced on the costal margin and armed with hooklets that catch in the fold in flight. These are features common to all *Aphididæ* known to me; but their prominence or faintness often has specific value, and the angle on the hind wing may, for descriptive purposes, be called the "hook-angle."

SCHIZONEURA AMERICANA, n. sp.

[Curling and gnarling the leaves of the White Elm (*Ulmus americana*), forming thereby a sort of pseudo-gall. The curl made by a single stem-mother in the spring takes the pretty constant form of a rather wrinkled roll of one side of the young leaf; but, according as there is more than one stem-mother, or as several contiguous leaves are affected, the deformation assumes various distorted shapes, sometimes involving quite large masses of the leaves.]

BIOLOGICAL.

There is a good deal of irregularity in the time of appearance of the different generations, but the general history of this species, as I have observed it for several years, is herewith given. There is much greater difficulty in fully tracing the life-history of one of these small creatures than might be supposed. They languish in confinement and ill bear handling. To trace their growth and movements in a state of nature requires vigilance and perseverance, and a great deal of time; and I have been fortunate, in my studies of this and the next species, in securing the patient aid of Miss M. E. Murtfeldt of Kirkwood, Mo., a lady to whom I have already had repeated occasion to express my indebtedness.

If, during the winter, we carefully examine the cracks and crevices of an American or White Elm that was badly infested with this leaf-curling species the previous summer, we shall be pretty sure to find its impregnated egg—a minute, dull-yellowish, ovoid object, about 0.5^{mm} long (Fig. 1, *a*), either free or still more or less effectually covered with the parent's dry skin, which faintly shows the insections that characterized the living female. The same spring influences that cause the leaf-buds to swell and open, likewise induce the hatching of this winter egg, and the little creature that issues from it instinctively crawls to the more terminal twigs and branches, and settles upon the first tender leaflet it meets with. It constitutes the stem-mother, or *first generation*, and, stationing itself on the under surface of the leaf, very soon causes the same to swell and curl by the irritation and punctures of its beak. The curl is usually from the lateral edge, and the more normal form it takes is shown at Fig. 1, *c*. It is, however, very irregular, and takes on many different forms, according as it is produced by one or several stem-mothers settling on the same leaf, and as it affects a portion of one leaf only or embraces several from the same bud. At first, pale yellowish-red, with dark members, the stem-mother increases in size more or less rapidly, depending to some extent on the development of the leaf. Moving about in her curled house, within which she is destined to live and die, this stem-mother goes through her last moult, and attains maturity about the twelfth day from the time of hatching. This period may be lengthened by unfavorable weather, as an indefinite period of lethargy, both of plant and insect, may ensue, after hatching, if the temperature be too low. The number of molts I have not definitely ascertained, but from analogy there will be three. Having attained maturity, she com-

mences peopling her pseudo-gall with young at the rate of about one every six or seven hours, according to temperature, increasing in bulk and prolificacy from day to day, until by the early part of May, in the latitude of Saint Louis, she has attained her fullest development, and soon perishes. She may attain to nearly four millimetres in length, and, with greatly swollen body, be almost as wide (Fig. 1, *b*). Her immediate issue, or the *second generation*, are like her in many respects, but never grow to be quite so large. The individuals of this generation soon accumulate in great numbers around her, and in their turn commence to bring forth young, some remaining within the original curl, others scattering to found new colonies. Their issue, or the *third generation*, show certain marked structural differences from the first (see description), and are destined to become winged.

During most of the month of May, we may find, where large clusters of leaves are affected, the few more or less exhausted stem-mothers, and these second and third generations in every stage of development. As the lice increase in numbers, the leaves no longer protect them, but present on both sides multitudes of busy atoms—livid, old and paler young—those with wings and those getting wings—interspersed with white exuviæ, cottony secretion, and globules of pearly liquid. At the same time, in single curls of more terminal leaves, we may find the second generation of wingless mothers surrounded by smaller colonies, all of which will become winged. The winged females (Fig. 1, *d*) are short-lived, bringing forth a dozen or more pseudova at average intervals of about half an hour. The glossy pellicle that compresses all the members of their newly-born issue is ruptured very shortly after birth, and is worked off in the course of about ten minutes. These facts are easily ascertained by confining the winged mother, but the exact positions to which the pseudova are naturally carried I have not been able to definitely learn; but we may rest pretty confident that they are consigned both to the leaves and to the twigs. The young lice, forming the *fourth generation*, are very active, running swiftly in all directions. In color, they are at first of a pale and bright red, but soon acquire a brownish tint. In general appearance, they resemble the young from the stem-mother. The beak is very long, thickened at the end, which always projects beyond the tip of the abdomen, and terminates in a sickle-like point. Experiments made by attaching and confining these young to the trunk of the tree show that they do not flourish thereon, but naturally crawl out to the more tender, terminal leaves, which they immediately begin to curl. They may be found scattered over an infested tree, with their beaks for the most part inserted in the tender leaf-stem or in the midrib on the under side, the leaf in such case already beginning to show the effect of the poisonous puncture. They are, however, able to sustain themselves on the tender bark of the twigs alone, and may be found nearly full-grown, there exposed to view and enveloped in the white cottony matter, which brushes off at the slightest touch. When full-grown,

they commence reproducing, and their progeny, under favorable circumstances, becomes exceedingly abundant. The growing points of the tree are affected with larger or smaller colonies, crowding and covering both the surfaces of the leaves, the petioles, and the stem. I have known young Elm trees to be so thoroughly covered with these lice, in the earlier part of June, that not a single leaf was unaffected, and upon giving the tree the slightest jar there would be a perfect shower of the liquid globules excreted by the lice. At this season of the year, when the lice are thus numerous, they may be found during the heat of the day actively crawling over all portions of the tree—a veritable migration, necessitated by the want of sufficient succulent leaves, but evidently premature, and destined to be the death of the individuals participating in it, excessive multiplication here, as in all other cases, obliging the destruction of the excess. While the individuals thus wandering are mostly the younger ones, the migrating instinct seems sometimes to possess individuals of all ages, especially where the tree is badly affected; and that they perish is proved by the mass of dead lice which in such a case may be found around the base of a tree. So far as I have been able to learn by confining specimens of the *fifth generation*, which is very similar to the fourth, but with shorter promuscis, the fifth reproduces like the fourth without acquiring wings. The individuals of the *sixth generation*, on the contrary, all acquire wings, the pupa being active, with but a small amount of flocculence, confined to the posterior part of the body The winged lice of this sixth generation abound during the latter part of June and the early part of July. They resemble those of the third generation, except that they are perhaps on the average somewhat smaller and paler, and less prolific. They instinctively congregate on the bark, and consign to the crevices, and sheltered parts thereof, their young, which, as in the fourth generation, are enveloped in a sort of pellicle. These young also resemble the young of the fourth generation in general form, but have very short and stout beaks. Instead of being active, they are quite sluggish, congregating in clusters in the sheltered portions of the bark, and being essentially bark-feeders. The color soon inclines strongly to orange or salmon, and, after two or three days of sluggish existence, they shed their skin, and become more active, penetrating more deeply into the interstices of the bark, and huddling together in groups of various sizes. They are now of a pale buff, or, more correctly, salmon color, the surface at first smooth and polished, but becoming in some instances slightly pulverulent. Simulating closely the color of the bark, and being quite small, they are not easily detected, unless in great numbers. A careful examination shows that they have entirely lost the beak, and that they consist of both males and females, the females being the larger, and the males showing the genital characters given in the description. They live grouped together for several days with little motion, the female (Fig. 1, *e*) increasing in size by the enlargement of the single egg contained in her body. Both soon perish,

leaving among their shrivelled bodies the shining, reddish-brown winter egg, either partially or entirely covered by the parent's skin.

On the 16th of June, 1877, I met with an isolated tree at Malvern, Iowa, belonging to Mr. H. K. Follett, which had been very badly infested with this species. The winged individuals crowded the trunk, and had perished in such quantities around the base of the tree as to lie in a matted mass three or four inches thick, being greedily devoured by their numerous enemies. One could not break off the smallest piece of the bark without finding the exposed interstices crowded with the salmon-colored sexual individuals.

Among the more prominent of the natural enemies of this species, I have noticed, of Coleoptera, *Coccinella 9-notata*, *Coccinella sanguinea* (*munda*) Say, *Hippodamia convergens*, and several species of *Scymnus*. I also found feeding upon them the perfect beetle of *Podabrus modestus*, and the Hemipterous *Cyllocoris scutellatus*, Uhler, and *Capsus linearis*, Beauv. A Lepidopterous inquiline, namely, the larva of *Semasia prunivora*, Walsh, is also quite common within the curled leaves, feeding both on the lice and on the substance of the leaf. A large green *Syrphus* larva and several *Chrysopa* larvæ also prey upon them.

DESCRIPTIVE.

SCHIZONEURA AMERICANA (Fig. 1).—*Impregnated egg* 0.5^{mm} long, gamboge-yellow, inclining to brown in color, with no especial external sculpture.

First generation.—Stem-mother: Pale yellowish-red, with black members when first hatched; the red deepening and becoming purplish or livid with age. When mature, averaging 3.5^{mm} in length, globose or pyriform, with subobsolete honey-tubes and six dorsal rows of darker piliferous and tuberculous spots. Antennæ 5-jointed, joint 3 more than equalling 4 and 5 together in length.

Second generation.—Differing in no essential respect from the preceding, except that the individuals do not attain so great a size. Bright brownish-red when born, they soon become livid brown.

Third generation.—Mature, winged female: Alar expanse 5 to 5.6^{mm}. Body dusky, the abdomen slightly reddish; legs either dusky or yellowish-red. Antennæ as long as head and thorax together, dusky, rarely yellowish, not pilose, but with a few short setous points; 6-jointed, the 1st and 2d joints slightly bulbous; 3d either surpassing or equaling in length the 4th, 5th, and 6th together, which are subequal; the terminal joint usually the shortest, the apical sub-joint being normal, and in some cases sufficiently constricted to resemble an additional joint; joints 3, 4, and 5 rather distinctly annulated, the constrictions being generally quite deep, and producing a moniliform aspect, there being on an average 22 such on joint 3. Tarsi with the basal joint distinctly separated into a lobe, the claws strong, and in length twice the diameter of the tarsus. Wings hyaline: front pair with the veins becoming obsolete at tips; stigma subhyaline, either of a yellowish tinge or somewhat dusky; stigmal vein starting from the middle of the stigma and normally curved; cubital vein obsolete for nearly one-third its length, the furcal forming with it almost a point; the terminal distance between first and second discoidals equal to about five times that between their bases (often rather more); terminal distance between furcal and cubital and second discoidal veins subequal, that between stigmal and furcal slightly shorter, that between second and first discoidal one-third greater, and about equal that between stigmal and tip of stigma. Hind wings with the subcostal vein almost straight, there being no curve where it gives off the discoidal veins, which are obsolete

at their extreme base, and not confluent with it. [The wing-venation is very constant. Out of nearly 100 specimens examined, I have found only an unusual shortening of the cubital in two individuals.] The larva and pupa in this third generation differ from the winged insect in being more reddish and in having the antennæ ringed with less distinct constrictions, in the legs being paler, in the claws being stronger, and in the basal joint of tarsus being more connate with the terminal joint. They have a distinct annulated elevation at each side posteriorly—a sort of pseudo-honeytube. When first born, they are of a pale dull yellow, and the antennal joints are more nearly subequal in length.

Fourth generation.—That from the first winged females: Differs from the preceding in the promuscis being much longer, in the antennæ having but five joints, the third being somewhat longest and the first the shortest, but all often being of much more nearly equal length, with no annulated constrictions. The color is more decidedly orange. When newly hatched, the thickened end of the promuscis often extends one-half the length of the body beyond anus. The legs are also long and stout, and the basal joint of the tarsus is distinct, but not separated. The capitate hairs are obsolete. It is born with an enveloping pellicle or pseudovum, and though of a bright red with pale legs at first, soon becomes brownish, with dark members.

Fifth generation.—The counterpart of the second.

Sixth generation.—Second winged: Resembles the third, but usually rather lighter-colored, with the wing-veins, the spinous armature of surfaces, and the constrictions of antennæ less strong, and with the third joint of antennæ rather less in length than the terminal three together.

Seventh generation.—True sexual individuals: Born within an egg-like pellicle. With stout promuscis reaching to between middle and hind coxæ; the antennæ 5-jointed, with the joints subequal. Bark-feeding. Orange in color. Undergoing one moult, and then being at once distinguished from the other forms by the brighter orange-yellow color, the rudimentary mouth, the more simple eyes (composed of three facets), by the shorter, 5-jointed antennæ, the joints subequal in length; by the shorter legs, with smaller claws to the tarsi, and more distinct terminal capitate hairs, or pulvilli. The skin is transparent, the body filled more or less with fatty globules. The female is nearly pyriform, and averages 0.4^{mm} in length. A single egg is visible through the translucent skin, and, according to age, occupies more or less of the whole of the body. The male is narrower and smaller, the penis being bulbous, with a couple of spine-like genital clasps.

This species is very closely allied to the European *S. ulmi* (Linn.), and until I was able to compare it with actual specimens, I was in doubt whether to look upon it as a mere variety or a distinct species. Judging from Kessler's figure and description of the European leaf-curl, and by a figure sent me by Mr. Buckton, it differs from ours, 1st, in bending upward, *i. e.*, the stem-mother settles on the upper instead of the under side of the leaf; 2d, in having a number of small, rounded or verrucose swellings. These differences in their dwellings are strongly presumptive of structural differences in the insects themselves; and the fact that *S. americana* does not attack the European Elms, either in Shaw's Botanical Gardens at Saint Louis, or in the grounds of the Department of Agriculture, points in the same direction. Differences are indeed easily enough made out if we take the more or less imperfect descriptions and figures of *ulmi*,* but are less apparent when the actual specimens are

*Koch's figure (evidently copied by Kessler) is faulty in several respects, and fails to indicate the hook-angle of hind wings, or the corresponding thickening of front wings, a fault that is, however, common to most of Koch's figures.

compared. The following are the more important differences, least subject to variation, between the winged females of *ulmi* as compared with those of *americana: ulmi* is a longer-winged species, averaging 7.3mm in expanse; the abdomen, wing-veins, and stigma are darker; the terminal distance between 1st and 2d discoidals slightly greater; the 3d joint of antennæ is relatively longer; the annulations are less deep and more numerous (those on 3d joint averaging 30); joints 5 and 6 are smoother, *i. e.*, without annulations, but they are more setous; joint 5 is shorter than 4; the apical, narrowed part of 6th joint is relatively longer and more pointed; the subcostal vein of hind wings is less straight; the cubital vein is often continuous to very near the subcostal, while I have not found any tendency of the kind in *americana*, the tendency being in the opposite direction, or to become shorter; the 2d discoidal of hind wings shows a tendency to fork; the hooklets on costa of hind wings are 3 in number, while in *americana* there are normally 4;* the legs are more setous.

COLOPHA† ULMICOLA (Fitch).

[Forming cock's-comb-like galls (Fig. 2, *a*) on the upper surface of the leaves of *Ulmus americana*, the galls appearing with the opening of the leaves, and turning brown and black in late summer.]

Another very common gall, which may be called the Cock's-comb Elm Gall (*ulmi-ulmicola*), is also found on the White Elm, and particularly, as in the case of the previous gall, on young trees. It was well described by Fitch‡ as an "excrescence or follicle like a cock's comb, arising abruptly on the upper side of the leaves, usually one inch long

* These hooklets get so easily broken off that they are not to be relied on; yet the normal number on most of the *Pemphiginæ* I have examined is 3, while in *Hormaphis* there are but 2. The fact that in *Sc. americana* there are 4 is therefore interesting, and of some value in this connection.

† The bibliography of this species very well illustrates the confusion that too often surrounds the proper determination, not only of insects of this family, but of all orders. It is due to three causes, not easily removed: 1st, the miserably insufficient nature of the earlier descriptions and definitions; 2d, the isolation of the earlier English entomologists from those of the continent, and the dual nomenclature that has arisen from independent work; 3d, the want of a common ground for generic characterization. Walsh referred the species to *Thelaxes*, which has, however, 5-jointed antennæ. *Vacuna*, Heyden, is synonymous with *Thelaxes*, though Walker would restrict the former to *alni*, Schrank, and the latter to *dryophila*, Schrank ("The Zoölogist," London, February, 1870, p. 2001), without pointing out generic differences, as the want of a fork in the cubital vein in Koch's figure is clearly an error of the artist. Mr. Monell founded the genus *Colopha* for *ulmicola* on the fact that the antennæ of the winged female are 6-jointed. Such a difference can hardly have generic value when we find *ulmicola* occasionally with but five antennal joints, and (if Huxley is correct in his determination) *dryophila* sometimes with six (Trans. Linn. Soc. xxii, pp. 203, 234). But, taken in connection with the fact that *ulmicola* is a flocculent species, the true female producing but one large egg, while *dryophila* is without flocculence, the female (according to Huxley) laying many eggs, *Colopha*, considering *ulmicola* as the type, may be accepted as a good genus.

‡ Fifth Report on the Noxious Insects of N. Y. § 347.

and ¼ of an inch high, compressed and its sides wrinkled perpendicularly and its summit irregularly gashed and toothed; of a paler green color than the leaf and more or less red on the side exposed to the sun; opening on the under side of the leaf by a long slit-like orifice; inside wrinkled perpendicularly into deep plates." The gall is always found between two of the branching parallel veins, and those between which it grows are generally drawn closer together than the rest. The corrugations and roughness, so characteristic of this gall, evidently result from the lesser susceptibility of the minute transverse veins to swell, compared with the more succulent tissue of the leaf. There is always a certain hoariness around the mouth of the gall below, while the base of the upper part is always contracted and compressed.

BIOLOGICAL.

The impregnated egg of this species is also to be found during the winter in exactly the same sheltered situations, in and under the bark of the White Elm, as that of *Schizoneura americana*. It is almost always sheltered by the dry and somewhat wrinkled skin of the true female, being seldom extruded, but occupying the whole of the body (Fig. 2, *b*). Occasionally the mother skin is more or less freed. The young stem-mothers hatch from the winter egg about the same time, and are minute dark olive-brown specks, just visible to the unaided eye, and quite active during pleasant weather, crawling nimbly about over the tree, till they reach a tender leaf that is just unfolding, when they also settle upon the under surface, and begin to feed on and fret the same. They doubtless insert their beaks in various portions of the buds or expanding leaves ere settling, since, before the gall begins to form, the little architect has generally obtained twice the size it had when first hatched. By the middle of April, in the latitude of Saint Louis, the galls generally begin to show, at first as slight elongate ridges on the upper surface, with corresponding closed depressions on the lower surface. Upon drawing apart the lips of the wrinkle beneath, at this stage of the growth of the gall, the stem-mother, who still retains her glossy olive-brown appearance, is seen constantly running back and forth in the cavity, and inflicting rapid punctures with her beak, the inner surface of her dwelling being smooth and glossy, with a slightly blistered appearance, in contrast with the normal, more rough and pubescent texture of the under surface of the leaf. The development of the gall is very rapid, and, with favorable weather, the top part begins to bulge so as to give the contracted appearance of the base, and the tooth-like prominences begin to appear by the third day. The inmate likewise grows apace. After the first molt, she soon becomes more pyrifrom and paler, with transverse rows of powdery secretion. She is less active, but still marches about, incessantly fretting the surface with her short, stout beak. A second molt takes place, and by the time the gall has fully developed, or about two weeks from the time it commenced forming, the

process of reproduction commences, and continues for two or three weeks, until the stem-mother is exhausted, and the gall is absolutely crowded with this second generation in all stages of growth. The lice are more or less covered and interspersed with the mealy or cottony excretion, and with the various-sized globules of gummy liquid, which is sometimes so abundant that it will fall upon the ground like a shower of milky fluid, whenever badly infested trees are shaken. The insects comprising this second generation, or the immediate issue from the stem-mother, thus born within the habitation which she had built up, are similar to their parent, but somewhat larger at the moment of birth than she was, and of a paler olive-green color. They are quite active within the gall, exploring its concavities, and obtaining their nourishment through its walls. After the second molt, they attain the pupa state, (Fig. 2, *d*), and in due time become winged. There is but one generation produced within the gall—a generation, however, that becomes very numerous under favorable conditions. They all become winged, and in this respect the species differs essentially from *Schizoneura americana*, as we have already seen. The winged lice carry their wings flat on the back while in the gall, but deflexed afterward. They issue from the slit on the lower surface of the leaf, which opens for their exit about the time they become fledged. They are all females, and give birth, in the course of a day or so, to upward of a dozen young, which, when first born, are enclosed in the usual delicate egg-like covering already alluded to, and which look like their immediate parent at a corresponding state of existence, except that their antennæ have five subequal joints, and the promuscis reaches to the hind coxæ (Fig. 2, *c*).

So far I have been able to trace the history of the species with absolute certainty, watching it for several years, and proving, by extracting the stem-mother soon after she had commenced reproducing, that the second generation, *i. e.*, her immediate progeny, all become winged, the species agreeing in this respect with the gall-making species of *Phylloxera* that affect the Hickory. There is, however, a link yet wanting in our knowledge of the history of this species, between this third generation and the mouthless sexual individuals, the females of which so often perish while yet covering their solitary winter eggs. I have not been able to prove absolutely that there are two broods of the gall-making female, and my observations all tend to the conclusion that no galls are formed except by the stem-mother that hatches from the impregnated egg. I have never succeeded in obtaining galls either by enclosing the winged females in muslin bags tied on the living trees, or by similarly enclosing her immediate progeny, though I have succeeded in obtaining, without any difficulty, an abundance of galls by so enclosing the stem-mother. Moreover, all such succulent galls as this one are produced on the tender young leaves only, and I have failed to find them on any but those which develop early in the season. It is true that we may frequently find the galls quite fresh, and containing larvæ, pupæ, and winged insects as late

as the first week in July, and these late galls, as well as the insects within them, are generally more yellowish than those found earlier in the year; but a careful study of the structure of the inmates shows them to be identical with those found in the earlier galls, and these late galls are, from present knowledge, to be attributed to the work of late hatching and late developing stem-mothers rather than to the work of the third generation. I am inclined to think that this third generation will be found to have a different habit, possibly feeding upon some other part of the tree, without forming galls, and producing in time the true sexual individuals, something as in the case of the seventh generation of *S. americana*. At all events, the true female (Fig. 2, *b*), with the solitary egg, is to be found about the trunk of the tree, as already described.

DESCRIPTIVE.

COLOPHA ULMICOLA.

Byrsocrypta ulmicola, Fitch, 4th N. Y. Rep. 1858, p. 63 (§ 347).—*Thelaxes ulmicola*, Walsh, Proc. Ent. Soc. Phil. vol. i, p. 305, 1862; American Entomologist, vol. i, p. 108, 1869.—*Colopha ulmicola*, Monell, Canadian Entomologist, vol. ix, p. 102, 1877.

Impregnated or winter egg (Fig. 2, *b*).—Length 0.38^{mm}, perfectly ovoid, shining olivaceous, inclining to brown, with no particular sculpture.

First generation, or stem-mother.—0.4^{mm} long when hatched. Antennæ 4-jointed, joints subequal in length and thickness, but with the bases of hairs rather strong. Promuscis very short, reaching only to middle coxæ or a little beyond. Upper tarsal hairs globate at tip and as long as tarsus. Smooth, dark olive-brown in color with black members. After first molt, the beak is still relatively shorter, as also the tarsal hairs; the color is paler, but the members are still black. She measures 1^{mm} in length when beginning to bear, and the third joint of antennæ is then somewhat clavate (Fig. 2, *g*), and as long as joints 1 and 2 together; the 4th narrower, as long as 3d, and rather truncate at tip, with two rather conspicuous piliferous prominences. Color translucent yellowish-green, often inclining to purple.

Second generation.—0.4^{mm} long when born (Fig. 2, *c*); nearly five times as long as wide; the antennæ (Fig. 2, *h*) short and 5-jointed, the joints subequal in length, the 3d shortest and narrowest, the 5th swollen and sub-fusiform, with rather strong bulbs at the base of the hairs. Promuscis reaching to hind coxæ. Distinct globate tips to the four tarsal hairs. Color pale olive-green, with black members and a dusky stripe on the notum. *Pupa* (Fig. 2, *d*) with antennæ smooth, 6-jointed, joints subequal in thickness, joint 4 only as long as 2; 5 and 6 each twice as long; 3 four times as long. Color dingy orange, with a paler band around the thorax, embracing the wing-pads, and reminding one, on this account, of the pupa of *Phylloxera*. *Winged female* (Fig. 2, *e*): Average expanse 3.7^{mm}; the form of body more as in *Phylloxera*, the abdomen tapering and narrower than the thorax, bearing from ten to twenty pseudova. Blackish, with an olive-green tint, the abdomen and under surface yellowish-green in the fresher individuals. Antennæ (Fig. 2, *f*) reaching only to insertion of front wings, 6-jointed; joints 4, 5, and 6 subequal, and together equal to 3 in length. [Three specimens examined have joints 4 and 5 very imperfectly separated, causing the antennæ to appear as 5-jointed.] Wings as described by Walsh, the stigma being well rounded and pale. [In three specimens examined, the third discoidal of the front wing is simple and precisely as in *Pemphigus;* in one specimen, the first discoidal is wanting on both front wings, and in another the fork of third discoidal is wanting on the left one.] Basal joint of tarsus rather short; tarsal claws only moderately strong.

Third generation.—The young from the winged female, after being freed from the pellicle in which they were born, have stout five-jointed antennæ, the joints subequal;

stout but short promuscis reaching to hind coxæ; rather large compound eyes. Proportions and shape of young *Phylloxera*.

True female: Legs short and the basal joint of tarsus rudimentary; antennæ short, four-jointed, smooth, joints subequal, the third somewhat longest. Mouth rudimentary. Described from skins surrounding impregnated egg. Males unknown.

PEMPHIGUS POPULI-MONILIS, n. sp.

[Gall (*populi-monilis*) on the Narrow-leaved Cottonwood (*Populus balsamifera*). A series of more or less confluent moniliform swellings (Fig. 3, *g*) on the upper side of the leaf, each containing a single female, destined to become winged, when it escapes from beneath, the winged insect occupying the entire cavity of the gall.]

BIOLOGICAL.

A very interesting gall, which may be called the Bead-like Cottonwood Gall, occurs on the Narrow-leaved Cottonwood (*Populus balsamifera*, L., var. *angustifolia*, Torrey), during the summer, in Colorado, and probably wherever this narrow-leaved variety grows. Though I have often found the tree in question so covered with these galls, especially at Greeley, that not a leaf was exempt, yet *Populus monilifera*, even when growing along the bank of the same irrigating ditch and mingling its branches with *angustifolia*, would be entirely free from them. The galls when not very numerous appear most commonly on the terminal leaves of a twig. They form a confluent series of pale yellow ovoid swellings, each side of the midrib (Fig. 3, *g*) recalling, in the distance, a lot of unripe cherries, or, again, the galls produced on a true willow by the Saw-fly larva—*Nematus salicis-pomum*, Walsh. There will sometimes be three rows of these swellings, and they are not infrequently tinted with red. There are, however, more often but two rows, occupying nearly the whole space each side of the midrib. The galls are formed by the folding-under of the sides of the leaf and the bulging of the same around the insect, which is always found solitary. The newly hatched louse is found in the younger galls, and on the same branch, according to the age of the swelling, the insect occurs in all stages of growth, the full-fledged female, with her wings folded flat, filling nearly the whole cavity. After leaving the gall, her wings are carried in the normal tectiform manner, and, when rendered transparent by liquid, her abdomen is seen to be swollen with fifty or more egg-like bodies, the dark eyes of which show conspicuously. These bodies are the pseudova, and the female commences at once to deposit them upon issuing from her dwelling. The young, which free themselves in the course of a few minutes from the confining pellicle, are of a pale yellowish-green, with black eyes. In structure, these young differ only from the preceding generation, at a similar age, by the somewhat narrowed body and by the promuscis reaching beyond the anus. Just where these young are deposited by the winged mother, I have not had opportunity to ascertain. They probably found new galls, the process continuing until the late summer or autumn generation of winged females give birth to the sexual individuals, and these consign to the permanent

parts of the plant the winter egg. The probability is, also, that the stem-mother that hatches in the spring has a different habit, producing not improbably a quite different gall.

DESCRIPTIVE.

PEMPHIGUS POPULI-MONILIS, n. sp.—*Winged female* (Fig. 3, *a*): Average expanse 6.5mm. Black, the abdomen a little lighter, especially at the tip. Finely powdered with white; broad across the shoulders, the scutellar lobes of the mesonotum being rather more flattened than the præscutum; the head rather small and narrow. Antennæ (Fig. 3, *b*) and legs rather short, the former reaching only to base of front wings; 6-jointed; joints 1, 2, 4, and 5 subequal in length; 3 twice as long; 6 not quite as long as 3. Joints 1 and 2 very stout; 3, 4, and 5 somewhat clavate; nearly smooth above, but with about twelve deep constrictions beneath. Legs normal, with basal joint of tarsus (Fig. 3, *f*) tolerably well separated, and unguis stout. Wings subhyaline; front wings with stigma strongly angulate, dusky, the lower portion almost black. Veins dusky, the costal and subcostal stout and darkest. Stigmal vein undulate, starting from a little beyond the middle of stigma. First and second discoidals almost connected at base [in three specimens entirely so], and the distance between them at tips about one-third greater than between 2d and 3d discoidals, and that between these two subequal with that between the last mentioned and stigmal; the 3d discoidal obsolete toward base. Fold of hind border but moderately thick. Hind wings ample, the hook-angle but moderate, the subcostal slightly undulate and considerably elbowed at basal third, whence spring the discoidals, the first bending slightly toward posterior margin, the second toward costal margin, the spaces between the tips of the costal and the discoidals subequal, and together rather more than half of posterior border. [An examination of fourteen specimens only showed one with the third discoidal forked on both wings, and another with the same vein forked on the left wing, and the second discoidal also forked near tip.] When newly hatched, or in the first age, the basal joint of tarsus is scarcely perceptible, and the tarsal hairs are simple; the antennæ (Fig. 3, *c*) are 4-jointed, the basal joint half as long as the 2d; 3d and 4th somewhat longer and subequal; the 4th suddenly narrowed at tip; the promuscis reaches beyond hind coxæ. After first molt, the antennæ (Fig. 3, *d*) are 5-jointed, the 4th very short and almost globular: the promuscis now reaches to the middle coxæ only. In the pupa state, the antennæ are 6-jointed.

Young from winged female similar to the same stage of its parent, except in the promuscis reaching beyond anus (Fig. 3, *e*). Length 0.15mm.

Throughout Central Colorado, July (Riley); Southern Kansas (Monell).

HORMAPHIS SPINOSUS (Shimer).

[Gall (*hamamelidis-spinosa*) on stem of *Hamamelis virginica* in autumn, being a deformation of the fruit-bud.]

Another gall (Fig. 4, *a*) I have found in autumn on the stems of the Witch-hazel. It is made by a new species of flocculent plant-louse, congeneric with one that is known to make conical galls on the leaves of the same plant. The gall is a deformation of the flower-bud, the puncture of the architect causing premature development, by which the calyx, bractlets, and petals are all changed into elongate bracts, more or less pointed terminally, and more or less completely soldered together at bases, so as to form a thin wall. In August, the gall is green and crowded inside with lice in all stages of growth, from the newly-born to the pupa and winged female, intermixed with flocculent matter and watery globules, the insects themselves being rather evenly covered with

a fine white powder. Later in the season, the tips of the bracts become blunter, and the gall becomes browner, and recalls externally the fruit-pod which would have developed the ensuing year. It is now perforated at some point, generally near either the top or base, and through the aperture the insects have either made their exit or may be noticed doing so. The young from the winged female are quite characteristic, being strongly granulated, and, as they were found as late as the end of October, they probably hibernate on the permanent parts of the tree. The sexed individuals and the stem-mother are yet unknown. The species was first described in 1867 by Dr. H. Shimer of Mt. Carroll, Ill., who erected a new genus for it and another well-known species on the same plant, not aware that the genus had been previously characterized by Baron Osten Sacken, in 1861.

HORMAPHIS SPINOSUS.

Hamamelistes spinosus, Shimer, Trans. Am. Ent. Soc. i, p. 284, 1867.

Winged female (Fig.4, *b*): Expanse 5mm. Color dark brown, uniformly pulverulent, the abdomen slightly paler and filled with egg-like bodies. Head with a frontal tubercle, and with the promuscis not reaching to beyond front coxæ. Antennæ (Fig. 4, *d*) reaching to base of front wing; 5-jointed, joints 1 and 2 bulbous and smooth, the others with about 50 close and regular and well-defined annulations; joint 3 six times as long as 1 and 2 together; joints 4 and 5 each half as long as 3, the terminal joint not being narrowed at tip. Thorax with the pronotum well defined, mesonotum having a thickened anterior border, with two small angles in front; the scutellar lobes and præscutum small. Tibiæ with a lobe each side at juncture with tarsus, the basal joint of tarsus not distinctly separated, and the tip furnished with two superior, knobbed hairs. Wings hyaline, the stigma and costal area fuliginous, the stigma pointed, but only slightly broadened; first discoidal almost transverse, second do. starting from it at upper third; cubital running straight toward base of first discoidal, but usually obsolete at basal half; terminal space between second discoidal and cubital wider than between it and the stigmal. Hind wings with the hooks strong, the costal vein straight, and a single discoidal, the first being obsolete. [Out of 20 specimens examined, I find the basal portion of the first discoidal of front wing connecting with the second at base, either on one wing (2 specimens) or on both wings (4 specimens), and in two cases this first discoidal is complete on one wing and incomplete on the other.] *Larva* quite broad and squarish anteriorly, with a frontal tubercle (Fig.4, *h*), and with the antennæ 4-jointed; promuscis reaching to hind coxæ; color brown, with mesonotal lobes more yellowish. Transverse dorsal rows of four piliferous spots are faintly observable. Antennæ after first molt 5-jointed, and promuscis hardly reaching to middle coxæ. *Pupa* with similar antennæ and somewhat shorter promuscis.

Young from winged female (Fig. 4, *e*): Resembling the larva of preceding generation, but distinguished by the absence of frontal tubercle, and by having the surface, except mesio-ventrally, evenly and conspicuously granulated. The terminal joint of antennæ also shows some constrictions (Fig. 4, *g*).

PEMPHIGUS POPULI-TRANSVERSUS, n. sp.

[Gall (*populi-transversa*, Fig. 5, *a–b*) formed upon the petiole near the base of the leaf of *Populus monilifera* and *P. balsamifera*. An elongate-oval swelling, causing the curving and broadening of the petiole, and opening on the opposite side by a transverse slit, with a whitish, slightly thickened, and elevated margin, recalling human lips. By the latter part of June, the stem-mother is surrounded with young of various sizes, all covered with the usual white secretion, and mixed with the liquid globules. Winged females produced in autumn, sometimes not until the leaves have fallen.]

Winged female (Fig. 5, *c*): Expanse 7mm. Pruinescent, with the abdomen more yellowish, inclining to green. Antennæ (Fig. 5, *d*) reaching a little beyond the base of

front wings; smooth; joints 3, 4, and 5 cylindrical, and of equal thickness; 3 as long as the other two together; 6 more slender at base, and with the apical unguis nearly as long as 3. Thorax with mesonotal swellings small. Terminal distance between 1st and 2d discoidal veins of front wings nearly equal to that between this last and the stigmal vein; discoidals almost connected; cubital obsolete at base; subcostal heavy; stigma scarcely wider than subcostal space, acuminate at tip, and with the vein starting a little in front of its middle. Hind wings with the discoidals connected at base, where the subcostal is slightly produced. Legs normal. Abdomen showing about 30 pseudova, and with 4 dorsal rows of faint piliferous dots. *Pupa* with joints 1, 2, 4, and 5 of antennæ subequal in length. The wingless forms are pale creamy-yellow, with faintly dusky members.

Missouri, Southern Texas, and Colorado (Riley). May possibly be *popularia*, Fitch, the description of which does not admit of identification.

This gall occurs all over the West and Southwest, and while it normally occurs in the position and of the form described, it may occur on any part of the petiole, and the opening may be more or less oblique, or form a mere circular hole. Sometimes two and even three coalesce. The lip-like bulging is, however, constant. In the galls, after they had fallen to the ground, I have found in Southern Texas a number of large, yellow, apterous females of an undescribed *Phylloxera*, surrounded with their numerous eggs and with young of all sizes—a fact that would be extremely confounding were *Phylloxera* and *Pemphigus* not so easily distinguished.

PEMPHIGUS POPULI-RAMULORUM, n. sp.

[Forming an irregular globular gall (*populi-ramulorum*), often somewhat flattened on the twigs of *Populus balsamifera* in Colorado. The gall averages 15mm in diameter, and opens in a suture sometimes transverse, sometimes oblique, but more often longitudinal with the axis of the twig: exceptionally the opening is round and bulging. Green when fresh, it becomes gray and woody with age.]

PEMPHIGUS POPULI-RAMULORUM.—*Winged female:* Alar expanse 6.8mm. Black and pruinescent, scarcely distinguishable from *populi-transversus*, except by the more annulate antennæ, the 4th, 5th, and 6th joints of which are much narrowed at base. The 6th joint (including subjoint) scarcely as long as 3d. The pupa is yellowish, with black eyes, and pulverulent.

Colorado (Riley).

Several of the species of *Pemphigus* forming galls upon *Populus* so closely resemble each other that they could not well be separated as species were it not for the differences in the galls they produce. Future careful investigation may show that the same species will produce different abnormities, and be slightly modified in appearance according as it affects different parts of the plant; but until we have such proof, the presumption is that the different galls are produced by distinct species, however similar the architects are in general appearance.

PEMPHIGUS ACERIFOLII, n. sp.

[Living in abundant and long cottony excretion, on the under side of the leaves of *Acer dasycarpum*, causing them to curl, and exuding an abundance of thick and very glutinous "honey-dew."]

PEMPHIGUS ACERIFOLII, n. sp.—*Winged female:* Alar expanse 10mm. Head and thorax bluish-black. Abdomen black, covered with long cottony threads. Antennæ reaching the wing-insertions; annulations not conspicuous; joints 3, 4, 5, and 6 somewhat contracted at base and apex; apical unguis not perceptible; joints 5 and 6

subequal; 4 distinctly clavate; 3 as long as the two preceding together. Wings subhyaline, of a whitish tinge; subcostal vein and the inner margin of the stigma black; oblique veins whitish; stigma short and broad, not angled at the base of the stigmal vein, which starts from a little behind its middle, and is comparatively straight, thereby making the apical cell rather narrow. Terminal distances between the veins subequal, that between 2d discoidal and cubital somewhat greatest; basal one-third of the cubitus hyaline, but not abortive, as it can usually be traced to its base, which is very close to that of the second discoidal; bases of the two discoidals either approximate or quite contiguous; discoidals of the hind wings proceeding connectedly from the subcostal vein. Larva with 5-jointed antennæ, and the promuscis extending beyond tip of abdomen.

June—July; Saint Louis, Mo. (Riley); Clinton, N. J. (Prof. W. D. Robbins).

PEMPHIGUS FRAXINIFOLII, n. sp.

[Infesting the terminal leaves of *Fraxinus americanus* and *F. sambucifolia* from spring till late summer, and producing a twisted curl thereof; the young lice varying in color from deep glaucous to livid, very flocculent and exuding the liquid globules quite copiously. Winged females appearing early in June.]

PEMPHIGUS FRAXINIFOLII, n. sp.—*Winged female:* Alar expanse 5.7^{mm}. Head and thorax dusky: abdomen dark green: antennæ reaching by the length of the apical joint beyond costal base of front wings; inconspicuously annulated and with joints 3—6 but moderately narrowed at base; joint 3 as long as 4 and 5 together; 6 (including unguis) nearly ⅘ths as long again as 5, with the unguis distinct and of normal length. Scutellar lobes of mesonotum broad and well marked. Legs normal. Wings hyaline; stigma linear, or not wider than subcostal space, yellowish and poorly defined anteriorly; veins very slender and sub-hyaline, the stigmal most distinct, starting a little in front of middle of stigma, and but faintly curved; cubital almost invisible, but not obsolete at base, where it nearly joins the 2d discoidal. Terminal spaces between 1st and 2d discoidals, and between this last and cubital, subequal; that between cubital and stigmal only half as great. Discoidals of hind wings proceeding connectedly from subcostal. Promuscis reaching beyond front coxæ; abdomen with 7 rather large roundish spots each side, each sending out 2 hairs. [In some specimens the cubital starts independently from the subcostal; in others it joins the 2d discoidal a short distance from base.] *Pupa* with the 3d joint of antennæ relatively somewhat shorter.

Larva of probable second generation: Antennæ smooth, 4-jointed; joint 3 somewhat longer than 4, and as long as 1 and 2 together; apical nipple ⅙th as long as the 4th joint. Promuscis slender, reaching beyond hind coxæ. Legs rather long and stout. Tibiæ, tarsi, and anal joints of abdomen with a few conspicuous hairs. Full-grown, apterous female, probably of this same generation, differs in having 6-jointed antennæ, proportioned much as in the winged female.

Larva from winged female; probable fourth generation: Antennæ 5-jointed; joints 1, 2, 3, 4, subequal in length; 3, 4, stouter; 5 very short and rounded at tip. Promuscis very long, reaching beyond tip of abdomen.

Tolerably common at Saint Louis, Mo. (Riley, Monell); Sauk City, Wis. (Thomas).

The life-history of this insect has not been fully studied, as the sexed individuals and the winter egg have not been observed. It will doubtless be found to agree in most particulars with that of *Schizoneura americana.*

The species stands somewhat in the same relation to the European *Pemphigus fraxini* (Fabr.)* as does *Schizoneura americana* to *S. ulmi.* The European species is larger, with the wing-veins differently placed, and inhabits the twigs and stems, instead of the leaves; but otherwise there is a good deal of resemblance between the two.

* *bumeliæ*, Schrank.

PART II.

NOTES ON APHIDINÆ, WITH DESCRIPTIONS OF NEW SPECIES.—J. MONELL.

Siphonophora, Koch.

Rostrum moderately long.
Antennæ seated on more or less conspicuous tubercles; longer or at least as long as the body; third joint long; first joint subcylindric; seventh joint setaceous, very much longer than the preceding; frontal tubercles approximate.
Nectaries long, subcylindric, slender.
Style (cauda) long, often compressed, falchion-shaped.
Legs slender, very long.
Wings deflexed.
Front wings with four oblique veins; the cubitus twice forked.
Hind wings with two oblique veins.

So far as is known, the oviparous females in this genus are always apterous and the males winged. The males usually have smaller abdomens, larger wings, and longer antennæ than the viviparous winged females. As in most other *Aphididæ*, the antennæ are, strictly speaking, six jointed, the so-called seventh joint being merely a slender prolongation of the true sixth joint.

Whatever opinion one may hold as to the characters that should be considered of generic importance, the first requirement of a system of classification must be practicability. In a family like the *Aphididæ*, where the species are numerous and exceedingly difficult to study, I should be inclined to accept any generic arrangement, however arbitrary, if it were but practicable. What Walsh said of species is equally applicable to genera. The only valid practical criterion of generic distinctness is the general non-existence of intermediate grades in the distinctive characters. Even granting that the existence or non-existence of the frontal tubercles would be of generic importance, which I very much doubt, the genera depending on this character must be united, as they are connected by so many intermediate gradations that it is impossible to fix a limit between them. So little is known in regard to these insects that for the present I prefer retaining the genera as generally adopted, as it would be useless, and only add to the confusion, to propose a generic arrangement which future observations may overturn. Though the connecting links between some of the genera have not yet been discovered, yet, as these genera are based on comparative, and not absolute, differences, it is more than probable that future discoveries will force us to unite most, if not all, of the genera of the *Aphidinæ*, and to readopt the generic arrangement given by Kaltenbach.

SIPHONOPHORA ACHYRANTES, n. sp.—*Apterous females:* Pale green, with a dark irregular stripe on each side of the abomen; in fully developed specimens occasionally with an additional short stripe near the basal part of the abdomen, extending over several

segments. *Winged females:* Head, prothorax, and sometimes the upper segments of the abdomen, brownish-black; the upper part of the thorax with a narrow, but conspicuous, transverse, yellow band; general color of the abdomen pale green, with irregular, broken, transverse, dark brown lines, three of these often becoming confluent, and producing a dark patch in the centre of the abdomen, just above the honey-tubes. Nectaries long, cylindrical, slightly dusky at their apices. Style long, slender, slightly curved upwards, more or less dusky. Length of the antennæ a little variable, as long as the body, or slightly longer. Frontal tubercles approximate at base, and somewhat porrect. Wings hyaline; stigma rather narrow and linear; stigmal vein very short, and curved much as in the genus *Callipterus*. The forklets of the cubitus are especially variable, their length being in one case four times and in another one-half that portion of the cubitus between the base of the lower branch and the base of the forklets. In the normal specimens, these distances are subequal. Length 2.28^{mm}; to tip of wings 3.81^{mm}.

On the under side of leaves of *Achyrantes* (*Amarantaceæ*). This is the first species that has been noticed as infesting plants belonging to this order. A species closely allied to this occurs on Polygonum and another on Lettuce, but my notes on their colors are not sufficient to enable me to describe them satisfactorily.

SIPHONOPHORA CALENDULELLA, n. sp.—*Viviparous apterous females:* General color very pale whitish-green, varying to yellowish. Antennæ whitish, as long as the body, mounted on porrect tubercles. Legs yellowish, except the tarsi. The nectaries and short style concolorous. Length 1.27—1.77^{mm}.

On the under side of leaves of *Calendula micrantha*. July, Saint Louis, Mo. Described from four viviparous females and two pupæ.

This species can be easily distinguished from the allied *S. achyrantes* by its very much paler colors, and by having the frontal tubercles more porrect in the apterous form.

What use the porrect tubercles can be to an Aphid I am unable to surmise, but I have observed on three occasions single individuals belonging respectively to *S. achyrantes*, *S. calendulella*, and *Phorodon mahaleb*, which held a small fragment of some black extraneous substance tightly clasped between the tubercles. Whether this was accidental or not, I will not presume to say.

SIPHONOPHORA GRANARIA (Kirby).
Aphis granaria, Kirby, Linn. Trans. iv, 238.
hordei, Kyber.
cerealis, Kalt.
avenæ, Fitch, et auct. amer.
Siphonophora cerealis, Koch, Kalt., Pass. et auct. plur.
avenæ, Thos.
granaria, W'lk., Buckt.

It is impossible to determine whether this is the *Aphis avenæ* of Fabr. and Gmelin, as these authors give no description of the species. *S. cerealis* seems to be the name which has been generally adopted in Europe, while *S. avenæ* is the one universally adopted in America.

SIPHONOPHORA TULIPÆ, n. sp.—*Apterous females:* Pale green, with a dusky-green stripe down the middle and darker green on the margins of the abdomen. Winged in-

dividuals with the antennæ as long as, or a very little longer than, the body, mounted on conspicuous tubercles which are not porrect; apical joint long and threadlike, longer than the fifth, and about five times as long as the sixth. Honey-tubes very long, dusky at apex. Tail, when extended, about twice the length of the tarsi, pale green. Length 3.04mm; to tip of wings 4.82mm.

On petals and stigma of Tulips, April; Saint Louis, Mo.

I believe that no other *Aphididæ* have been found on Liliaceous plants, excepting an undescribed *Aphis* collected by Prof. Riley on Yucca flowers at Greeley, Colo.

SIPHONOPHORA TILIÆ, n. sp.—*Apterous individuals:* Head and thorax yellowish or yellowish-green; abdomen green; nectaries with the basal one-third green, apical portion black. *Winged individuals:* Head and thorax reddish-yellow; abdomen and style green. Antennæ about twice as long as the body, mounted on conspicuous tubercles. Wings hyaline. Stigma yellowish. Nectaries subcylindric, four or five times as long as the tarsi. Length 2.54–3.04mm; to tip of wings 5.08mm.

On the under side of Linden leaves, causing them to curl.

SIPHONOPHORA LIRIODENDRI, n. sp.—*Winged female:* Head, thorax, and two basal joints of the antennæ red. Abdomen green. Nectaries and apical portion of the antennæ black. Antennæ much longer than the body; the tubercle near the apex of the fifth joint very distinct. Nectaries usually slightly incrassated at the base, about four times as long as the tarsi. Style slender, when fully extended one-third as long as the nectaries, more or less greenish. Wings hyaline. Stigma long, much tapered at base and apex; apex acute, nearly opposite the middle of the stigmal vein. Distance between the apex of the stigmal vein and the apex of the upper forklet equal to half that between the forklets. Length 2.54mm; to tip of wings 4.57mm.

On *Liriodendron tulipifera*, June, July; Saint Louis, Mo.

The leaves on which this species lives do not curl up as in *S. tiliæ*, but soon turn brown and drop off.

The following form also occurs on *Liriodendron*, sometimes in company with the above, but more frequently by itself. I can find no structural differences between the two; but as it seems to present the same differences in coloration in all its stages, it is possible that it may deserve to rank as a distinct species.

Var. RUFA.—General color pale reddish. Abdomen with the ground-color green, the margins red, and a red longitudinal stripe in the middle. Stigma whitish or slightly dusky. Tibiæ, tarsi, antennæ, and nectaries black. Style reddish.

June, July. Saint Louis, Mo.

Walker mentions the occurrence of a red variety of *S. rosæ* (Linn.).

SIPHONOPHORA CRATÆGI, n. sp.—*Apterous individuals:* General color pale yellowish-green, with a darker green mark on each side of the base of the abdomen and scarcely perceptible, darker green, irregular marks near the base of the nectaries. Antennæ about three times as long as the body, black, with the basal third pale greenish; frontal tubercles fully as long as the second antennal joint; seventh joint tapering to an exceedingly slender point, in the adult apterous individuals as long as the fourth, fifth, and sixth joints taken together. Nectaries long, subcylindric, extending beyond the tip of the abdomen, pale, almost translucent. Style half as long as the nectaries, pale yellowish. Legs entirely greenish. Length 2.28mm.

On the under side of leaves of *Cratægus coccinea*. July, Saint Louis, Mo. Described from four specimens.

The antennæ are longer than in any *Siphonophora* known to me. This, together with the exceedingly long and slender seventh joint, will easily distinguish it from all described species.

SIPHONOPHORA SONCHELLA, n. sp.—General color very dark dull greenish-brown. Head and thorax inclined to fuscous. General color of legs green; apical half of femora black; tibiæ dusky at base and apex; tarsi black. Tail yellowish-green, very long. Nectaries entirely black, reaching to the tip, subcylindric. Dorsum smooth. Antennæ much longer than the body; black; third joint very tubercular; fourth joint distinctly tubercular; remaining joints not so; third joint about as long as the fifth, sixth, and seventh joints taken together; seventh joint as long as the fourth and fifth taken together. Length 2.28—2.78mm; to tip of wings 3.81mm.

On *Sonchus oleracea*. July, Saint Louis, Mo.

This species is remarkable for the habit of at once dropping to the ground when disturbed. Several other undescribed species which occur on this same plant can be distinguished by having the third joint of the antennæ very much shorter.

SIPHONOPHORA CALENDULÆ, n. sp.—*Apterous individuals:* General color brownish-black; dorsum smooth and shining, a little reddish towards the nectaries. Legs yellow, except the knees, tarsi, and apex of the tibiæ, which are jet-black. Nectaries black, subcylindric, very long. Style yellow, slender, acute, two-thirds as long as the nectaries or a little less. *Winged individuals:* General color black; head and thorax slightly fuscous. Antennæ black, half as long again as the body; third joint as long as the sixth and fifth taken together, very slightly tubercular; the following joints not so. Nectaries slightly fuscous towards the apex. Wings hyaline. Length 2.28—3.04mm; to tip of wings 3.81—4.56mm.

On stems of *Calendula micrantha*. June—July, Saint Louis, Mo.

I have specimens of what is perhaps this same species, taken at Cordova, Ill., on *Bidens chrysanthemoides*, but having made no notes on the colors, cannot decide positively.

The allied North American species may be arranged as follows:

A. Body entirely red ..... *rudbeckiæ*.
AA. Body dark brown.
  B. Dorsum smooth.
    C. Third and fourth joints of the antennæ very tubercular ..... *sonchella*.
    CC. Fourth joint not tubercular. Third joint short ..... *calendulæ*.
  BB. Dorsum of the apterous individuals more or less covered with tubercles ..... *ambrosiæ*.

SIPHONOPHORA RUDBECKIÆ, Fitch.

This species has been taken at Saint Louis on *Vernonia novæboracensis*, *V. Lindheimeriana*, *Solidago rigida*, *S. serotina*, *Bidens chrysanthemoides*, *Ambrosia trifida*, *Cirsium arvense*, *Silphium perfoliatum*, *S. integrifolia*, and *Cacalia suaveolens*. A yellowish-red variety has been found on *Cirsium*. It is rather remarkable that Rafinesque should have overlooked this species, which I believe is the commonest of all American

Aphidians, and is very generally distributed over the eastern portion of the United States.

SIPHONOPHORA FRAGARIÆ?, Koch, var. IMMACULATA, Riley.*

According to Professor Riley, this form is similar to *S. fragariæ* Koch, differing chiefly in lacking the row of minute black spots on each side of the back, and in the head of the apterous females not being black, but yellowish. November, Kansas City, Mo.

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* Professor Thomas omits this species in his "List of the Aphidini which have been heretofore named," &c. As the great merit of a list is completeness, the following enumeration of omitted species may serve as a supplement to that author's paper:

Siphonophora fragariæ var. *immaculata* Riley, Rural World, December, 1875.

Aphis quercifolii Walsh, Ent. Soc. Phila. i, December, 1862, Genera of N. Am. Aphidæ.

Aphis carduella Walsh, l. c.

Aphis tritici Fitch, 1861, (loc. ignot.). Referred to in Ann. de la Soc. Ent. de France, 1867, p. 26, Library Catalogue.

Aphis rubecula Haldm. Proc. Bost. Soc. Nat. Hist. vol. i, p. 168, 1844.

Aphis bicolor Haldm. l. c. p. 168.

Aphis marginipennis Haldm. l. c. p. 168.

Aphis pilosa Haldm. l. c. p. 169.

Aphis discolor Haldm. l. c. p. 169.

Aphis verticolor Raf. Am. Monthly Mag. and Critical Review, i, p. 361, 1817.

Aphis furcipes Raf. l. c. i, 361.

Aphis rhodryas Raf. l. c. iii, 15, 1818.

Aphis diplepha Raf. l. c. iii, 15.

Aphis oreaster Raf. l. c. iii, 17.

Aphis gibbosa Raf. l. c. iii, 17.

Aphis xanthelis Raf. l. c. iii, 17.

Aphis annulipes Raf. l. c. iii, 17.

Aphis ambrosia Raf. (nec Thos.) iii, 17.

Aphis acaroides Raf. l. c. iii, 17.

Callipterus mucidus Fitch, N. Y. Rept. iii, § 20.

Callipterus castaneæ Fitch, l. c. ii, § 199.

Callipterus bella (Walsh), *Aphis bella* Walsh, l. c.

Calaphis betulella Walsh, l. c.

Whether or not the writings of Rafinesque on the *Aphididæ* are deserving of credence and acceptance is a question which I do not propose to discuss; I however think that such of his species as are named in accordance with the binomial rule should be placed in the same list as the early descriptions of Fitch, and, like them, should be held subject to recognition. The recognition of these imperfectly described species is little more than a matter of courtesy, and mere courtesy would never prevail on us to burden the nomenclature of the *Aphididæ* with such sesquipedalians as *Aphis melampyrum-latifolium*, &c.

Rafinesque's statement that *A. diervilla-lutea* and *A. erigeron-philadelphicum* have bent antennæ, on account of which he erects the genus *Loxerates*, would make me doubt whether they belonged to the *Aphididæ*, but his mentioning the nectaries in the description of the latter species places the matter beyond doubt. It is probable that the antennæ are merely bent back over the body, as in many species of *Siphonophora*. *Cladoxus* Raf. does not belong to the *Aphididæ*. Inclusive of Rafinesque's binomial species (and excluding the trinomial ones), the described *Aphididæ* of the United States amount in all to 166 species, 107 of which belong to the *Aphidinæ*.

The strawberries on which these Aphides occurred came from Palmyra, N. Y., and South Bend, La., from which places this species was probably imported. From an examination of a single dry specimen in the cabinet of Professor Riley, I am inclined to think that this will prove to be a distinct species. The second cubital cell is smaller than in *S. fragariæ*, and the distance between the first and second discoidals a little more than twice that between their bases.

Aphis, Linn. (emend.).

Rostrum moderately long.
Antennæ remote at base, not seated on frontal tubercles, or seated on very inconspicuous ones; usually smooth, and generally shorter than the body.
Seventh joint longer than the sixth.
Front flat or convex.
Nectaries subcylindric, rarely very small, very rarely none.
Style more or less prominent, very rarely none.
Wings deflexed.
Front wings with four oblique veins, the cubitus twice forked.
Hind wings with two oblique veins.

APHIS LUTESCENS, n. sp.—*Winged individuals:* General color bright lemon-yellow. Antennæ somewhat pilose, a little shorter than the body. The length of the joints is quite variable: in some specimens, the third joint is subequal to the preceding, while in others it is one-third longer. Seventh joint filiform, very much longer than the third. Nectaries somewhat dusky, gently tapering from base to apex, the apical diameter being about two-thirds that of the base; about three times as long as the tarsi. Style dusky yellow, blunt at apex, when fully extended about half the length of the nectaries. Fore wings hyaline; stigma dusky yellowish, acute at the apex, which is opposite the middle of the stigmal vein. Stigmal vein in one regular curve. Discoidal veins of the hind wings nearly parallel; subcostal comparatively straight. Length 1.65—2.03^{mm}; to tip of wings 3.04—3.54^{mm}.

On *Asclepias syriaca*. July, September. Saint Louis, Mo.; Montrose, Iowa; Dubuque, Iowa; Rock Island, Ill.; Cordova, Ill.

The very bright yellow color will at once distinguish this from other North American species.

APHIS VERNONIÆ, Thos.—*Winged individuals:* Abdomen pale yellow; head and thorax somewhat dusky. Antennæ two-thirds as long as the body, the fourth, fifth, and sixth joints subequal to the third. Nectaries cylindric, very slender, about three times as long as the tarsi.

Aphis beccabungæ, with which Professor Thomas supposes this may be identical, has the nectaries and tail black (Passerini).

APHIS SETARIÆ (Thos.).
Siphonophora setariæ, Thos. Ill. St. Lab. Nat. Hist. ii, 5.
Siphonophora panicola, Thos. l. c.

The peculiar brownish-red color of this species will easily distinguish it from other non-pulverulent species. The bases of the tibiæ are always pale yellowish. Leaves and spikes of *Panicum proliferum*. August—September. Saint Louis, Mo.; Keokuk, Iowa; Rock Island, Ill.

APHIS CALENDULICOLA, n. sp.—*Apterous individuals:* General color uniform pale green, the disk of the abdomen usually a little paler, often with a few faint, irregular,

darker green marks near the base of the nectaries. Antennæ about two-thirds as long as the body, pale, slightly dusky towards the apex; apical joint as long as, or slightly longer than, the third. Nectaries entirely black, slightly tapered towards the apex, twice as long as the tarsi. Style short, pale green. Legs entirely pale, except the faintly dusky tarsi and tips of the tibiæ. Length 1.52mm.

On the under side of leaves of *Calendula micrantha*. July; Saint Louis, Mo. This species may be expected to occur on the genus *Tagetes*, to which the "French marigold" belongs. The apical joint of the rostrum is rather short and robust.

APHIS CEPHALANTHI, Thos.

This species does not approach the genus *Callipterus*, as its describer supposes. The semicircular fourth vein, which I suppose suggested this, is a character common to many species of *Aphidinæ*, and is only valuable in distinguishing some genera from *Lachnus*. A closely allied species occurs on *Penthorum sedoides* (*Crassulaceæ*), having much the same color, and showing the same characteristic pruinose spots.

APHIS MEDICAGINIS, Koch.

On *Caragana arborescens*, *Robinia viscosa*, and *Melilotus italica*. This species has not been previously noticed as occurring in America. The shining black dorsum of fully developed individuals will distinguish it from other American species.

Length 1.27—1.77mm; to tip of wings 2.54—3.04mm. July; Saint Louis, Mo.

APHIS SALICICOLA (Thos.).

Siphonophora salicicola, Thos. Bull. Ill. St. Lab. Nat. Hist. ii, p. 8.
Aphis brevifurca, Monl. MSS.

In April last, Miss E. A. Smith sent me a short nectaried Aphidian, which I have provisionally referred to the genus *Cladobius*, with the information that it was the same species which she had sent to Professor Thomas the previous year, and which he had described as *S. salicicola*. Thinking the error a very strange one, I wrote to Professor Thomas in regard to it, and have received through his kindness a number of type-specimens of *salicicola*, an examination of which proves them identical with an *Aphis*, which I have previously found on leaves of Blue-grass. It is very probable that the labels on the vials containing these two species were interchanged, or else that the two species were mixed together; though it is not impossible that the species may occur on both grass and willow. I should have thought that the error was made by myself had I not collected this species on two separate occasions. The stigma is rather linear, a little wider than the forklets are long, and tapered at apex. Forklets of the cubitus smaller than in any known species, their length being about one-fifth the distance between their bases and that of the lower cubital branch.

Length 1.27—2.03mm; alar expanse 5.84mm. April.

The species plainly belongs to *Aphis*, and not to *Siphonophora*.

APHIS CORNIFOLIÆ, Fitch.—*Winged individual:* Head and thorax dusky; abdomen dark fuscous. Fore femora entirely yellow; hind femora yellow only at base; base of the tibiæ yellow in all the legs; tarsi more or less dusky. Antennæ more or less dusky, as long as, or a little longer than, the body. Nectaries dusky, cylindric, scarcely longer than the tarsi. Abdomen truncate. Style dusky, short, but distinct. Wings hyaline. The stigma projecting somewhat above the margin, much as in *A. corcopsidis*, tapered abruptly at apex. Costa and stigma pale yellow; oblique veins dusky. Apterous individuals pulverulent.

Length 1.27^{mm}; to tip of wings 2.28^{mm}.

On the under side of leaves of *Cornus florida* and *C. paniculata*, June—July; Saint Louis, Mo.

APHIS CRATÆGIFOLIÆ, Fitch.

This interesting species belongs to the genus *Aphis, sensu strictiori*, and can be distinguished from its allies by its longer stigma, which is gently tapered at apex, and prolonged until opposite the middle of the stigmal vein. This is evidently the same species as that mentioned by Walsh (Phil. Ent. Soc. 1862, p. 301).

On *Cratægus coccinea*, Saint Louis, Mo., June.

APHIS ATRIPLICIS, Linn.

The common *Aphis* on *Chenopodiaceæ* appears to be identical with the European. Its occurrence in America has not been previously noticed. Saint Louis, Mo.; Carbondale, Ill. (Miss N. Middleton).

APHIS HYPERICI, n. sp.—*Winged individuals*: General color light reddish, covered with pulverulent matter; antennæ on short tubercles, a little longer than the body; third joint as long as the fourth, fifth, and sixth taken together; apical joint about twice as long as the preceding. Wings hyaline; stigmal vein much curved; distance between the base of the cubitus and that of the stigmal vein equal to the distance between the apices of the lower forklet and the lower branch of the cubitus. Nectaries very short, only detected with difficulty. Tail reddish, little over half as long as the tarsi, slender and terete.

Length 1.06—1.27^{mm}; to tip of wings 1.77—2.28^{mm}.

Living in colonies on the young twigs and under side of leaves of *Hypericum kalmianum*, to which species it seems to be confined. July, Saint Louis, Mo.

The allied American pulverulent species may be arranged as follows:

A. Nectaries scarcely perceptible.
  b. General color red ..... *hyperici.*
  bb. General color green ..... *loniceræ.*
AA. Nectaries distinct:
  b. Nectaries longer than the style, both more or less dusky.
    c. Abdomen of the winged individuals dusky or reddish; antennæ more than half as long as the body.
      d. Body red or dusky-reddish, with two pruinose spots on base of abdomen ..... *cephalanthi.*
      dd. Body dusky, without pruinose spots ..... *cornifoliæ.*
    cc. Abdomen of winged individuals green or yellowish-green.
      d. Antennæ half as long as the body; nectaries as long as the tarsi; stigma short (Walsh) ..... *maidis.*
      dd. Antennæ two-thirds as long as the body; nectaries scarcely half as long as the tarsi ..... *brassicæ.*
  bb. Nectaries and style green, subequal; as long as the tarsi ..... *atriplicis.*

APHIS LONICERÆ, n. sp.—*Winged individuals:* Green, often with two darker green longitudinal stripes. Head and thorax brownish. Antennæ about as long as the body; frontal tubercles short, but distinct; apical joint filiform, as long as the two preceding taken together. Rostrum reaching below the second pair of coxæ. Wings hyaline; stigma rather long. Nectaries scarcely projecting above the surface of the abdomen. Lateral edges of the abdomen with four or five very short, green, mammiform tubercles. Style not perceptible. Length 2.54^{mm}; to tip of wings 4.57^{mm}.

On young twigs and leaves of *Lonicera*. Living in colonies, covered with an abundant pulverulent secretion; May—July, St. Louis, Mo.

APHIS PRUNIFOLII, Fitch, N. Y. State Agric. Trans. 1854, p. 826.

It is doubtful whether *prunifoliæ* Fitch is identical with *pruni* Koch; but even should they prove to be indentical, it has not yet been satisfactorily shown that Koch's name has precedence. Were the dates on the title-pages of these two books correct, Fitch would have three years' priority; but from what Carus and Engelmann say about Koch's work, it is probable that the second number was published in the latter half of 1854. The exact date of Fitch's article I have been unable to ascertain. At Saint Louis, this species occurs only on varieties of native Plums.

APHIS CANDICANS, Fitch.

Professor Thomas's citation of Fitch's name as the describer of this species is doubtless a clerical error, as no such species as *A. candicans* has ever been described, and the only other mention of the name that we have been able to find is that given in a compiled article in Ill. St. Hort. Soc. Trans. x, p. 169 (1877), where it is printed without giving either description or authority. Professor Thomas informs me that he feels sure that he has seen some description of this species by Fitch, but is unable to say where.

APHIS HELIANTHI, n. sp.—*Apterous individuals:* Varying from pale green to dark green, with various irregular and variable darker shadings on the abdomen, the most constant and conspicuous of which is a dark green transverse band on the segment above the nectaries. Nectaries dusky; style, at least the apical two-thirds, pale dusky. *Winged individuals:* Head and thorax jet-black; abomen green, with a transverse band on the segment above the nectaries, and occasionally with some darker spots on the margin. Antennæ two-thirds as long as the body, entirely black; third joint as long as the two preceding taken together; fourth and fifth joints subequal. Nectaries subcylindric, pale dusky, hardly reaching the base of the style, and less than twice the length of the tarsi. Wings hyaline; venation normal. Length 1.77^{mm}; to tip of wings 3.04—3.29^{mm}.

On stems and leaves of Helianthus, Saint Louis, Mo.

Rhopalosiphum, Koch.

Similar to *Aphis*, but with the nectaries clavate.

RHOPALOSIPHUM SALICIS, n. sp.—*Winged individuals:* Head and thorax dusky; abdomen green, with various irregular, darker green markings. Antennæ about half as long as the body, not mounted on frontal tubercles; the third and fourth joints somewhat dentate; apical joint half as long again as the preceding; third and fourth joints

often subconnate. Nectaries light green, reaching to the tip; the basal portion slender, expanding at the middle to twice its former diameter, and again suddenly contracted at the mouth, which is furnished with the usual annulus. Tail yellowish, about one-third as long as the nectaries.

Length 1.52mm; to tip of wings 3.04mm. Apterous individuals entirely pale green, with two darker green dorsal vittæ.

On the under side of leaves of *Salix lucida*, *S. nigra*, and *S. babylonica*. June, Saint Louis, Mo. This species comes under *Siphocoryne* Pass., but I do not think that the characters given by Passerini justify its separation from *Rhopalosiphum* Koch.

RHOPALOSIPHUM RHOIS, n. sp.—*Winged individuals:* Antennæ a little longer than the body, mounted on very inconspicuous tubercles; joints proportioned as usual; seventh joint a little longer than the two preceding taken together. Nectaries three times as long as the slender style; the diameter of the apical two-thirds in normal specimens nearly twice the basal diameter; the apex contracted to about the same diameter as the base, and with the mouth very slightly flaring.

Length 1.52—2.02mm; to tip of wings 3.81mm.

This interesting species was collected some years ago on an undetermined species of Sumach. The only note of its colors that I have is that the general color is reddish-brown.

Individuals occasionally occur having one of the nectaries lacking the basal constriction, and I have seen a single specimen having one of its nectaries subcylindric.

Drepanosiphum, Koch.

Rostrum short.
Antennæ long and slender, seated on frontal tubercles; third and setaceous seventh joint long.
Nectaries long, enlarged beneath towards the base.
Style inconspicuous or none.
Wings long.
Front wings with four oblique veins; the cubitus twice forked; marginal cell elongated towards the apex of the wing.
Hind wings with two discoidals.
Habits sporadic.

Professor Passerini is evidently in error in uniting this genus with *Siphonophora*. Its structure, habits, and the non-existence of viviparous apterous females point towards a relationship with the genus *Callipterus*, together with which it may be considered as forming a group in the *Aphidinæ*.

DREPANOSIPHUM ACERIFOLII (Thos.).
Siphonophora acerifoliæ, Thos. Bull. ii, Ill. St. Lab. Nat. Hist.
Siphonophora acericola, Thos. (icon. l. c.).

The antennæ are longer and the marginal cell broader than in any previously described American Aphid. The nectaries reach about to the tip of the abdomen, and are suddenly dilated at base to twice the diameter of their apices. The stigmal vein is usually enlarged at base for a distance equal to the breadth of the stigma. The dorsal tubercles, though very characteristic, are not sufficient to warrant a generic separation. Some species of *Callipterus* have somewhat similar processes,

and in some forms of *Phylloxera Rileyi* the tubercles are proportionally as great. The fore tibiæ have each a short robust tubercle on the front edge, close to the knee. Hairs on the dorsum of apterous individuals capitate. Normal specimens in this locality have the cubitus and stigmal veins lying in more or less distinct brown bands; in variety *hyalinus*, the wings lack these brown shadings, but do not differ otherwise.

Callipterus, Koch.

Rostrum short.
Antennæ not on frontal tubercles, or else on very short ones, seven-jointed; transition from the sixth to the seventh joint very gradual.
Nectaries short, often scarcely perceptible.
Style short, enlarged at apex.
Wings deflexed; front wings with the stigmal vein much curved, not robust, usually more or less hyaline; cubital vein springing from near the base of the stigma; second discoidal sinuous.
Hind wings with two discoidals.
Body elongate, slender, of very pale colors.
Habits sporadic.

This genus seems to form a sort of transition between the *Aphidinæ* and *Lachninæ*, and should be placed in the former section principally on account of the shortness of the rostrum. Several divisions of *Callipterus* have been proposed, based on the relative length of the sixth and seventh antennal joints, but in such species as I have examined this character seems particularly variable and not deserving the importance which has been attached to it. In the species known to me, and probably in all European species, the wings are deflexed, but according to Fitch the species described by him have the wings horizontal. I was at first inclined to doubt the accuracy of this statement, but as it is a character very easy to observe, and as Dr. Fitch mentions it on two separate occasions, I do not see how he could possibly have made a mistake. Further investigation may possibly prove that his species do not appertain to this genus. As I have never been able to find viviparous apterous females, I consider it very probable that insects belonging to this genus acquire wings before producing living young.

A. Dorsum of winged individuals with spine-like tubercles ..... *C. ulmifolii*, n. sp.
AA. Dorsum without spine-like tubercles.
a. Marginal cell dusky.
b. Middle tibiæ pale yellow. Femora pale yellow ..... *C. walshii*, n. sp.
bb. Tibiæ black. Apical portion of femora black ..... *C. bella* (Walsh).
aa. Marginal cell hyaline.
b. Wings with transverse, shaded bands.
c. Abdomen with conspicuous dusky spots ..... *C. discolor*, n. sp.
cc. Abdomen yellow, concolorous, or with very faint transverse bands.
C. asclepiadis, n. sp.
bb. Wings subhyaline.
c. Nectaries distinct.
d. Dusky shadings at tips of veins; a dusky mark at base of stigmal vein.
C. punctata, n. sp.

dd. Wings hyaline.

e. Apical joint of antennæ a little longer than the sixth. Veins whitish. *C. hyalinus*, n. sp.

ee. Apical joint of antennæ three times as long as the sixth. First and second discoidals black ..... *C. betulæcolens*, n. sp.

cc. Nectaries not perceptible.

d. Wings hyaline ..... *C. caryæ*, n. sp.

dd. Veins bordered with brown ..... *C. quercicola*, n. sp.

CALLIPTERUS ULMIFOLII, n. sp.—Pale whitish-yellow. *Apterous individuals:* Tubercular, with capitate hairs, which disappear when the insect acquires wings. *Winged individuals:* Antennæ as long as the body; third, fourth, and sometimes the fifth joint slightly dusky at apex; apical joint a very little longer or shorter than the sixth. Wings hyaline; all of the veins, and especially the stigmal vein, subhyaline. Dorsum with four long, spine-like tubercles on its basal portion, and with various shorter tubercles on the apical portion. Length 1.77^{mm}; to tip of wings 3.04^{mm}.

On the under side of leaves of *Ulmus americana*, May—June. Closely allied to the European *C. quercus*, which has also four dorsal tubercles.

CALLIPTERUS WALSHII, n. sp.—*Winged form:* Bright yellow. Antennæ, with the tips of joints 3 to 6, black; seventh joint more than twice as long as the preceding. Thorax with a lateral black vitta extending from the eye to the wing-insertions. Femora pale whitish-yellow; fore tibiæ black; middle tibiæ faintly dusky; hind tibiæ more dusky than the middle pair. Tarsi and tips of tibiæ black. Nectaries yellowish, half as long as the tarsi. Wings hyaline. Front wings with the entire costa as well as its nervures black to the tip of the stigma, whence there extends a marginal dusky vitta, as wide as, or a little wider than, the costa at base and middle, but tapering at the tip and extending a little beyond the upper furcal of the cubitus. The stigmal vein lies entirely in this vitta, and curved so as to make the width of the marginal cell just equal to the distance between the apex of the stigma and that of the stigmal vein. Hind wings with a dusky costal vitta extending to the tip of the wing. Remaining veins of both wings slender and pale dusky. Length 1.27^{mm}; width of abdomen 0.5^{mm}; length of wing 1.77—2.03^{mm}; to tip of wings 2.28—2.54^{mm}.

May—July; Saint Louis, Mo.

On the under side of leaves of *Quercus rubra*.

Very closely related to *C. bella* (Walsh), with which it has been hitherto confounded.

CALLIPTERUS BELLA (Walsh).

Aphis bella, Walsh, Genera of N. Am. Aphidæ, Phil. Ent. Soc. 1862.

In some specimens, a series of capitate hairs can be detected on the margin of the abdomen of the unborn larvæ, which can be seen through the sides of the abdomen of the viviparous females. The young of some individuals seem to lack these hairs. A similar case has been noticed by Professor Riley in *Schizoneura fungicola?* (Walsh), in which the very young larvæ occur with and without capitate hairs. These hairs, on being very highly magnified, appear to be hollow, with a funnel-shaped opening at the apex.

Length 2.54—3.04^{mm}; of wings 3.55—3.81^{mm}; to tip of wings 4.06—4.31^{mm}.

CALLIPTERUS ASCLEPIADIS, n. sp.—*Winged form:* General color yellow. Antennæ filiform, mounted on very short tubercles, as long as, or a little longer than, the body;

apical joint much longer than the preceding. Nectaries yellowish, short. *Apterous individuals:* With capitate hairs, which disappear when the insect acquires wings; abdomen somewhat tubercular. *Winged individuals:* Wings blotched with dusky or dusky brown; an irregular broad band running from the apex of the second discoidal to the apex of the upper forklet, and another running from the apex of the first discoidal towards the base of the cubitus, but becoming obsolete before reaching that point. Stigma short, abruptly tapered at apex. Distance between the tips of the first and second discoidals one-half that between the tip of the second discoidal and the lower cubital branch. Distance between the base of the cubitus and the base of the stigmal vein nearly equal to the distance between the apices of the lower forklet and the lower branch of the cubitus. Length 1.27—1.52mm; to tip of wings 2.54mm.

May—August.

Very common at Saint Louis on *Asclepias cornuti* and *A. obtusifolia*. This is the first species belonging to this genus which has been found on a herbaceous plant.

CALLIPTERUS DISCOLOR, n. sp.—*Winged form:* Abdomen greenish or yellowish, with four rows of irregular brownish spots, often with smaller dots between them, the two middle rows becoming confluent just above the nectaries. Antennæ with the sixth joint less than the seventh. Wings with irregular dusky bands arranged similarly to those in *C. asclepiadis*. Length 1.77mm; to tip of wings 3.29mm.

Under side of leaves of *Quercus bicolor*. Saint Louis, Mo., May.

CALLIPTERUS PUNCTATA, n. sp.—*Winged form:* General color pale yellow; abdomen with faint dusky shadings, representing the dots of the preceding species. Sixth joint of the antennæ much less than the seventh. Wings hyaline, except dusky markings at the tips of the second discoidal, cubital, and stigmal vein, and a dusky mark at base of stigmal vein. Length 1.52—1.77mm; to tip of wings 3.04—3.29mm.

On the under side of leaves of *Quercus bicolor*. May—June, Saint Louis, Mo. It is possible that this is merely a variety of *C. discolor*, but I have never succeeded in finding intermediate forms.

CALLIPTERUS HYALINUS, n. sp.—*Winged form:* General color pale yellowish. Apterous individuals with the usual capitate hairs. Seventh joint of the antennæ longer than the preceding. Wings hyaline, without any markings, or with a scarcely perceptible shading at the tips of the wings. Stigma rather long, the distance between the base of the stigmal vein and the base of the cubitus being much greater than that between the tips of the lower forklet and lower cubital branch. Basal two-thirds of the stigmal vein subhyaline. Second discoidal not so much curved as in *C. punctata*. Length 1.77—2.02mm; to tip of wings 3.04mm.

On the under side of leaves of *Quercus imbricaria*, to which species I believe it is confined. May—June, Saint Louis, Mo.

CALLIPTERUS BETULÆCOLENS, n. sp. *Aphis betulæcolens?*, Fitch, N. Y. Catl. Hom. p. 66.—*Winged individuals:* General color yellow; antennæ, first and second joints entirely yellow, the apical half of the remaining joints more or less dusky. Dorsum uniform yellow, without tubercles; wings hyaline; costal and subcostal veins whitish; first and second discoidals black. Stigma yellowish; basal two-thirds of the stigmal vein obsolete; apical portion hyaline, subobsolete. Nectaries yellow, a little fuscous, fully as long as the tarsi. The rostrum barely reaches the middle coxæ. Length 2.02mm; to tip of wings 3.81mm.

On the under side of Birch leaves. June, Saint Louis, Mo.

Dr. Fitch's description of *A. betulæcolens* is not sufficiently exact to

enable one to recognize the species. It is, however, probable that it is distinct, as the measurement he gives would make his species slightly larger than the present one; besides, were they identical, it would be rather singular that Dr. Fitch should omit to mention the obsolete stigmal vein, and at the same time be at the pains to mention that the base of the cubitus was hyaline.

I am unacquainted with *Calaphis betulella* Walsh; but, unless there are other distinguishing characters, the mere absence of the stigmal vein will not be sufficient to separate *Calaphis* from *Callipterus*, as there is a complete series of transitions between the two.

CALLIPTERUS CARYÆ, n. sp.—*Winged form:* General color pale yellow; tips of the antennal joints black; legs entirely pale whitish. Antennæ a little shorter than the body; seventh joint equal to or one-third longer than the preceding; fifth joint as long as eth two following taken together. Nectaries not perceptible. Rostrum not reaching to the middle coxæ. Wings hyaline; veins pale; stigma rather short and blunt at apex. Stigmal vein subobsolete, its course being only traced with difficulty. The distance between the apex of the lower cubital branch and that of the second discoidal equal to about one-half the distance between the apices of the first and second discoidals. Apterous viviparous females and pupæ with four longitudinal rows of tubercles, each mounted with a capitate bristle.

Leaves of Walnut, Hickory, and Pecan. June—July. Saint Louis, Mo.

CALLIPTERUS? QUERCICOLA, n. sp.—*Winged form:* Antennæ about half as long as the body; not mounted on frontal tubercles; remote at base; third, fourth, and fifth joints equal in length; transition from the sixth to the seventh joint exceedingly gradual; seventh joint about half as long as the preceding. Rostrum short, not reaching the second coxæ; apical joint very acute. Nectaries reduced to mere openings. Style none. Wings with the veins bordered with brown. Stigma rather short, and blunt at apex; the cubital vein arising from its base. Stigmal vein not so much curved as usual in this genus, not hyaline; distance between the base of the cubitus and that of the stigmal vein equal to the distance between the furcals and less than the distance between the base of the cubitus and that of the second discoidal. Second discoidal not sinuous. Body rather elongate. Length 1.77^{mm}; to tip of wings 2.79^{mm}.

It is with considerable doubt that I place this species in the genus *Callipterus*. It is very probable that it should be placed under *Asiphum;* but the only description of this genus which has been published is that given by Koch, and, like the other generic descriptions which were made from memory after the loss of his eyesight, is somewhat unsatisfactory. The following is a translation of the salient points in his description:

Asiphum, Koch.—"Beak short. Antennæ rather short, the third, fourth, and fifth joints subequal, the apical joint very small, scarcely perceptible." Of this interesting species, I have only seen two winged specimens, mounted on a slide, which was communicated by a correspondent with the information that it occurred at Saint Louis on Oak.

Chaitophorus, Koch (emend.).

Similar to *Aphis*, but with the antennæ and body distinctly pilose.
Style tubercle-like.

CHAITOPHORUS VIMINALIS, n. sp.—*Apterous individuals:* Varying from pale green to light yellow, with two darker vittæ on the abdomen, which are often obsolete. Entire

insect covered with long white hair. *Winged individuals:* Head and thorax black; abdomen black, except the margins and style, which are yellow. Nectaries a little longer than thick, yellowish, often slightly fuscous. Antennæ hairy; seventh joint filiform, almost as long as the three preceding taken together. Wings hyaline. Length 1.52mm; to tip of wings 2.54mm.

On young twigs and leaves of *Salix lucida and S. babylonica.* The venation of the wings is exceedingly variable; in one abnormal specimen I have observed a robust transverse vein running from the middle of the second discoidal to the base of the lower branch of the cubitus, thereby forming a closed trapezoidal cell.

CHAITOPHORUS SMITHIÆ, n. sp.—*Winged form:* General color dusky reddish. Wings hyaline; venation very variable. Nectaries two-thirds as long as the tarsi, vasiform, contracted at the base, expanding in the middle, and again contracted at the apex; the mouth flaring. Antennæ a little over half as long as the body, the third joint the longest, the fourth and fifth subequal, and the sixth joint two-thirds as long as the preceding. Seventh joint slender, very little longer than the preceding. Rostrum reaching the third pair of coxæ. Length 2.28mm; to tip of wings 4.56mm.

On leaves of *Salix alba.* May—June. Peoria, Ill. (Miss E. A. Smith).

This species comes under *Cladobius* Koch, a genus which does not seem sufficiently distinct from *Chaitophorus.*

Though the shape of the nectaries is very remarkable, it seems to me scarcely sufficient to justify a generic separation.

CHAITOPHORUS QUERCICOLA, n. sp.—*Apterous individuals:* Dorsum greenish, with four rows of short tubercles, all of which, except a few in the side-rows, are black; their apical circumference with from three to five bristles; the two middle rows of tubercles stop at the head, but the two lateral rows are continued by smaller tubercles until near the base of the labrum. Rostrum reaching the second coxæ. Nectaries yellow, about as long as the tarsi, slightly enlarged at base, the mouth conspicuously flaring. Style not perceptible. *Winged individuals:* Antennæ very slightly pilose; fourth joint subequal to the fifth and two-thirds as long as the third joint; sixth about half as long as the preceding, and very little longer than the seventh. Wings with the stigma and veins much as in *Ch. populicola;* the veins lying in narrow dusky bands. Length of apterous individuals 1.52—2.02mm; length of wing 2.54mm.

On the under side of the leaf near the midrib. *Quercus prinus.* May—June. Peoria, Ill. Of this interesting species, I have seen a number of apterous individuals, but only a single winged specimen, which was mounted on a slide kindly communicated by Miss E. A. Smith of Peoria, Ill. The dorsum of the winged individual is probably not tubercular, but this cannot be decided with certainty on account of the manner in which the specimen is mounted.

Though the antennæ of this species are not sufficiently pilose to justify its being placed in *Chaitophorus,* its general appearance seems to point to this as its rightful position.

Art. II.—The Relations of the Horizons of Extinct Vertebrata of Europe and North America.

By E. D. Cope.

The history of the succession of life upon any one portion of the earth's surface is replete with matter for speculation. It shows us a series of faunæ succeeding each other, each of which, in many instances, commences without previous announcement in the forms of older periods, and disappears without leaving representatives in later ones. With this basis of fact, which naturally enough has been furnished by the longest explored and best known portion of the earth, Europe, we turn to other lands with the hope of obtaining further light upon a subject so full of mystery. These types of life, did they originate in a single centre, from which they disseminated themselves? and, if so, did each form originate in a region of its own or not? Or, did the same types of generic structure appear at different points on the earth's surface independently; and, if so, whether cotemporaneously, or at different times?

For a solution of these and similar questions, we naturally look to a comparison of the facts first established, with those obtained more recently by exploration in other regions. In this quest, no portion of the earth offers greater promise of results than America. As the second great continent, separated from the other by the greatest possible water surface, we anticipate the widest diversity in the character of its life-history. If the types of life have originated independently, we will find evidence of it by studying American palæontology; if their origin has been through gradual modification, America should furnish us with many intermediate faunæ.

The identification of the generic types of North American *Vertebrata* has now advanced to a point which renders such a comparison possible. Although the subject is in its infancy, the following pages will show that an important contribution to it can be now made. The comparisons instituted in this paper commence with the coal-measures, and with the *Batrachia* of that period. As regards the palæozoic fishes, I have not yet devoted that attention to them which is necessary for their discussion, and I refer to the papers of Newberry for several important identifications of genera as common to the two continents.

The structure of the *Batrachia* of the coal-measures is not yet sufficiently well known to enable the most exact comparisons to be made, but close parallels, if not identities, of genera exist. Such are the

Oëstocephalus and *Ceraterpeton* of Ohio as compared with the *Urocordylus* and *Ceraterpeton* of Great Britain.

The Permian vertebrate fauna which I discovered in Illinois and Texas, exhibits close parallels, but not yet generic identity, in the two continents. Thus, the American *Clepsydrops* and *Dimetrodon* are near to the *Deuterosaurus* of Perm in Russia, and the *Lycosaurus* of the mountains of South Africa. The Texan genus *Pariotichus* may, with further information, prove to be identical with *Procolophon* Ow. from the Tafelberg. Humeri of the type discovered by Kutorga in Russia, and by Owen in South Africa, are found in North America, and the same remarkable type has been recently discovered by Gaudry in France. The peculiar type of Labyrinthodont vertebræ described by me under the genus *Rhachitomus* from Texas has been discovered by Gaudry in France. The present indications are that close similarity between the faunæ of this period in Europe and America will be discovered. Nevertheless, up to the present time no representatives of the striking American forms *Diadectes*, *Bolosaurus*, *Empedocles*, and *Cricotus* have yet been found in any other continent.

As regards the Triassic fauna, it differs from that of the Permian in being better known in Europe than America. As marine Trias is little developed in North America, so the vertebrate fauna of the Muschelkalk has not been discovered in the latter country. It is otherwise with the Keuper. The characteristic genus of that epoch, *Belodon*, existed in America, and parallels, if not identity, exist in the genera *Thecodontosaurus* and *Palæosaurus*. These are known in America from teeth only. The reptiles are accompanied in North America, as in Europe, by Stegocephalous *Batrachia*, mostly Labyrinthodonts, but their generic affinities are yet unknown.

The great Jurassic faunæ are as yet but sparsely represented in North American palæontology. The marine *Vertebrata* of the Lias are either unknown or are represented by a few provisional identifications of unsatisfactory fragments. We do not yet know any deposits in North America which contain the typical reptilian genera *Plesiosaurus*, *Ichthyosaurus*, *Pliosaurus*, and *Dimorphodon*, or the fishes of the *Dapediidæ*. This formation, so important in Europe, is almost omitted from the North American series. A few more characteristic fossils of the Rocky Mountain region represent the Oölite, particularly the Upper Oölite, while *Teleosaurus* and *Steneosaurus*, and their allies, are not yet known from North American beds. Strata said to be included in the Dakota (which on the evidence of plants and invertebrate fossils has been placed at the bottom of the Cretaceous series) have produced a genus not yet distinguishable from *Megalosaurus*. This genus has not been identified beyond doubt from above the Oölite in England. From the same beds in the Rocky Mountain region come genera which nearly resemble the one from the English Oölite (Forest Marble) called by Phillips, *Cetiosaurus*, and the genus from the Oxfordian of Honfleur, called by von Meyer,

Streptospondylus. Beyond this no comparisons can be made, and we therefore pass to the rich fauna of the Kimmeridge. North America cannot show such records of this epoch as have been found in Europe. There are no *Archæopteryx*, *Rhamphorhynchus*, nor *Pterodactylus*; no *Leptolepis*, *Thrissops*, nor other of the numerous fishes of Solenhofen. The *Omosaurus* has, however, some very close relatives in the supposed Dakota beds of the Rocky Mountains. No remains of that primitive Marsupial fauna which occurs in the Purbeck have yet been detected in the Western Continent. A partial representation of the Wealden fauna of Europe is found in the beds of the Rocky Mountains mingled with the types of the Oölite and Kimmeridge already mentioned. The relationships of this fauna to those of the European Jurassic series may be thus exhibited:

American.	European.
CAMARASAURUS BEDS.	WEALDEN.
?	*Iguanodon.*
? Hypsilophodon.	*Hypsilophodon.*
	Hylæosaurus.
? Cetiosaurus.	*Cetiosaurus.*
Camarasaurus.	*Eucamerotus.**
	Ornithopsis.
Amphicœlias.	
? Goniopholis.	*Goniopholis.*
	KIMMERIDGE.
Hypsirhophus.	*Omosaurus.*
Caulodon.	*? Caulodon.†*
	OXFORD.
Epanterias.	*Streptospondylus.*
	OÖLITE
	"Cetiosaurus."
? Megalosaurus.	*Megalosaurus.*

From the above table it will be seen how difficult it is at the present to parallelize the related beds of the Jurassic periods of the two continents at the present time. All that can be said is that many types resembling‡ nearly those of different horizons of the European Jurassic are found to have lived together or near together in the Rocky Mountain region of North America.

That the Cretaceous fauna of North America was the richest in the cold-blooded *Vertebrata* is indicated by the present state of discovery. The ocean of the interior of the continent deepened from the beginning

* *Chondrosteosaurus* Owen.

† *Iguanodon præcursor* Sauv.

‡ A near affinity has been shown by Professor Owen to exist between *Eucamerotus* and *Camarasaurus*. Professor Owen believes these genera to be identical; but the neural spines of the anterior dorsal vertebræ are very different, being single in the former, and double in the latter.

of the period until the epoch of the Niobrara, and then gradually shallowed until the elevations of the bottom began to divide the waters. The closing scenes of this great period were enacted amid a labyrinth of lagoons and lakes of brackish and fresh water, whose deposits form the beds of the Laramie epoch.

The fauna of the deep-sea epoch, the Niobrara, is the best known. Here the remains of *Pythonomorpha* constitute its prevailing characteristic, while *Elasmosaurus* and *Polycotylus*, with but few species, represent the numerous *Sauropterygia* of Europe. Crocodiles were apparently wanting, while turtles and a peculiar group of *Pterosauria* were only moderately abundant. The fish fauna was very rich and varied. Here the *Saurodontidæ*, like the Molluscous family of the *Rudistes*, appeared, and as soon disappeared, accompanied by the peculiar form, *Erisichthe*, and the family of *Stratodontidæ*. The genera of Mount Lebanon, *Leptotrachelus* and *Spaniodon*, occur in this bed in Dakota; but the closest parallelism is exhibited with the Lower Chalk or Turonian of Western Europe. The general *facies* of the reptilian fauna is that of the Lower Chalk, and there is little doubt that several genera are identical in the two continents, e. g. *Elasmosaurus*. The apparent peculiarity of the Chalk in America is the abundance of forms (four genera) of *Pythonomorpha* with numerous species, while but two genera have yet been found in Europe, and the presence of birds, with *biconcave* vertebræ, and teeth. This interesting type, which was first discovered by Seeley in the genus named by him *Enaliornis*, and afterwards found by Marsh to possess teeth, has been found at a lower horizon in England, the Upper Greensand. But in England, France, and Westphalia occur the genera of fishes above mentioned, as *Portheus*, *Ichthyodectes*, *Saurodon*, *Saurocephalus*, *Erisichthe*, *Empo*, *Pachyrhizodus*, *Enchodus*, *Leptotrachelus*, etc. This close relationship of the horizons permits an identification, and it is the first instance which appears to me to be susceptible of satisfactory demonstration.

The next horizon of the Cretaceous which has yielded many vertebrate remains in North America is the Fox Hills formation (including the Fort Pierre bed). Here the genus *Mosasaurus* appears in America, and is accompanied by the earliest crocodiles with procœlous vertebræ, and by numerous marine turtles which partake of the characters of both *Chelydridæ* and *Cheloniidæ*, which I have called the *Propleuridæ*. *Beryx* appears first here in America. The predominant genus of fishes is *Enchodus*, and the principal *Dinosauria* are *Lælaps* and *Hadrosaurus*. This horizon has been parallelized with the Maestricht of Europe, and several genera are common to the two beds; such are *Mosasaurus* and *Enchodus*. The genus *Hadrosaurus*, and the family of turtles I have called the *Adocidæ*, remain undiscovered in Europe; hence the identity of faunæ cannot be established.

The lacustrine beds, or summit of the American Cretaceous series, the Laramie of Hayden, present the remains of a populous fauna and a rich

flora. The students of the palæobotany have declared this flora to be of Eocene, and the later portions of Miocene character, while the lacustrine constitution of the strata has influenced the stratigraphic geologists to concur in the view that the formation should be arranged with the Tertiary epochs. That the fauna was of a mixed character is the result of a study of its vertebrate fossils. The predominant type in North America was the *Dinosauria*, which were abundant in species and individuals, and this fact alone will suffice most palæontologists as a reason for referring the epoch to the Cretaceous series. The genera of *Dinosauria* (*Palæoscincus*, *Cionodon*, *Diclonius*, *Monoclonius*, *Dysganus*, etc.) have not yet been found in any other part of the world. Mingled with them were species of crocodiles and turtles of indifferent character, while a number of other forms existed which had a limited range in time, and hence are important indicators of stratigraphic position. Such are the genera of fishes, *Myledaphus* Cope and *Clastes* Cope, which have been found also near Reims, France, by Dr. Lemoine, in the Sables de Bracheux, which are regarded as the lowest Tertiary. Such is the curious Saurian type *Champsosaurus* (Cope) (*Simædosaurus* Gerv.), and the turtle genus *Compsemys* Leidy, which Lemoine finds a little higher up in the series, in the Conglomerate of Cerny, which is in the lower part of the Suessonian. In France, a genus of the Laramie, *Polythorax*, extends into the Lignite or upper *Coryphodon* bed of the Suessonian. Thus the Laramie is intercalated by its characters between the Cretaceous period on the one hand and the Tertiary on the other, and its fauna includes genera and orders of both great series. These relations may be exhibited in tabular form as follows. I here include the faunæ of the Sables de Bracheux and of the Conglomerate of Cerny as one, since both possess the types of the Laramie, while the horizon of the Lignite of Meudon, or the Suessonian, does not.

Sables de Bracheux and Conglomerate de Cerny.	Laramie.
a. Tertiary.	
Lophiochœrus.	
Plesiodapis.	
Pleuraspidotherium.	
Arctocyon.	
Clastes.	*Clastes.*
β. Peculiar.	
Champsosaurus.	*Champsosaurus.*
Compsemys.	*Compsemys.*
Myledaphus.	*Myledaphus.*
	Scapherpeton.

SABLES DE BRACHEUX AND CONGLOMERATE DE CERNY.	LARAMIE.

γ. CRETACEOUS.

Palæoscincus.
Dysganus.
Monoclonius.
Diclonius.
Cionodon.
Lælaps.
Aublysodon.

If the Conglomerate of Cerny is the same horizon as the Conglomerate of Meudon, we must add *Coryphodon* to the upper left-hand column, and probably *Gastornis* also. The result is clear that the French and American formations together bridge most completely the interval between the Cretaceous and Tertiary series, as has been anticipated by Hayden, in America, on geological grounds. It is also evident that another formation must be added to the series already recognized in France, viz, the Laramie or Post-Cretaceous. This will be defined as the beds of the genera *Champsosaurus* and *Myledaphus*. In France, the presence of mammalia will characterize the formation as a subdivision, for which it is probable that the name Thanetian must be retained; while to the American division, which is characterized by the presence of *Dinosauria*, the name of Laramie beds has been given.

The Eocene fauna is so varied, especially in Europe, that it is necessary to compare the divisions separately, as in the case of the Cretaceous. Thus, the fauna of the Suessonian is quite as distinct from that of the Calcaire Grossier and Gypse (Parisian and Tongrian) in France as are those of the Wasatch and Bridger epochs in North America.

I have already identified the Wasatch with the Suessonian or Orthrocene, on account of the community of the following genera in the two continents: *Coryphodon*, *Hyracotherium*, *Amblyctonus*, *Clastes*, and a form of birds close to *Gastornis*. I can now add *Phenacodus*, *Orotherium* (Cope), and very probably *Hyopsodus*, *Adapis*, *Opisthotomus*, and *Prototomus*. But, as above mentioned, in the lower beds of the Suessonian in France occur genera which are, so far as yet known, wanting in the Wasatch of America, but present in the beds of the Laramie. Such are two genera in the Conglomerate of Cerny, and four genera in the lower Sables de Bracheux. In the former bed, they are associated with the mammalian genera *Lophiochærus*, *Plesiodapis*, *Pleuraspidotherium*, and *Arctocyon;* and in the lowest, with a form referred with doubt to *Hyracotherium*. Thus the generalization may be made that the characteristic genera of reptiles and fishes of the Laramie of North America are in America associated with Cretaceous *Dinosauria*, and not with *Mammalia;* while in Europe they are associated with *Mammalia*, and not with *Dinosauria*. In arranging the Laramie Group, its necessary position is

between Tertiary and Cretaceous, but on the Cretaceous side of the boundary, if we retain those grand divisions, which it appears to me to be desirable to do. The reasons for retaining it in the Cretaceous are two, viz: (1) because *Dinosauria* are a Mesozoic type, not known elsewhere from the Tertiary; (2) because *Mammalia* (should they be found in the future in the Fort Union) are not equal as evidence of Tertiary age, since they have been also found in Jurassic and Triassic beds. The parallelism of the American Wasatch with the Upper Suessonian of France is the second identification which may be regarded as provisionally established. The only discordant elements at present known are the *Tæniodonta* of the Wasatch, which have not been so far found in Europe, and the genus *Lophiodon*, which is unknown in America.

Above the Suessonian, a divergence in the characters of the European and North American faunæ commences, and continues to be marked throughout the remainder of Tertiary time. So far as the *Mammalia* are concerned, the diversity between the continents was greater during the periods of the Upper Eocene and Miocene than at the present era. During these periods, a limited number of genera, common to the two continents, was associated with numerous genera in the one which did not exist in the other. As a consequence, our palæontological means of identification of the horizons are limited to a restricted list, and the task of applying a uniform nomenclature is, under the circumstances, difficult. Another difficulty in the way of determining the place of the American beds in the European scale consists in the fact that the physical history of the two continents during the Tertiary period appears to have been different. In America, the changes of level appear to have been more uniform in character over large areas. Each deposit has a wider geographical extent, and the fauna presents less irregular variation. In Europe we have a great number of comparatively restricted deposits, each of which differs from the others in possessing more or less peculiarity of fauna. After a study of these faunæ, their natural arrangement in Europe into three series, Eocene, Miocene, and Pliocene, does not appear to rest on any solid basis. This is especially true of the distinction between the first two; and authors are at variance as to the point of demarkation between the last two. Thus, the Tongrian is the summit of the Eocene according to Renevier, while Gaudry, with Filhol and others, places it at the base of the Miocene. One opinion is as well supported by facts, as now interpreted, as the other.

Let us now consider the nature of the evidence on which we should rely in classifying faunæ and the deposits which contain them. We are accustomed, at present, to rely for our definitions upon all the faunal peculiarities upon which we can seize: the period of appearance of certain types; the duration of certain types; and the disappearance of certain types, depending on orders, families, and genera for the major divisions, and species at a given locality for the lesser. It is, of course, evident

that either of the above-mentioned three criteria are variable quantities, since discovery is constantly extending our knowledge of the distribution of types. Hence the definitions are empirical and temporary. We must then, if we desire a stable system, examine the principles involved, and endeavor to discover definitions which stand on stronger foundations than those which we now possess.

As a matter of fact, the old definitions of epochs and periods are continually invalidated by new discoveries. As a matter of theory, this should be the case.

To the believers in the doctrine of derivation, the obliteration of faunal distinctions is not a cause of surprise. Such await with confidence the day when complete phylogenies will be possible, and at present regard the interruptions in the succession of life as local only. Will the result then be, that palæontology will cease to be available in the definition of ages and of deposits? I answer no, on various grounds. Interruptions in the succession of life in any given locality due to various causes have doubtless often occurred, and have left traces in the crust of the earth which are ineffaceable by discovery. But apart from this, one fact in this history is patent both to the friends and to the opponents of the doctrine of derivation. It is known that the world has witnessed, at every stage of its history, the extinction of some important type of life. Familiar examples are the *Placodermi* of palæozoic time, the various reptilian groups of Mesozoic time, and the *Amblypoda* of the Tertiary. Each minor subdivision of time offers its own record of persistences and extinctions of particular families and genera.

Now, all departments of biology compel us to recognize the law of classification, that the order of forms is from the less to the more generalized, from the simple to the more complex, and *vice versa*, whether the lines of succession be those of descent or of creative order; and this law is true in time as well as in classification. It follows from this, that all types of life are, at the time of their appearance, less distinct and more general in their characters than they are later in their history.

It also follows, as a consequence of the principle of descent, which states that the types of one age have taken their origin from generalized types of preceding ages, that there is no descent from the most specialized types; which is to say, conversely, that the genera, families, and orders whose extinction has been a marked feature of every geologic age have been the specialized types of those ages.

We now have a clue to a basis of a definition for faunæ, and hence for epochs, which discovery can safely build upon. The successive increments of structure by which an important modification of animal type is introduced preclude the possibility of exact determination of the time at which such type may be said to have *appeared*. Even where such a point may be arbitrarily fixed, the type must then be less char-

acteristically represented than it is at the other limit of its existence, viz, the period of its disappearance.

For these reasons I must regard the latter criterion as the true one in the discrimination of the subdivisions of geologic time, while the point of the appearance of types must be looked upon as of provisional use only, and this quite independently of the changes which discovery will from time to time compel us to make in our knowledge of the distribution of life in time and space. It must, however, be borne in mind that disappearance may be due to two causes: first, to extinction; and, secondly, to modification; a distinction which is entirely essential. The case of disappearance by modification is identical with that of appearance by modification, and cannot be used otherwise in classification. It is then the period of extinction of types to which I have reference.

With these principles in view, we continue the comparison of the extinct faunæ of Europe and North America. If we take a general view of the Tertiary faunæ, we find that the following well marked types representing families and higher groups have become extinct, and have left no living descendants or successors: Among *Insectivora*, the *Leptictidæ* in North America; also the American Bunotherian groups *Tæniodonta* and *Tillodonta;* also the *Mesodonta* of both continents; of *Edentata*, *Macrotherium* and *Ancylotherium* in Europe, and the *Megatheriidæ* in North America; among the *Carnivora*, the *Hyænodons* and *Proviverræ*, with the *Machærodi;* of *Ungulata*, the entire order of *Amblypoda*, which, however, doubtless disappeared in some of its members by modification; but its only known suborders, the *Pantodonta* and the *Dinocerata*, became absolutely extinct. Among *Perissodactyla*, both continents lost by extinction the *Chalicotheriidæ*, which terminated in a great development in North America; the genera *Hippotherium** and *Stylonus* of the line of the horses, and the *Rhinoceridæ*. Of *Artiodactyla*, two great divisions, representative of each other in the two continents, totally disappeared, viz, the *Oreodontidæ* and the *Anoplotheriidæ;* to which must be added the *Hyopotamidæ*. Of true ruminants, the most important type which has disappeared from both continents is that of the *Camelidæ*. Of Suilline genera, *Anthracotherium* and *Elotherium* may be looked upon as having left no persistent successors. Last of all, the *Proboscidea* retreated to the continents of the south.

In view of the complexity of the European record, I first present the relations of the above mentioned phenomena as displayed in the simpler American system. As the present essay commences with the earliest periods, I exhibit the succession in descending order on the page. The horizons of the Tertiary which present distinct terrestrial faunæ in North America have been named the Wasatch, the Bridger, the Uinta, the White River, the Loup Fork, the *Equus* beds, and the Champlain.

* *Equus* came through *Protohippus*, the cotemporary of *Hippotherium*.

The types which became extinct* with the close of each of these epochs are the following:

WASATCH.
- *Gastornithidæ*
- *Pantodonta.*

BRIDGER.
- *Baënidæ.*
- *Tillodonta.*
- *Mesodonta.*
- *Proviverra.*
- *Dinocerata.*

WHITE RIVER.
- *Leptictidæ.*
- *Hyænodon.*
- *Chalicotheriidæ.*
- *Hyopotamidæ.*

LOUP FORK.
- *Rhinoceridæ.*
- *Hippotherium.*
- *Stylonus.*
- *Oreodontidæ.*

EQUUS BEDS.
- *Megatheriidæ.*
- *Machærodus.*
- *Tapiridæ.*
- *Elephas.*
- *Camelidæ.*

The above table exhibits the present state of our knowledge: it will doubtless be much extended by future discovery, but not otherwise modified.

The numerous able writers on European vertebrate palæontology have more frequently recorded the appearance of types in defining their faunal divisions than their disappearance. The following table is compiled from the writings of Gervais, Gaudry, Pomel, Filhol, Renevier, and others, but is not as complete as I would desire.

SUESSONIAN.
- *Pantodonta.*

PARISIAN (Bruxellian, Bartonian, and Sestian).
- *Palæophis* (Bruxellian).
- *Proviverra.*
- *Pterodon.*
- *Mesodonta.*
- *Lophiodon* (Bruxellian).

TONGRIAN.
- *Palæotheriidæ.*
- *Chalicotherium.*
- *Anoplotheridæ.*
- *Elotherium.*

AQUITANIAN.
- *Hyænodon.*
- *Hyopotamus.*

FALUNIAN.
- *Anchitherium.*
- *Anthracotherium.*
- *Palæochœrus.*
- *Cœnotherium.*

OENINGIAN.
- *Ancylotherium.*
- *Dinotherium.*
- *Hippotherium.*
- *Aceratherium.*

SUBAPENNINE.
- *Mastodon.*
- *Tapiridæ.*

DILUVIAL.
- *Hyæna.*
- *Machærodus.*
- *Elephas.*
- *Rhinocerus.*
- *Hippopotamus.*

*This means, as already mentioned, the forms which left no direct successors in the Nearctic and Palæarctic Faunæ.

The above tables show that the history of mammalian life in the two continents presents many points of resemblance; but that there is a great difficulty in correlating the epochs represented by the known faunæ. As regards the two primary divisions, Eocene and Miocene, they have no special *raison d'être*, as such faunæ as the Tongrian and Oeningian are absolutely transitional in their character. More detailed comparisons of the European and American faunæ bring out many relationships not displayed by the above tables, and which I will now briefly consider.

In the American Bridger, various genera of *Mesodonta* represent the few *Adapidæ* of the Parisian, the genus *Adapis** Cuv. being probably common to the two continents. The American *Anaptomorphus*, a true Lemur, has been found by M. Filhol in the Phosphorites, and named *Necrolemur*. The characters of the numerous *Carnivora* of the Bridger are as yet unknown. The *Stypolophus* of the Bridger is perhaps the *Prototomus* of the Wasatch, and this again has been discovered by M. Filhol† in France; while a very similar, if not the same, genus has been discovered in the Swiss Siderolitic, and named *Proviverra*. *Hyænodontidæ* probably occur in the Bridger. Nowhere in Europe do we find the *Dinocerata* and *Tillodonta* of the Bridger. *Palæosyops* is also unknown in Europe, but it plays the part in America of the *Palæotherium*, from which it does not greatly differ in structure. The latter genus is most largely developed in the Parisian, but is also characteristic of the Tongrian. *Hyrachyus* is the American *Lophiodon*, the difference between them being but slight: both are found in France; the former in the Lower Parisian, the latter in the Phosphorites. *Tapirulus*‡ Gerv. is a genus common to the Bridger and to more than one horizon of the Parisian. The squirrel-like rodents of the Bridger are like those of the Parisian, but they are not confined to either epoch. The character which distinguishes the Parisian most widely from the Bridger, besides the absence of the *Dinocerata* and *Tillodonta*, is the presence of numerous Selenodont *Artiodactyla*, as *Xiphodon*, *Cœnotherium*, *Amphimeryx*, *Anoplotherium*, etc. These are of primitive type, it is true; the *Anoplotheriidæ* especially having probably four toes in the very short manus (*Eurytherium*), including the pollex, and three behind. They also display the character of a fifth crescent of the superior molars, which is wanting in the higher Selenodont types. But even these genera are absent from the Bridger. The *ensemble* is then, that the latter displays relationships backwards, or to the Suessonian, while the Parisian has a later *facies*, constituting an approach to the Tongrian and White River.§

The following table presents the relations of the Bridger fauna succinctly, but it is much less complete than we hope to make it when its

* *Notharctus* is undistinguishable from *Adapis* in inferior dental characters.

† It is described as *Cynohyænodon* with two species.

‡ Gervais, 1850; *Helaletes* Marsh, 1872.

§ See Ann. Rept. U. S. Geol. Surv. Terrs. 1873, pp. 461–2, where this view is proposed.

numerous species now represented by catalogues of names are fully described. The Parisian is here regarded as including the divisions Bruxellian, Bartonian, and Sestian (Gypse).

PARISIAN.	BRIDGER.
Didelphys.	*?Didelphys.*
Vespertilionidæ.	*Vespertilionidæ*
Plesiarctomys.	*Plesiarctomys.*
	Tillodonta.
Hyænodontidæ.	*Hyænodontidæ.*
Adapis.	*Adapis.*
Anaptomorphus (Phosph.).	*Anaptomorphus.*
	Dinocerata.
	Palæosyops.
Palæotherium.	
Lophiodon.	
Hyrachyus (Phosph.).	*Hyrachyus.*
Tapirulus.	*Tapirulus.*
Anthracotherium.	*Achænodon.*
Chœropotamus.	
Dichobune.	
Anoplotherium.	
Xiphodon.	
Amphimeryx.	

The rich Tongrian (Stampian) fauna is, according to authors, represented in the Sables de Fontainebleau, Puy en Velay, Ronzon, Hempstead, and Cadibona in Italy. We find here *Didelphys* in abundance, *Hyænodon*, *Amphicyon*, *Cynodon*, *Palæotherium*, *Paloplotherium*, *Chalicotherium*, and *Aceratherium*. Of *Artiodactyla*, the Suillines are *Anthracotherium* and *Elotherium;* the Selenodonts, *Hyopotamus* and *Gelocus*. This list is the nearest known counterpart of that of the fauna of the White River epoch of North America. To reproduce the latter, we must omit from the above catalogue the genera of *Palæotheriidæ*, and replace them by the allied Chalicotheroid *Menodus* and *Symborodon*, subtract *Anthracotherium*, and add the great body of the *Oreodontidæ*. Then there are included in the White River fauna the higher Selenodont Artiodactyles of the *Poëbrotheriidæ* and *Hypertragulidæ*, the corresponding types of which belong to the fauna of St. Gerand le Puy in France, or the Aquitanian epoch, which directly succeeded the Stampian. In Europe we have here *Dremotherium*, *Amphitragulus*, *Lophiomeryx*, *Dorcatherium;* in America, *Leptomeryx*, *Hypertragulus*, *Hypisodus*, and *Poëbrotherium*. It is curious that while *Leptomeryx* is also European,* it has not yet been found above the Phosphorites. Among Suillines, the *Palæochœrus*† of the Oregon White River beds has also not been found

* I think M. Filhol's *Prodremotherium* is identical with *Leptomeryx*.

† *Thinohyus* Marsh appears to be the same.

below the Aquitanian in Europe. But the American *Didelphys*,* *Hyænodon*, *Amphicyon*, *Elotherium*, and *Hyopotamus*, with the numerous Chalicotheroid species, show clearly that the White River fauna may be looked upon as a mixture of those of the Stampian and Aquitanian, the former of which is sometimes referred with reason to the Upper Eocene, while the latter is always left in the lowest Miocene. And the solution of this question of position as regards the White River beds appears to me to be at present by no means easy.† According to the system of Naumann, it should be called Oligocene.

Although Artiodactyles with Selenodont molars are far more abundant in both continents during this period than the last, a remarkable difference is to be observed between them. Those of Europe still largely consist of the types with five crescents, as represented by the numerous *Hyopotami* and *Cænotheria*, while in America the modern four-crescent-bearing molar characterizes almost the entire suborder, the only exception being two species of *Hyopotamus*.

The following table will represent the relations of the White River fauna:

Stampian and Aquitanian.	White River.
Didelphys.	*Didelphys.*
	Leptictidæ.
Protomyidæ.	*Protomyidæ.*‡
	Saccomyidæ.§
Steneofiber.	*Steneofiber.*
Leporidæ.	*Leporidæ.*
Hyænodon.	*Hyænodon.*
Amphicyon.	*Amphicyon.*
Canis.	*Canis.*
	Temnocyon.
	Enhydrocyon.
Gulo.‖	*Gulo.*‖
	Dinictis.
Machærodus.	*Machærodus.*
	Chalicotheriidæ.
Palæotheriidæ.	
	Hyracodon.
	Aceratherium.
	Anchitherium.
Elotherium.	*Elotherium.*
Palæochœrus.	*Palæochœrus.*

* *Herpetotherium* Cope; *Peratherium* Aym.

† See Ann. Report U. S. Geol. Surv. Terrs. 1873, p. 462, where the White River beds are determined as Lower Miocene.

‡ *Ischyromys* Leidy.

§ *Entoptychus* and *Pleurolicus* Cope.

‖ *Amphictis* Pom.

Stampian and Aquitanian.	White River.
Anthracotherium.	
	Oreodontidæ.
Anoplotheriidæ.	
Hyopotamidæ.	*Merycopater.*
	Poëbrotherium.
Lophiomeryx.	*Hypertragulus.*
Amphitragulus.	
Leptomeryx (Phosph.).	*Leptomeryx.*
Dremotherium.	
	Hypisodus.

The Falunian epoch includes in the large sense the Langhian, Helvetian, and Tortonian divisions, embracing the rich deposits of the Orléanais, of Simorre, and of Sansan. We have here the true Miocene fauna, of which the following genera are characteristic: Edentata, *Macrotherium;* Proboscidea, *Dinotherium*, *Mastodon;* Perissodactyla, *Anchitherium*, *Listriodon;* Artiodactyla, *Palæomeryx*, *Dicrocerus*, *Procervulus;** Carnivora, *Amphicyon*, *Hyænarctos*, *? Machærodus;* Quadrumana, *Pliopithecus.* The ancient genera *Anthracotherium* and *Cænotherium* continue throughout, and the existing genera *Arvicola*, *Lutra*, and *Sus* appear. The succeeding epoch, the Oeningian, including with it the horizons of Epplesheim and Pikermi, presents the additional genera *Dorcatherium*, *Helladotherium*, several genera allied to *Antilope*, with *Hippotherium*, the huge edentate *Ancylotherium*, and the monkey *Mesopithecus.*

It is from these materials that we must determine by comparison the American Loup Fork epoch, whose deposits are widely spread, and whose fauna is of well-marked character. Although called by my predecessors Pliocene in age, I have insisted that it should be referred to the Miocene series, and I think that the evidence to that effect, which I have produced, will be found conclusive. Nevertheless, here, as in other American Tertiary horizons, the element of geographical peculiarity enters, and diminishes the number of identical types.

Falunian.	Loup Fork.
Steneofiber.	*Steneofiber.*
Macrotherium. }	*Morotherium.*
Ancylotherium. }	
Amphicyon.	*Amphicyon.*†
Dinotherium.	*Cænobasileus.*
Tetralophodon.	*Tetralophodon.*
Aceratherium.	*Aphelops.*
Anchitherium.	
Listriodon.	

* Gaudry, 1878; *Dicrocerus* Cope, 1874 (not Lartet); *Merycodus* et *Cosoryx* Leidy, nomina nuda.

† *Canis ursinus* Cope.

FALUNIAN.	LOUP FORK.
Hippotherium (Oeningian).	*Hippotherium.*
	Protohippus.
	*Hippidium.**
Cœnotherium.	*Oreodontidæ.*
Anthracotherium.	
Palæomeryx.	*Blastomeryx.*
Dicrocerus.	
Procervulus.	*Procervulus.*
	Protolabis.
	Procamelus.

The existing genera mentioned as found in the Falunian fauna are paralleled by the *Dicotyles*, *Hystrix*, and *Mustela* of the Loup Fork beds. It is evident that this latter horizon retains in its *Oreodontidæ* the same traces of antiquity that the Falunian does in its *Cœnotherium*, but shows a more modern aspect in the omission of *Anchitherium* and its replacement by *Hippotherium* and *Protohippus*, and in the still more modern type *Hippidium*. Although but six genera of the two continents are determined as identical in the above table, yet others, which are facing on the same line, are very nearly allied. Other differences are geographical. The *facies* of the Loup Fork horizon is then a compound of that of the Falunian and Oeningian, or Middle and Upper Miocene.

In commenting on the above-described fauna in 1874,† I remarked that "the proper discrimination of American Pliocene remains to be accomplished." It was not long after that date that material for making the identification of this horizon on this continent first came into my hands. This was derived from the superior Tertiary of Oregon, and includes a considerable number of species of fishes, birds, and *Mammalia*. I published a list of some of the species in 1878.‡ The character of the fauna from that region coincides with that which has from time to time been unearthed in the caves and other Eastern deposits to such an extent as to lead us to suspect that the differences between them are geographical only. In Europe, the Pliocene, or Subapennine, includes, according to D'Orbigny (1855) and Gaudry (1878), the Plaisancian and Astian, which are represented at the following localities:

SUBAPENNINE.

Plaisancian.—Montpellier; Casino (Tuscany).

Astian.—Perrier, near Issoir, Coupet, Vialette (Upper Loire), Chagny; English Crag; part of deposits of the Val d'Arno.

The characteristic of this fauna is the fact that the species belong mostly to existing genera, the chief exception being *Hippotherium*. The horses are chiefly represented by *Equus*. Common genera are *Arctomys*,

* *Pliohippus* Marsh.

† Report Lieut. G. M. Wheeler, IV, Palæontology of New Mexico, 1874, p. 364.

‡ Bull. Hayden's U. S. Geol. Surv. Terrs. iv, 1878, p. 389.

Lepus, *Elephas*, *Mastodon*, *Tapirus*, *Sus*, *Cervus*, *Antilope*, *Bos*, *Canis*, *Machærodus*, *Felis*, *Ursus*. In the *Equus* beds of Oregon, a few extinct genera in like manner share the field with various recent ones, while not a few of the bones are not distinguishable from those of recent species. I give the following list, the extinct species being in italics:

Mylodon sodalis.	Canis latrans.	*Auchenia magna.*
Thomomys (nr.) clusius.	*Elephas primigenius.*	*Auchenia vitakeriana.*
Thomomys talpoides.	*Equus occidentalis.*	*Cervus fortis.*
Castor fiber.	*Equus major.*	
Lutra near *piscinaria.*	*Auchenia hesterna.*	

The species derived from the cave formations of the Eastern States are more numerous, and differ from the Oregon fauna in many respects; yet the parallelism is close in the genera with the *Equus* beds on the one hand and the Pliocene of Europe and South America on the other. The differences distinguishing it from the *Equus* beds of Oregon are, however, such as compel me to regard it as a distinct division of the Pliocene, under the name of the *Megalonyx* beds.

Megatherium (p).	*Castoroides.*	*Machærodus* (sp).
Mylodon (p).	Lagomys (s).	*Mastodon* (sp).
Megalonyx (p).	Lepus (s).	Equus (sp).
Sciurus (s).	*Anomodon.*	*? Hippotherium* (s).
Arctomys (s).	Scalops.	Tapirus (s).
Jaculus.	*Arctotherium* (p).	Dicotyles (p).
Arvicola (s).	Procyon.	Cariacus (p).
Erethizon.	Canis (sp).	Bos (s).
Hydrochœrus (p).	Mustela (sp).	

In the above list, the extinct genera are marked in italics. There exists, as a marked feature of the North American Pliocene, to which I called attention several years ago,* a considerable representation of the fauna of the Pampean formation of South America: such are twelve genera, of which six are extinct genera, and four are peculiar to that formation and fauna. The genera found in the Pampean are marked (*p*), and those of the Subapennine (*s*). In the list from the Oregon localities, *Mylodon* and *Auchenia* were observed to be the only distinctively Pampean genera. As a conclusion of the comparison of the American *Equus* beds in general with those of Europe, it may be stated that the number of identical genera is so large that we may not hesitate to parallelize them as stratigraphically the same. On the other hand, the agreement with the South American Pampean formation is so marked in some respects as to induce us to believe that the distinction is geographic rather than stratigraphic. Believing that the Pampean formation contains too large a percentage of extinct genera to be properly regarded, as it has been, as Postpliocene or Quaternary, its characters, both essentially and as a result of the comparison which I have been able to make, refer it properly to the Pliocene.

* Proc. Acad. Phila. 1857, 156; Proc. Am. Philos. Soc. 1869, 178.

It appears, then, that the term Pliocene or Subapennine is applicable to the horizon of this fauna in Europe and North and South America.

RÉSUMÉ OF COMPARISONS.

The conclusions to be derived from the facts enumerated in the preceding pages are as follows:

I. Portions of all the faunæ of all the primary divisions of geologic time have been recognized on both the European and North American continents.

II. Parallels requiring general identification of principal divisions of these faunæ may be detected. These are: the Coal-Measures; the Permian; the Laramie; the Maestrichtian; the Eocene; the Miocene.

III. Exact identifications of restricted divisions may be made in a few instances only; such are the Turonian and the Niobrara; the Suessonian and the Wasatch; the *Equus beds* and the Pliocene.

It is not impossible that some of the relations mentioned in II will be by the accession of further information, referrible to the list of exact comparisons in III. In all cases of identification it will be necessary to employ the name first proposed with definition, for the horizon, other names taking places as synonymes. But in the majority of strata it will be necessary to preserve the local names: thus those of Judith River, Bridger, White River, and Loup Fork, applying to beds having no exact equivalents in Europe, cannot be set aside for older ones, but must themselves be applied to corresponding faunal horizons elsewhere, should any such be found in future. And it will rarely happen that the minor subdivisions of such faunæ will be found to have an extent sufficient to warrant their having other than local names.

In the accompanying diagram the series of strata of Europe and North America, as determined by their palæontology, are placed side by side for the purpose of comparison. Complete parallelism can only be predicated of divisions of the first order separated by horizontal lines. Such relation is indicated by exact opposition of the areas representing the epochs in question. In giving the minor divisions of the European epochs I have generally restricted myself to those of the epochs which have American equivalents. Where there is no equivalent on one side or the other, the vacancy is represented by a diagonal line. In employing names for epochs and their divisions, I have adhered to the law of priority as far as my knowledge of the literature allows.* I have given a few names to American formations, but only in instances where such had not been previously given. In such cases I have preferred employing the name of some characteristic genus of fossils, rather than one of local origin.

* In the European system I have been much aided by the atlas of Prof. Renevier of Lausanne, and by the writings of Woodward, Gervais, Hébert, Pomel, Gaudry, Filhol, etc.

WEST EUROPE.			NORTH AMERICA.	
Astian.	Pliocene.	Tertiary.	Pliocene.	Equus beds.
Plaisancian.				Megalonyx beds.
Oeningian.	Oeningian.		Loup Fork.	Procamelus beds.
Tortonian.	Falunian.			Ticholeptus beds.
Langhian.				
Aquitanian.	Aquitanian.		White River.	Oregon beds.
Stampian.	Tongrian.			White River.
Sestian.	Parisian.		Uinta.	Uinta.
Bartonian.			Bridger.	Bridger.
Bruxellian.				
Suessonian.	Suessonian.		Wasatch.	Green River.
				Wasatch.
Thanetian.	Thanetian.	Post-cretaceous.	? Puerco.	Puerco.
			Laramie.	Fort Union.
				Judith River.
Maestrichtian.	Senonian.	Cretaceous.	Fox Hills.	Fox Hills.
Campanian.				Fort Pierre.
Santonian.				
Turonian.	Cenomanian.		Colorado.	Niobrara.
Carentonian.				Fort Benton.
Rhotomagian.			Dakota.	Dakota.
Vraconian.	Gault.			
Albian.				
Aptian.	Urgaptian.			
Rhodanian.				
Urgonian.				
Hauterivian.	Wealden.	Jurassic.	Camarasaurus beds.	
Valangian.				
Purbeckian.	Portland.			
Portlandian.				
Kimmeridgian.				
	Corallian.			
	Oxfordian.			
	Bathian.			
	Upper Lias.			
	Lower Lias.			

WEST EUROPE—Continued.			NORTH AMERICA—Continued.	
	Rhaetic.	Trias.		
Karnian.	Keuper.		Keuper.	
Norian.				
	Muschelkalk.			
Thuringian.	Permian.	Carboniferous.	Permian.	Clepsydrops shales.
Lodevian.				Eryops beds.
Coal-Measures.	Coal period.		Coal period.	Coal-Measures.
Conglomerate.				Conglomerate.
Mountain limestone.				Mountain limestone.
Fammenian.	Upper Devonian.		Upper Devonian.	Catskill.
				Chemung.
Eifelian.	Middle Devonian.			Hamilton.
Coblenzian.	Lower Devonian.		Lower Devonian.	Corniferous.
				Oriskany.
Ledburian.	Upper Silurian.	Silurian.	Upper Silurian.	Lower Helderberg.
Ludlovian.				Salina.
Wenlockian.				Niagara.
Llandoverian.	Lower Silurian.		Lower Silurian.	Hudson.
Caradocian.				
Llandeilian.				Trenton.
Tremadocian.				
	Primordial.		Primordial.	Calciferous.
				Potsdam.
		Archæan.		

The oldest of these I have called the *Eryops* beds, from the most abundant genus of Labyrinthodonts which is found in it. They contain, also, abundance of other *Vertebrata*, none of which are higher than *Reptilia* (order *Theromorpha*), with plants, mollusks, etc. They consist of sandstones, alternating with beds of red clay and coarse conglomerate and sphærosiderite, etc. They are chiefly distributed in Northern Texas and Southern Indian Territory.

The *Clepsydrops* shale, named by me in 1865, forms a thin stratum, in Southeast Illinois and Southwest Indiana, consisting of black and rarely reddish carbonaceous shales and clays. These appear in some places to lie conformably on the Coal-Measures, to which they have been referred by previous geologists, but Collett, Gibson, and others have shown that it is unconformable over considerable areas. It does not belong to the Coal-Measures.

The Puerco marls were first observed by me in New Mexico in 1874, and afterwards found to have an extensive development in Southwestern Colorado, by Endlich, in 1875. He has referred them to the lowest place in the Tertiary series, but the absence of fossils renders it difficult to conclude whether they belong here or in the Laramie series.

The Oregon White River beds differ from those found east of the Rocky Mountains, although they contain a majority of the same genera, and many of the same species. They are wanting in the important genera *Symborodon* and *Menodus*. To represent these genera, they have *Dæodon*, and, in addition, some peculiar genera of *Rodentia*, as *Entoptychus*, *Pleurolicus*, and *Meniscomys*, and the Suilline *Palæochœrus*. Among Carnivora, the genus *Enhydrocyon* is, so far as known, characteristic of them.

The Loup Fork beds are represented in the valley of Smith's River, Montana, by a horizon which may be somewhat older than that heretofore known. The fauna presents us with the typical genera *Procamelus*, *Hippotherium*, *Protohippus*, *Mastodon*, and *Merycochœrus*, but, in addition, with the peculiar genera of *Oreodontidæ*, *Ticholeptus*, *Cyclopidius*, and *Pithecistes*,* and with Ruminants similar to *Palæomeryx*. These are wanting from the other parts of the formation, and I therefore name the two divisions the *Ticholeptus* and the *Procamelus* beds.

I have already mentioned the *Megalonyx* beds as the equivalents in the east of North America of the *Equus* beds of Oregon and California, but which present such important differences that they cannot be identified. The differences are displayed in the catalogues already given, the list of the *Megalonyx* fauna having been derived from the exploration of caves in Pennsylvania†, Virginia, and Illinois. The remains of this fauna are by no means found in caves only, but are found in swamps and Pliocene clays. The extinct genera characteristic of the *Megalonyx* beds are *Megatherium*, *Megalonyx*, *Castoroides*, and *Arctotherium;* the genera no longer living in North America, *Hydrochœrus*, *Tapirus*.

* Proc. Am. Philos. Soc. 1877, p. 219.

† Loc. cit. 1871, p. 73.

In conclusion, it may be observed that the lacunæ in the series as presented by one continent render us dependent on the other for the evidence necessary for the complete elucidation of the laws of the creation of animal life. Phylogenies can be thus constructed which would otherwise be impossible, and the results of researches into the earliest types of *Vertebrata* become intelligible. Thus I have been able to prove, in support of a thesis published in 1874, that the earliest Ungulate *Mammalia* were pentadactyle and plantigrade. I have also shown that the ankle-joint had not, in the primitive *Mammalia*, the hinge-like character that it has in the later ones, but that it is without the interlocking superior articulation. The small size of the brain of early *Mammalia*, already pointed out by Lartet, has received extensive confirmation by the researches of Marsh, who has also shown the progressive increase in size of the whole body in various Mammalian lines. To these results I now add another, which is derived from the study of numerous Permian *Vertebrata*, viz, that the earliest land vertebrates had a persistent chorda dorsalis.

COMPARISON WITH THE SCALE DERIVED FROM PALÆOBOTANY.

I now consider another kind of relation presented by the American and European horizons. I allude to the floræ, for my knowledge of which I am necessarily dependent on the labors of others. I first exhibit the determinations of the ages of the American formations already discussed, made by Mr. Lesquereux on the basis of the vegetable remains which they contain. I place by the side of these my own determinations of the ages of the same beds, as already related. The former are derived from the full memoir of Mr. Lesquereux in the Annual Report of the United States Geological Survey of the Territories for 1872, pp. 410–417. It will be observed that there is a constant discrepancy between the two tables.

Lesquereux.	Formation.	Cope.
.....	Loup Fork	Miocene.
.....	White River	Oligocene.
Upper Miocene	Bridger	Middle Eocene.
Miocene	Wasatch	Lower Eocene.
	Green River	
Lower Eocene	Laramie	Upper Cretaceous.

If the determinations of Mr. Lesquereux be correct,* it is evident from the above that the vegetable life of North America reached its present condition one epoch or period earlier than the higher *Vertebrata*, and that the nomenclature is thus thrown back by so much. It would appear that the recent flora of North America is a period older than the

*The above parallels are well presented by Dr. Peale in his report to Dr. Hayden, Ann. Rept. U. S. Geol. Surv. Terrs. 1874, p. 141 *et seq.*

fauna, *i. e.*, has persisted longer than the latter by a certain length of geologic time. Applying the same reasoning to the past, I embodied the idea in reference to the Laramie period ("Fort Union") in the statement that "a cretaceous fauna was then contemporary with a tertiary flora"; and, later, that "an eocene fauna was contemporary with a miocene flora." It may have to be added that a miocene fauna was contemporary with a pliocene flora. Since Mr. Lesquereux has the support of the best palæobotanists of Europe, in his conclusions, it is useless to take the ground assumed by a few of my colleagues, that the former gentleman has simply erred in his determinations. He gives us grounds for believing that he has not done so, by giving us the European standard by which his identifications are governed.* It is as follows:

Pliocene.....	Lower limits not positively fixed; largely developed in Italy. ? (Subapennine, E.D.C.)
Miocene.....	Oeningian; Mayencian; Aquitanian.
Oligocene...	Tongrian.
Eocene.....	Gypse of Aix; Alum Bay; Mt. Bolca; London Clay; Sheppey; Grès of the Sarthe.
Paleocene...	Upper Landenian; Sezanne (=Paniselian). Suessonian (Lignitic Soissonais; Sables de Bracheux); Lower Landenian. Hersian; Gelinden. Limestone of Mons, overlying unconformably the Maestrichtian.

This system, it will be observed, is almost exactly identical with that employed in the preceding pages as the standard of comparison for the *Vertebrata*. Yet it has resulted, from a most careful comparison of both faunæ and floræ of America with this standard scale, that two distinct palæontological series have to be adopted, the one for the vertebrate life and the other for the plants of the Western Continent. If this result be accurate, and there appears to be no avoiding it, an explanation must be sought. There are only two possible ones: either the animal life of North America has lagged behind that of Europe by one period during past geologic time; or, secondly, the vegetable life of America has been equally in advance of that of Europe during the same period. In other words, if the plant-life of the continents was contemporaneous, ancient types of animals remained a period longer in North America than in Europe. If animal life was contemporaneous, plant-life had advanced by one period in Europe beyond that which it had attained in North America. In either case, the faunal or the floral standard of estimation of geologic age of strata for North America is a false one, since there can be but one standard of comparison for anything. But this great fact being understood, the evidence of each of the great departments of life possesses its own intrinsic value.

* Ann. Report U. S. Geol. Surv. Terrs. 1874, p. 285.

Art. III.—Observations on the Faunæ of the Miocene Tertiaries of Oregon.

By E. D. Cope.

A considerable number of *Vertebrata*, almost exclusively *Mammalia*, have been described by authors from the White River and Pliocene formations of Oregon. The descriptions are found in Professor Leidy's contribution to the Final Report of the United States Geological Survey under Dr. Hayden (Vol. I); in those of Professor Marsh in the American Journal of Science; in a paper by Mr. Bettany in the Quarterly Journal of the Geological Society of London for 1876; and in a paper by myself (Paleontological Bulletin No. 30) in the Proceedings of the American Philosophical Society, published in December, 1878.* Having recently had the opportunity of inspecting a considerable amount of material from the horizons in question, I give a list of the species which I have observed. A few new ones occur in collections received since the publication of my last paper, and are now described, together with some of interest from the Loup Fork beds of the same region.

White River Fauna.

TESTUDINATA.

STYLEMYS OREGONENSIS Leidy.

RODENTIA.

STENEOFIBER GRADATUS Cope.
STENEOFIBER ? NEBRASCENSIS Leidy.
MENISCOMYS HIPPODUS Cope.
MENISCOMYS MULTIPLICATUS Cope.
PLEUROLICUS SULCIFRONS Cope.
ENTOPTYCHUS CAVIFRONS Cope.
ENTOPTYCHUS PLANIFRONS Cope.
ENTOPTYCHUS CRASSIRAMIS Cope.
PALÆOLAGUS HAYDENI Leidy.

*See also the American Naturalist, December, 1878.

CARNIVORA.

HOPLOPHONEUS BRACHYOPS Cope.

MACHÆRODUS STRIGIDENS Cope.

ENHYDROCYON STENOCEPHALUS, gen. et sp. nov.

Generic Characters.—Dental formula: I. $\frac{?}{?}$; C. $\frac{1}{1}$; Pm. $\frac{3}{3}$; M. $\frac{2}{?}$. The superior premolars consist of two ordinary and one sectorial; the first and second are both compressed, two-rooted, and in the typical species with median lobe of posterior cutting edge. The two true molars are transverse and tubercular. The three inferior premolars are all two-rooted, and with posterior lobe in the two known species. The heel of the sectorial is cutting, as in *Temnocyon*, and the internal tubercle is present. There is at least one inferior tubercular tooth; specimens are injured so as not to display a second.

In a nearly complete cranium belonging to the typical species of this genus, we observe the shortness of the facial part of the skull as compared with the length of the cerebral, and also the constriction of the skull behind the orbits. The zygomatic arches are robust and expanded, and the sagittal crest is high. The auditory bullæ are inflated and thin-walled.

The dentition of this genus refers it to the *Canidæ*, but the form of the skull resembles that of *Putorius vison* and *Lutra*.

Specific Characters.—The principal cusps of the inferior premolars present cutting edges, as does the median posterior lobe. In both third and fourth there is a small conic heel posteriorly, but an anterior basal tubercle on the fourth only. The sectorial is large and robust, and the heel is short, with an absolutely median cutting edge. The first tubercular is longer than wide, and presents a nearly median cusp in front, which is joined to a low one on the internal border of the crown.

The superior canine has an obtuse cutting edge on the anterior and posterior borders of the inner side. The first (third) superior premolar is near to it, and is rather large, displaying a median cutting lobe and low posterior heel. The fourth is similar but larger. The sectorial is much worn in the only specimen where it is preserved; it is rather short, and is widened anteriorly. The first tubercular is large, and has considerable transverse extent; it is a little wider externally than internally, and has much the form of the corresponding tooth in *Canis*. The second tubercular is transverse and small, not being much more than half the length of the first, and is situated in contact with it.

The cranium is remarkable for the anterior position of the orbits, and the associated shortening of the face and lengthening of the parietal region. The orbits look somewhat forwards and very little upwards. The superciliary region is slightly prominent, and there is a prelachrymal concavity. The infraorbital foramen is moderate, and is situated mostly above the posterior part of the fourth premolar. The muzzle is flat

above, and the nasal bones are wide, and are not emarginate above the osseous nares, as in many recent *Carnivora*. Posteriorly, the superior border of the brain-case descends, but the parietal bones maintain a gently convex outline in their high sagittal crest. The supraoccipital region is elevated, and projects posteriorly.

Measurements.

Specimen No. 1.

	M.
Antero-posterior diameter of second superior premolar	0.010
Antero-posterior diameter of third inferior premolar	0.013
Width of base of third inferior premolar	0.0065
Elevation of crown of third inferior premolar	0.010
Diameter of inferior sectorial { transverse	0.010
Diameter of inferior sectorial { antero-posterior	0.021
Width of first tubercular	0.006

Specimen No. 2.

Total length of cranium	0.170
Width across zygomatic arches	0.114
Least width behind orbits	0.024
Depth of cranium with crest at otic bulla	0.070
Vertical diameter of orbit	0.025
Length from orbit to end of muzzle (axial)	0.040
Interorbital width	0.043
Width of muzzle above second premolar	0.018
Length of superior molar series	0.051
Length of fourth premolar	0.012
Length of sectorial	0.016
Length of first tubercular	0.008
Width of first tubercular	0.015
Width of second tubercular	0.0085

The length of the skull is about that of the Coyote, but it is much more robust in all its proportions excepting the postorbital constriction.

Discovered by Charles H. Sternberg in the Oregon White River beds of the John Day River region.

ENHYDROCYON BASILATUS, sp. nov.

This Carnivore is represented by a mandible with coössified rami, which are broken off behind the sectorial teeth. The crowns of the latter and but one incisor and one canine tooth remain. The premolars and one canine are in good preservation.

These portions indicate an animal of the same general character as the *Enhydrocyon stenocephalus*, but of larger and more robust proportions, and characterized by many dental peculiarities. These will be at once pointed out. The canine is directed upwards and a little outwards, and possesses two obtuse ridges bounding the interior face. The third incisor is compressed and truncate superiorly and distally. The first (second) premolar is two-rooted, compressed, and trilobate. It consists of a principal cutting edge little elevated, and a small accessory lobe

at each extremity of the crown; its base is expanded posteriorly. The principal cusp of the third premolar is more elevated, and, besides the anterior and posterior tubercles, there is a basal posterior heel, which is continued as an expansion of the inner base of the crown. In the fourth premolar, the base of the crown is expanded, especially posteriorly; the principal cusp has a nearly circular section at the base, and the posterior median lobe is a subconic tubercle standing on the middle of the heel. The sectorial is large and relatively rather narrow, but the details of its form are not ascertainable.

Measurements.

	M.
Length of dental series, including canine and sectorial	0.076
Length of the base of the sectorial	0.024
Length of the premolar series	0.037
Length of the fourth premolar	0.016
Width of the fourth premolar	0.009
Length of the third premolar	0.013
Width of the third premolar	0.008
Length of the second premolar	0.009
Width between centres of crowns of fourth premolars	0.034
Length of symphysis	0.035

This species was probably of the dimensions of the Gray Wolf. Found by Mr. Sternberg in the same region as the *E. stenocephalus*.

TEMNOCYON ALTIGENIS Cope.

CANIS HARTSHORNIANUS Cope

CANIS GEISMARIANUS Cope.

CANIS CUSPIGERUS Cope.

CANIS LIPPINCOTTIANUS Cope.

CANIS GREGARIUS Cope.

PERISSODACTYLA.

DÆODON SHOSHONENSIS Cope.

ACERATHERIUM PACIFICUM Leidy.

ANCHITHERIUM EQUICEPS Cope.

ANCHITHERIUM BRACHYLOPHUM Cope.

ANCHITHERIUM LONGICRISTE Cope.

ARTIODACTYLA.

ELOTHERIUM IMPERATOR Leidy.

PALÆOCHŒRUS CONDONI Marsh.

PALÆOCHŒRUS PRISTINUS Leidy.

PALÆOCHŒRUS SOCIALIS Marsh.

MERYCOPATER GUYOTIANUS Cope.

EUCROTAPHUS SUPERBUS Leidy.

EUCROTAPHUS OCCIDENTALIS Marsh.

MERYCOCHŒRUS LEIDYI Bettany.

MERYCOCHŒRUS TEMPORALIS Bettany.

POËBROTHERIUM STERNBERGII, sp. nov.

This Ruminant is represented by a considerable part of the skeleton with both mandibular rami supporting the teeth, of one individual. The bones are all in close proximity, and sometimes in undisturbed relation, in a single block of stone.

The species to which I give the above name presents the characters already ascribed to the genus *Poèbrotherium* by Leidy as regards cranial features, and by myself as regards the rest of the skeleton. The third and fourth metacarpals are not coössified, and the second and fifth are not distinguishable. The preservation of the premaxillary bone in this species enables me to demonstrate the presence of superior incisor teeth, a character the presence of which I have heretofore only inferred. As compared with the *P. vilsoni*, the species differs in its superior size and greater relative robustness. This is seen in the greater depth of the mandibular ramus, and the greater stoutness of the metapodial and other limb-bones. The last inferior molar tooth presents a characteristic peculiarity. The anterior external cusp is separated by a deep groove which divides the external side of the crown to the base from the succeeding cusp. It results that on trituration, the anterior external crescent is isolated, and does not communicate by its posterior horn with the succeeding crescent, as in *P. vilsoni*. The last premolar is more robust than that of the *P. vilsoni*, the width of the half-worn surface being half the length of the tooth and enclosing behind an enamel fossa. In *P. vilsoni*, this tooth is more compressed, and the fossa is represented by an open groove. The first inferior premolar occupies the middle of the diastema following the canine, instead of standing near the canine as in *P. vilsoni*.

Measurements.

		M.
Diameter of last molar	antero-posterior	0.020
	transverse	0.009
Diameter of penultimate molar	antero-posterior	0.013
	transverse	0.009
Depth of ramus at second molar		0.025
Length of ramus from third molar to extreme posterior edge		0.061
Length of metacarpus		0.178
Transverse proximal diameter of the two metacarpi		0.029
Greatest diameter of the head of the humerus		0.053
Antero-posterior diameter of the condyle of the femur		0.048

This species is named in honor of Charles H. Sternberg, the indefatigable explorer of the fossil deposits of the West.

BOÖCHŒRUS HUMEROSUS, gen. et sp. nov.

Generic Characters.—The species on which this genus is founded, is represented by a part of the skeleton, which is unfortunately not accom-

panied by cranial bones or teeth. The characters are, however, sufficiently clear for purposes of determination. The great tuberosity of the humerus is produced beyond the head, and does not close round the bicipital groove. The intertrochlear ridge is well developed, and there is no internal epicondyle; the external epicondyle is moderately developed. On the carpal extremity of the ulno-radius, the facets of the scaphoid, lunar, and cuneiform bones, are distinguished by strong oblique ridges, and the last named is nearly in the horizontal line of the two others. In the carpus, the trapezoides is distinct, and the trapezium wanting. The unciform is in contact with the lunar. Metacarpals two, distinct from each other, with free rudiments of the second and fifth at their proximal extremities. Their distal keels confined to the posterior faces of their extremities. Phalanges depressed; ungues short, obtuse.

In the above description is found a combination of characters not known to me to exist in any recent or extinct genus of *Artiodactyla*. Several of its features indicate affinity to the suilline division, while others point to the *Ruminantia*. The imperfect distal articulation of the metacarpals is characteristic of the extinct types *Oreodontidæ* and *Poëbrotheriidæ*, and the two distinct metacarpals constitute the resemblance to the latter family the stronger. The latter character is, however, not inconsistent with the *Omnivora*, and the depressed phalanges add to the weight of affinity in this direction. The distal extremity of the humerus is much like that of a peccary. The distal articular surface of the ulno-radius points, however, again to the *Ruminantia* of the group *Pecora*, displaying a specialization quite in contrast with the primitive character of the metacarpo-phalangeal articulation. From these considerations it can be seen that it is not easy to affirm whether this genus possesses bunodont or selenodont dentition. If I may venture an inference as to the affinities of the genus, I would suggest that it will be found to be as nearly allied to the *Hypertragulidæ* as to the *Oreodontidæ*, though not without suilline affinities.

Specific Characters.—The only species of this genus known to me is of large size. It is represented by the greater part of a scapula and both anterior limbs and feet; by the pelvis, femur, and part of tibia, and by some vertebræ; all found in immediate association by Mr. Sternberg. These remains indicate an animal of the size of the *Rhinocerus indicus*. The animal is characterized by the massive proportions of the humerus as compared with the femur, and by the short, robust form of the metacarpals.

In the *humerus*, the external border of the great tuberosity is entire, and is not reverted, but descends backwards like the remainder of the surface. The apex of the great tuberosity is much recurved, rising steeply proximad of the head. The bicipital groove is deep. The lesser trochanter is large and simply conic; its transverse extent is not great. External to its base is a small tuberosity, which is represented in *Bos*, but not in *Dicotyles* or *Sus*. The deltoid crest is very prominent, de-

scending to the middle of the length of the humerus, before abruptly sinking to the shaft. Its continuation is very prominent as it crosses the axis of the shaft and becomes the anterior bounding ridge of the internal side of the distal extremity. The section of the shaft is thus subtriangular at all points, the obtuse apex of the triangles revolving from the external side proximally, to the internal distally. The external epicondyle is proximal to the condyle, as in *Dicotyles*, but is more prominent than in that genus, and more as in *Oreodon*. It is the extremity of the external acute edge of the humerus, which, rising from the shaft at a point 90° posterior to the extremity of the deltoid ridge, turns forwards to the external epicondyle. The condyles are transverse and not much contracted from side to side. The intertrochlear ridge is sharper than in the species of *Oreodon*, *Dicotyles*, or *Sus*, and is continued round to the shaft anteriorly, as in *Bos*. The condyles otherwise resemble those of *Dicotyles*, not being so contracted in their free margins as in *Bos*.

Measurements of the Humerus.

	M.
Total length	0.500
Length from middle of head	0.425
Diameter of proximal end, antero-posterior	0.140
Diameter of proximal end, transverse	0.170
Diameter of head, antero-posterior	0.100
Diameter of head, transverse	0.100
Width of humerus near extremity of deltoid crest	0.130
Diameter of shaft just below extremity of deltoid crest, antero-posterior	0.078
Diameter of shaft just below extremity of deltoid crest, transverse	0.065
Width at epicondyle	0.130
Transverse diameter of condyles	0.120
Antero-posterior diameter of condyles, internally	0.070
Antero-posterior diameter of condyles, at constriction	0.055
Antero-posterior diameter of condyles, externally	0.050

This bone has about the size of the corresponding one of the *Rhinocerus indicus*.

The carpal extremity of the *ulno-radius* is extended transversely. The cuneiform or ulnar articular face forms posteriorly two-fifths the entire extremity, and is only recurved in the external part of its posterior border, which is very concave. The ridge which separates it from the lunar surface is very oblique, following just outside of the ulno-radial suture, and contracting the cuneiform facet anteriorly. Distally and posteriorly it forms the external border of the posteriorly reverted lunar facet, bounding a deep fossa, which is posterior to the cuneiform facet on its inner side. The lunar facet widens behind at the expense of the scaphoid, so that the scapho-lunar ridge is even more oblique than the luno-cuneiform. This ridge disappears supero-anteriorly, and the lunar facet is recurved upwards, occupying the distal extremity of a strong median ridge of the ulno-radius. The reverted portion is almost a half circle in outline, and is partly continuous with the scaphoid facet. The

latter is subtriangular in outline, its apex being the point of conjunction of the scapho-lunar ridge with the internal border, just posterior to its greatest convexity. Its superior boundary is interrupted by the wide groove which separates the median ridge from the internal border of the distal part of the radius.

Measurements of the Ulno-radius.

		M.
Transverse diameter, total		0.110
Transverse diameter of ulna		0.050
Antero-posterior diameter of articular face	externally	0.035
	at middle of ulna	0.021
	at luno-cuneiform ridge	0.055
	internally	0.045

But for the extent and transverse position of the ulnar portion of this articular face, it might be regarded as pertaining to a typical Ruminant.

The length of the *carpus* is about three-fourths its width, the proximal elements being larger than the distal. A feature of its anterior face is the close approximation of the inferior angle of the lunar to the superior angle of the third metacarpus, which allows the magnum and unciform a very slight contact. The external face of the scaphoid is chiefly lateral; its posterior border is a vertical, short tuberosity. The proximal face is abruptly decurved at the anterior outer angle, to meet the lunar. There are two separate oval superior lunar facets, and one narrow anterior inferior one. The inferior face is nearly equally divided by a low cross ridge which fits a concavity of the posterior part of the magnum. The lunar is the largest bone of the carpus. Its proximal face is decurved anteriorly, posteriorly, and on each side, and is twice as long as wide at the middle. The postero-internal and antero-external angles are produced, the latter into a compressed process which articulates with the adjacent angle of the cuneiform. Besides this facet there is one other for the cuneiform, which occupies the posterior half of the inferior part of the outer side, and is separated from the superior edge by a deep groove. The unciform facet is in front nearly as wide as that of the magnum, but grows gradually narrower posteriorly. The facet for the magnum is concave, and grows very wide posteriorly, with the posterior internal angle produced downwards. The proximal facet of the cuneiform is very concave, the anterior and posterior borders being elevated, and the internal and external decurved; the latter prolonged a little backwards. Below this extremity on the external aspect is a fossa. The pisiform facet makes an angle of 90° with the ulnar, and extends behind and along the posterior edge of the latter to its apex. The unciform facet is simple, and is in shape a right-angled triangle with convex hypothenuse. The posterior aspect of this bone is concave.

The proximal face of the trapezoides is longer than wide, convex antero-posteriorly, and subdiamond-shaped. The inferior face is narrow subdiamond-shaped, and has less than half the area of the proximal. There is a small round tuberosity on the posterior border, and no trace

of facet for a trapezium. The anterior face of the magnum is wider than long, and is divided into three planes. The proximal extremity is divided into two areas by a high antero-posterior keel. The inner area is the larger, and is bounded by the entire superior border of the anterior face of the bone. The outer area, or the lunar facet, extends very obliquely downwards, most so in front, where it forms the external side of the magnum. It is interrupted by a large sinus, which leaves the posterior portion of the face narrow and transverse. Behind it is first a fossa and then two short tuberosities, one above and external to the other. The inferior face is undivided, and is concave antero-posteriorly, and convex transversely. The unciform is the second bone of the carpus in size. Its anterior face is broader than long, and is convex transversely. The inner face has in front a large trapezoidal facet for the third metacarpus, which is only separated from that of the lunar by the angle. The superior face is divided, by an angular ridge nearly parallel with the inner border, into two unequal faces for the lunar and cuneiform. The latter is half as wide posteriorly as long, and terminates anteriorly in an obtuse angle. The distal face is undivided, but is recurved postero-externally, apparently offering a narrow facet for the fifth metacarpus. This face nearly meets the cuneiform face posteriorly. Behind both the unciform is produced into a decurved, subconic tuberosity.

*Measurements of the Carpus.**

			M.
Diameter of scaphoid	antero-posterior		0.066
	longitudinal		0.048
Diameter of proximal face of scaphoid	antero-posterior		0.048
	transverse		0.030
Diameter of distal face of scaphoid	antero-posterior		0.048
	transverse		0.023
Diameter of proximal face of lunar	transverse	anteriorly	0.047
		at middle	0.032
	longitudinal		0.053
Diameter of anterior face of lunar	longitudinal		0.048
	transverse		0.032
Diameter of cuneiform	antero-posterior, oblique		0.059
	transverse, behind		0.040
Diameter of proximal face of cuneiform	antero-posterior		0.040
	transverse		0.044
Diameter of distal face of cuneiform	antero-posterior		0.040
	transverse		0.031
Length of trapezoides			0.027
Diameter of proximal face of trapezoides	antero-posterior		0.029
	transverse		0.016
Diameter of distal end of trapezoides	antero-posterior		0.020
	transverse		0.010
Diameter of magnum	longitudinal	anteriorly	0.029
		externally	0.040
	transverse, posteriorly		0.047
	antero-posteriorly, outer side		0.055

*These measurements are always the greatest, and are axial, or in straight lines.

Measurements of the Carpus—Continued.

		M.
Diameter of lunar face of magnum	antero-posteriorly	0.046
	transversely	0.031
Diameter of distal face of magnum	antero-posteriorly	0.040
	transversely	0.048
Diameter of unciform	antero-posterior	0.080
	transverse	0.053
	longitudinal, in front	0.040
Diameter of lunar facet	antero-posterior	0.047
	transverse (least)	0.016
Diameter of cuneiform facet	antero-posterior	0.052
	transverse (behind)	0.028
Diameter of 4th metacarpal facet	antero-posterior	0.044
	transverse	0.046

As already remarked, this carpus displays resemblances to some recent types, and possesses some which are not known among living *Artiodactyla*. The inferior face of the scaphoid is narrower from side to side than in the *Ruminantia* or *Sus*, *Dicotyles* only approaching but not equalling it in this respect. The strong inferior keel of the lunar exceeds that seen in any of the *Ruminantia* or *Omnivora*. The pisiform facet is more oblique than in those groups. The posterior tuberosities of the magnum and unciform are larger than those of the genera of either group, while the distinct trapezoides, the slightly shortened magnum and unciform, and slight decurvature of the cuneiform facet of the unciform posteriorly, are suilline characters.

The *metacarpals* are robust, but flattened antero-posteriorly. The rudiments of the second and fifth are free, and the latter is the larger. The third has a considerable surface of contact with the unciform; its anterior face displays two shallow fossæ, one at each superior angle. The corresponding positions on the fourth metacarpal are occupied by two low bosses. Otherwise the surfaces of the shafts of these bones are uniform. The phalangeal articular face is well reverted anteriorly and posteriorly, and is not bounded by a transverse depression anteriorly above. The carina is short, though prominent, and extends to the middle of the distal extremity. The lateral distal tuberosities are very low.

Measurements of the Metacarpals.

		M.
Length of M. III		0.210
Length of M. IV		0.190
Diameter of M. III proximally	transverse (total)	0.063
	antero-posterior	0.055
Diameter of M. III distally	transverse	0.053
	antero-posterior (chord)	0.045
Diameter of M. IV proximally	transverse	0.054
	antero-posterior	0.045
Diameter of M. IV distally	transverse	0.043
	antero-posterior (chord)	0.048
Length of M. II		0.055
Length of M. V		0.040
Diameter of M. V antero-posteriorly		0.021

The *phalanges* are more depressed than in any genus of *Artiodactyla* known to me, excepting *Hippopotamus*. The proximal articular surface of the first is gently concave, with the anterior border not produced. The shaft is not contracted, and is regularly convex above or anteriorly. The distal articular face is narrower above and not produced. The superior border of the proximal face of the second phalange is produced medially. The distal face is narrowed and produced upwards, so as to stand in high relief, from which it results that the middle of the shaft is very concave above. The external and internal borders of the inferior or posterior part of the distal face, are produced backwards, covering lateral basal ridges of more than half the length of the shaft, which form the inferior border of lateral fossæ. One unguis is preserved. It is distinct in form from that of *Hippopotamus*, *Sus*, or *Dicotyles*, and resembles that of the llama. It is short, obtuse, and compressed. The external face is nearly plane fore and aft, and slightly convex vertically. The inner is convex fore and aft, and concave vertically. The profile descends steeply to the apex, the curve commencing but little beyond the base. The inferior face is at right angles to the interior face, and is moderately wide.

Measurements of the Phalanges.

		M.
Median length of first of M. IV		0.066
Proximal diameter	antero-posterior	0.042
	transverse	0.055
Distal diameter	antero-posterior (median)	0.030
	transverse (greatest)	0.055
Median length of second phalange		0.055
Diameter of second phalange proximally	antero-posterior	0.035
	transverse	0.045
Diameter of second phalange distally	antero-posterior	0.032
	transverse	0.041
Length of ungual phalange below		0.042
Proximal diameter of ungual phalange	antero-posterior	0.032
	transverse	0.025

The *femur* is slender as compared with the humerus, and of moderate length. The great trochanter is produced, but not beyond the line of the convexity of the head, and is not much recurved. The expanse externally is about as great as that of the head internally. The trochanteric fossa is not large, and is cut off below by a plane surface at the base of the great trochanter, whose superior border forms a curved line connecting the great and little trochanters. The latter is large and projects well inwards. The *fossa ligamenti teris* is large and central, having no connection with the border of the head of the femur. The posterior side of the shaft is flat, and the anterior face regularly convex. The two faces meet externally in a well-marked representative of the *linea aspera*. The rotular face of the femur is short and wide, with the borders somewhat oblique, and the inner edge is higher than the outer at its proximal part. It is strongly convex from above downwards, and

does not connect below with the condylar surfaces. Its entire inferior border is well defined and angulate. The condyles are well separated, and the intercondylar fossa is wide above or anteriorly. The external is a little the larger, and the internal is distinguished by the presence of a deep lateral fossa.

The head of the *tibia* is characterized by a distinct bifid spine, and a low, wide crest, which presents an open, shallow groove forwards. The articular faces are of subequal width, but the external is shortened anteriorly by the usual notch; it is also decurved posteriorly.

Measurements of the Femur.

	M.
Expanse proximally (greatest)	0.170
Expanse proximally at extremity	0.150
Diameter of head	0.068
Diameter of shaft at middle, antero-posteriorly	0.053
Diameter of shaft at middle, transversely	0.060
Length of chord of rotular face	0.088
Width of rotular face	0.070
Expanse of condyles (greatest)	0.122
Greatest chord of distal end of femur	0.110

Measurements of the Tibia.

	M.
Diameter of head of tibia, antero-posterior	0.130
Diameter of head of tibia, transverse	0.125

The form of the head of the tibia is much like the corresponding region in *Oreodon culbertsoni;* but the characters of the femur do not resemble those of that species, particularly as regards the distal extremity.

A peculiarity of the long bones of this species is seen in their very large medullary cavities. This is especially true of the humerus, whose walls are remarkably thin; those of the femur are thicker.

This species was found by Mr. C. H. Sternberg in the John Day River region.

LEPTOMERYX EVANSI Leidy.

HYPERTRAGULUS CALCARATUS Cope.

This species is much more abundant in the John Day River deposit than the *Leptomeryx evansi.* The two genera represent a peculiar family, which I call the *Hypertragulidæ*, with the following characters:

Selenodont *Ruminantia* with an interrupted dental series, coössified ulna and radius, cuboid and navicular bones, and third and fourth metapodial bones. Only two continuous metapodial bones, their distal articular extremities not presenting a complete trochlear keel. No fibula. Premolars except the fourth, cutting.

This family connects the *Tragulidæ* with more typical *Ruminantia.* It differs from that family in the absence of the fibula and the external metapodial bones. From the typical *Ruminantia* or *Pecora*, it differs

in the incompleteness of the trochlear keel of the metapodials, and the trenchant character of the premolars, excepting the last.

The species of the preceding list which I have observed in other localities are the following, which I procured in the White River beds of Eastern Colorado: *Palæolagus haydeni*, *Canis hartshornianus*, *Canis lippincottianus*, *Canis gregarius*, *Leptomeryx evansi*, *Hypertragulus calcaratus*. Professor Leidy has recognized a number of species as those previously found in the White River beds of Dakota by Dr. Hayden.

Loup Fork Fauna.

Two new species were obtained by Mr. Sternberg at this horizon, which present characters of considerable interest. They are as follows:

LUTRICTIS? LYCOPOTAMICUS, sp. nov.

This Carnivore is represented by a left mandibular ramus, which contains alveoli and crowns of the canine and molars, excepting those posterior to the sectorial. These teeth have the formula, four premolars, of *Mustela* and of the Dogs, but the sectorial is much more like that of *Lutra* than that of either of the genera named. The heel of this tooth is long, and encloses a wide space transversely, while the sectorial portion is short and low, and includes a large internal tubercle. In the absence of the tubercular teeth, the generic reference is uncertain; but its characters agreeing, so far as they go, with the genus *Lutrictis* of Pomel, I refer it there provisionally.

The first premolar only is one-rooted; the third is wide behind, developing a low heel. The heel of the fourth is a little better developed, and there is a small anterior basal cutting lobe; there is also a tubercle on the posterior cutting edge at the middle. The three cusps of the anterior part of the sectorial tooth are situated at the corners of an imaginary equilateral triangle. The heel continues the width of the crown, is wider than long, and is abruptly truncate behind. It supports a long cutting edge just within the external border, and a shorter one on the internal. The surface of the enamel is smooth. There are two mental foramina, one below the interval between the first and second premolars, the other beneath the anterior root of the third premolar.

Measurements.

	M.
Length of molar series without tubercular	0.0220
Diameter of sectorial { antero-posterior	0.0066
Diameter of sectorial { transverse	0.0040
Length of heel of sectorial	0.0024
Length of fourth premolar	0.0045
Elevation of fourth premolar	0.0036

From the Loup Fork formation of Cottonwood Creek, Oregon; discovered by Charles H. Sternberg.

PROTOLABIS TRANSMONTANUS, sp. nov.

A nearly complete cranium, without lower jaw, of an adult animal, is

the basis of our knowledge of this species. It presents the characters of the genus in the following superior dental formula: I. 3; C. 1; P.m. 4; M. 3. The first premolar is situated in the middle of a long diastema, and a short one separates the canine from the third incisor.

On comparison of this species with the *P. heterodontus*, the type, and heretofore the only known species of the genus, various characteristic peculiarities may be observed, which will be noticed in the course of the description. It is considerably smaller than the *P. heterodontus*, resembling in its dimensions the *Procamelus occidentalis*.

The crown of the second superior incisor is directed forwards, and the cutting edge is oblique to the long axis of the tooth. The first incisor is equally large, and its alveolus occupies the apex of the premaxillary bone. In *P. heterodontus*, the alveolus is smaller, and the apex extends considerably beyond it. The third incisor has a conic crown, with subround section. In *P. heterodontus* it is more robust, and is oval in section, with weak posterior cutting edge. The canine is less robust than the third incisor, and is about as far posterior to it as the latter is from the second incisor. The crown is slightly compressed, and is less robust than that of *P. heterodontus*. The first premolar is still weaker, and the crown is compressed; the roots are only discrete at their extremities. It is situated a little more than one-third the distance between the canine and second premolar behind the former. The second premolar is well developed, and is two-rooted. The third premolar is also large, with the grinding surface of the crown about half as wide as long. It has a strong internal basal cingulum, which on attrition encloses a groove-like fossa with the principal crown. The external face of the crown is gently convex between an anterior and a posterior ridge. The internal face of the crown is uniformly convex. The fourth premolar has both crescents well developed. Its grinding face is subsemicircular, and there are a strong anterior and a weak posterior external vertical ridge. In *P. heterodontus*, the grinding surface of this tooth is more nearly subquadrate.

The true molars are subquadrate in horizontal section, and have short crowns, well distinguished from the roots. The anterior horn of each external crescent is prolonged, constituting a section of a prominent vertical external ridge of the crown at each point. The external sides of the columns are but slightly convex. The inner sides of the internal columns are strongly convex. The enamel borders of the lakes are absolutely simple, and there are no included enamel fossæ. The posterior outer angle of the last superior molar is not produced.

As compared with the true molars of *P. transmontanus*, those of the *P. heterodontus* are relatively smaller in transverse diameter. The masticating surfaces of the crowns of the second and third are thus more elongate in outline. They are also rather more prismatic, and the last two apparently occupied longer time in the process of protrusion. They are much larger than those of *P. transmontanus*.

The *foramen infraorbitale* issues above the middle of the fourth pre-

molar. In *P. heterodontus* it issues above the anterior part of the first true molar. A sharp angle separates the exterior and extero-inferior faces of the malar bone.

Measurements.

	M.
Length of dental series from base of first incisor	0.257
Length of incisors on chord	0.028
Space between third incisor and canine	0.006
Length of crown of third incisor	0.013
Antero-posterior diameter of third incisor	0.008
Length of interval between canine and first premolar	0.011
Length of interval between first premolar and second premolar	0.020
Length of three contiguous premolars	0.035
Length of third premolar	0.014
Width of third premolar (greatest)	0.0075
Length of true molar series	0.057
Diameter of second true molar, antero-posterior	0.018
Diameter of second true molar, transverse	0.018
Diameter of third true molar, antero-posterior	0.022
Diameter of third true molar, transverse	0.019

Discovered by C. H. Sternberg in the Loup Fork beds of Cottonwood Creek, Oregon.

Art. IV.—Notes on the Birds of Fort Sisseton, Dakota Territory.

By Chas. E. McChesney, Acting Assistant Surgeon U. S. A.

LETTER OF TRANSMITTAL.

FORT SISSETON, DAKOTA TERRITORY,
December 25, 1878.

SIR: I have the honor to transmit herewith my notes on the Birds of the vicinity of Fort Sisseton, Dakota Territory. I beg to tender you the use of these notes in any connection in which you may see proper to use them.

As you are aware, I have spent considerable time during the past three years in a zoölogical examination of this region, and, as the locality has never been reported upon in the interest of ornithological science, I submit these notes as an attempt to fill the gap.

In many respects, the region differs from any other part of the Northwest. The "Coteau des Prairies" consists of an extensive plateau, rising, somewhat abruptly, nearly four hundred feet above the level of the surrounding country, having a length of over one hundred miles, and a variable width of from twenty to fifty miles. Upon this elevated plateau are many lakes, which are the annual resort of thousands of waders and wild fowl, and the region differs greatly in its fauna from that of the lower country.

Descriptions of the game birds occurring in Dakota and Montana are incorporated in these pages. This has been done in accordance with the wish of many officers of the Army stationed in these Territories, and their publication would be of great benefit to a class of intelligent gentlemen from whose observations at the various posts on the frontier we may reasonably hope for much addition to our knowledge of the habits and occurrence of birds in different localities. These descriptions have been taken, with modification, from your "Key to North American Birds," by your permission, for which, as well as for valuable assistance rendered me in identifying specimens sent you at various times, I am under great obligations.

I am, Sir, very respectfully, your obedient servant,

CHAS. E. MCCHESNEY,
Acting Assistant Surgeon U. S. A.

DR. ELLIOTT COUES, U. S. A.,
Secretary U. S. Geological Survey,
Washington, D, C.

TURDIDÆ.

TURDUS MIGRATORIUS, L.—*Robin.*

This bird appears about April 24, in small numbers, but the locality does not seem to be well suited to its summer residence, probably on account of scarcity of timber, for the bird migrates in a few days, to

return in larger numbers about September 28, and finally disappears for the season, October 28, on the approach of winter. It may breed, sparingly, on the slopes of the Coteau, in the deep ravines.

TURDUS SWAINSONI ALICIÆ, (Bd.) Coues.—*Alice's Thrush.*

Is seen here for the first time each season about the 20th of May; is not common at any time, and is generally confined to the dense foliage of the thick undergrowths. I have never heard its song here.

MIMUS CAROLINENSIS, (L.) Gr.—*Catbird.*

Appears about the 1st of June, and remains until the end of September, in large numbers. Breeds here. Is usually found in the low and thick undergrowths, and is one of the most restless of our birds.

HARPORHYNCHUS RUFUS, (L.) Cab.—*Brown Thrasher.*

Usually appears by the end of April, and remains until the end of September, in limited numbers; breeds here. The Brown Thrasher, as a rule, is found only in thick timber, the outer edges of which it occasionally skirts, and I have found it to be very shy during the entire period of its stay here, so that the acquisition of specimens is very difficult.

SAXICOLIDÆ.

SIALIA SIALIS, (L.) Haldeman.—*Eastern Bluebird.*

The typical Eastern Bluebird is found here; usually appears by the 10th of May, and I believe a very few remain through the summer in some of the heavily wooded ravines on the slopes of the Coteau, as now and then one is seen in July and August. Is at no time common.

PARIDÆ.

PARUS ATRICAPILLUS, Linn.—*Black-capped Chickadee.*

Is seen from September 28 until November 14, and occasionally later, in large numbers. When nearly all of our small birds have departed, the Black-capped Chickadee remains to represent bird-life during that short interval between fall and winter. I have rarely observed it here after November, and presume it departs before winter fairly commences.

TROGLODYTIDÆ.

TROGLODYTES DOMESTICUS, (Bartr.) Coues.—*House Wren.*

June 6, 1877, I secured at the Post one specimen of true *T. domesticus*, and not var. *parkmani*, the usual Western Wren. Several were seen in the woods during the summer of 1877, which were probably of the latter variety, but no specimens were secured. Var. *parkmani* arrives in May, and, I believe, does not take its departure before October.

ALAUDIDÆ.

EREMOPHILA ALPESTRIS, (Forst.) Boie.—*Horned Lark.*

Appears September 28, and is found in small numbers until November 15, when, as a rule, it leaves this vicinity. Returns from the middle of February to the middle of March, and is then found in large numbers in company with the Snowbird (*Junco hyemalis*), with which it lives on terms of the utmost intimacy, and seems to take its departure about the same time, *i. e.*, April 17.

Occasionally the Horned Lark is observed here during the entire winter months, but such only occurs during mild seasons, although this bird is able to withstand considerable cold.

SYLVICOLIDÆ.

MNIOTILTA VARIA, (L.) V.—*Black-and-white Creeper.*

This Creeper is seen in numbers from May 20 until the 1st of June in each year, after which date its numbers rapidly diminish, and I believe it entirely withdraws from this vicinity by the middle of June.

DENDRŒCA ÆSTIVA, (Gm.) Bd.—*Summer Warbler.*

This bird arrives about May 17, and remains until September 17; is found in large numbers. Breeds here. Wherever there is timber in this region, the Summer Yellowbird will there greet you, warbling its notes, and hopping about from bough to bough, as happy, apparently, as possible; for nothing ever appears to go wrong with the Summer Yellowbird.

DENDRŒCA CORONATA, (L.) Gr.—*Yellow-crowned Warbler.*

This Warbler arrives about the 10th of May each year, and is seen in numbers in the thick foliage of the smaller trees during a week or ten days. Does not pass the summer in this region.

DENDRŒCA BLACKBURNIÆ, (Gm.) Bd.—*Blackburnian Warbler.*

Occurs only as a spring migrant. Arrives usually the 20th of May, and tarries but a day or two in this vicinity before resuming its northward flight.

DENDRŒCA STRIATA, (Forst.) Bd.—*Black-poll Warbler.*

Arrives about the 10th of May, and is seen in numbers until the 20th of that month, after which date only a few scattering ones are met with; and I believe it does not breed anywhere in this vicinity, or, if so, very sparingly, in the thick undergrowth of the woods. I have never met with it after June 15.

DENDRŒCA PENNSYLVANICA, (L.) Bd.—*Chestnut-sided Warbler.*

The Chestnut-sided Warbler is not common in this region. It ar-

rives about May 20, but soon passes on, so that by the 1st of June none are to be seen here. Breeds further north.

DENDRŒCA MACULOSA, (Gm.) Bd.—*Black and Yellow Warbler.*

Occurs during the spring migration, and usually arrives by May 20, in some numbers, but soon disappears, as I have not seen any after the first week in June.

DENDRŒCA PINÛS, (Wils.) Bd.—*Pine-creeping Warbler.*

Is seen, in small numbers only, from May 22 until about the 1st of June each year; does not breed on the "Coteau des Prairies," to my knowledge.

SIURUS NÆVIUS, (Bodd.) Coues.—*Water Thrush.*

May 14, 1878, while out collecting in the vicinity of Fort Sisseton, Dakota Territory, I secured a single specimen of the Water Thrush. This is the only one I have seen here, and its presence is believed to be rare or casual.

GEOTHLYPIS TRICHAS, (L.) Cab.—*Maryland Yellowthroat.*

This bird occurs regularly during the spring migrations, being observed about the 1st of June, not, however, in any numbers. It does not spend the summer in this vicinity.

MYIODIOCTES CANADENSIS, (L.) Aud.—*Canadian Fly-catching Warbler.*

This Warbler arrives by the 22d of May, and is seen in some numbers for a few days, but appears to depart by the 1st of June, as I have never observed it after that date.

SETOPHAGA RUTICILLA, (L.) Sw.—*Redstart.*

Arrives between the 15th and 20th of May, each year, in small numbers. Breeds and then departs.

HIRUNDINIDÆ.

HIRUNDO HORREORUM, Barton.—*American Barn Swallow.*

Is found in small numbers from about May 25 until September 19. Breeds about the stables and often in the deserted buildings in the vicinity of the post.

TACHYCINETA (IRIDOPROCNE [*]) BICOLOR, (V.) Coues.—*White-bellied Swallow.*

I saw quite a number of White-bellied Swallows at Fort Sisseton, June 3, 1878, and secured specimens. I did not meet with it during either 1876 or 1877, and do not think it regularly visits this region.

PETROCHELIDON LUNIFRONS, (Say) Cab.—*Cliff Swallow.*

Appears May 4, and takes its departure about August 9; very abundant, and breeds here. As civilization advances, so does the Cliff Swal-

[* *Iridoprocne*, g. n., COUES, B. C. V. i. 1878, p. 412; type *H. bicolor*, V.]

low; for here, as elsewhere, this Swallow has deserted his native cliffs for the buildings, which they persist in using, notwithstanding their nests are often roughly handled. I have seen a pair cheerfully set to work and entirely rebuild in twenty-four hours a nest that had been destroyed in an instant. On one occasion, when the entrance to the nest had been closed by plugging with a newspaper, I observed the pair go for assistance, and in a few minutes return with as many of their friends as could get around the nest, when they all took hold of the paper and tugged with a will, but to no avail, as their united strength was not sufficient to remove the obstruction; and, in consequence, the nest was abandoned.

COTYLE RIPARIA, (Linn.) Boie.—*Bank Swallow.*

Appears May 18, in considerable numbers; breeds here, and disappears about July 20. The Bank Swallow will occupy the same nest season after season if it remains undisturbed, and in case of destruction will often rebuild on or as near the site of the old nest as possible.

PROGNE PURPUREA, (Linn.) Boie.—*Purple Martin.*

Arrives about the end of May, and remains until September 9; is seen in considerable numbers and breeds here. The Purple Martin appears to be following the example of the Cliff Swallow in building its nest in the eaves of houses, not to the same extent, however, as that Swallow does, and while it has not entirely deserted the hollow trees, still the change that has been observed in more settled portions of the country is becoming quite noticeable here.

VIREONIDÆ.

VIREO OLIVACEUS, (Linn.) Vieill.—*Red-eyed Vireo.*

A single specimen of the Red-eyed Vireo was taken by me on the 6th of June, 1877, near Fort Sisseton. I had not met with the bird before, nor have I since seen it, and its occurrence here must be accidental.

VIREO GILVUS, (Vieill.) Bp.—*Warbling Vireo.*

On the same day that the preceding Vireo was taken, I also shot a Warbling Vireo about the same place. It is the only one I have ever seen on the "Coteau des Prairies." I kept a sharp lookout for these two Vireos during the spring migrations of 1878, but did not observe any.

LANIIDÆ.

LANIUS LUDOVICIANUS EXCUBITORIDES, (Sw.) Coues.—*White-rumped Shrike.*

On May 16, 1877, I secured a single specimen of this Shrike in the vicinity of Fort Sisseton: this is the only bird of the family I have seen in this region. The specimen measured as follows: 13.00 by 8.60; wing 3.90; tail 3.90; bill 0.60; tarsus 1.02; middle toe and claw 0.80. Black of side of the head meeting that of the opposite side on the forehead, and not interrupted by the white of the under eyelid.

FRINGILLIDÆ.

CHRYSOMITRIS TRISTIS, (L.) Bp.—*American Goldfinch.*

This beautiful little bird is quite common here from May 25 until the first week in June, when its numbers rapidly diminish, a few, however, spending the summer in this vicinity.

PLECTROPHANES LAPPONICUS, (L.) Selby.—*Lapland Longspur.*

Appears April 10, and remains till about May 25; is quite abundant. It does not appear in this region on its southern flight in the fall.

The specimens measure as follows:

No. 606, ♂, 11.00 × 6.50; wing 3.51; tail 2.59.
No. 607, ♂, 11.25 × 6.63; wing 3.75; tail 2.67.

PLECTROPHANES PICTUS, Sw.—*Painted Lark Bunting.*

Is seen here from April 20 until near the end of May, in large flocks (from 25 to 100 birds in each). It passes south in October in company with *P. ornatus*, and when thus migrating, I have seen immense flocks of this bird. I have sat for two hours at a time on a duck-pass, some twelve miles south of the post, and had an almost constant flight of these birds go over me. I estimated that a thousand birds passed me every minute, and their flight appeared in no wise lessening when I departed.

PLECTROPHANES ORNATUS, Towns.—*Chestnut-collared Bunting.*

Is found here during the same period as *P. pictus*, and in large numbers.

PASSERCULUS SAVANNA, (Wils.) Bp.—*Savanna Sparrow.*

Is seen from June 10 until about June 17, probably passing north. Is not common; does not breed in this vicinity so far as I have been able to discover; but I cannot understand the reason of its presence here so late in June, unless it be that it rests in the vicinity.

POŒCETES GRAMINEUS CONFINIS, Bd.—*Western Grassfinch.*

Arrives about April 17 and remains until October 18; is one of the most abundant of our birds, and is found all over the prairie. Breeds here. I observed it off and on during the entire winter of 1877–78 in sheltered places, but this was an unusual occurrence, probably accounted for by the mildness of that winter, for careful search during more severe winters has failed to reveal its presence here during that season.

MELOSPIZA PALUSTRIS, (Wils.) Bd.—*Swamp Sparrow.*

Is a rare visitor to this region. On May 14, 1878, while collecting in the vicinity of the post, I shot a single bird of this species.

MELOSPIZA MELODA [*], (Wils.) Bd.—*Song Sparrow.*

Is seen for four or five days from June 10 in small numbers; is prob-

[* The indefensible orthography "melodia" has stood long enough. There is, indeed, the Latin noun *melodia* (μελῳδία); but the word is obviously the adjective *melod-us, -a, -um.*—ED.]

ably passing north during this time, and tarries but a few days in this region. I have not observed it returning south. As in the case of the Savanna Sparrow, I am unable to account for its presence here as a migrant so late in June, as it certainly does not breed in this vicinity.

JUNCO HYEMALIS, (L.) Scl.—*Snowbird.*

Is a regular winter resident. Arrives about November 14, generally with the first snow-storm, and disappears about April 16, with stragglers seen until May 8. As a rule is quite common during this time, but through mild winters but few are seen here.

The specimens measure as follows:

No. 602, ♂, 11.75 × 6.90; wing 4.20; tail 2.85.
No. 603, ♀, 11.73 × 6.90; wing 4.23; tail 2.90.
No. 604, ♂, 11.70 × 6.87; wing 4.20; tail 2.85.
No. 696, ♀, 12.20 × 7.00; wing 4.30; tail 2.70.
No. 697, ♂, 12.25 × 7.05; wing 4.40; tail 2.90.

SPIZELLA MONTICOLA, (Gm.) Bd.—*Tree Sparrow.*

Appears April 10 and remains until the end of October; is very abundant and breeds here. During early spring, before the trees have put forth their leaves, it is one of the most familiar birds one meets about the woods.

SPIZELLA PALLIDA, (Sw.) Bp.—*Clay-colored Sparrow.*

June 28, 1878, I shot a single Clay-colored Sparrow near the Post. This is the only one I have met with in three years' collecting here, and I therefore conclude it is only of very occasional occurrence in this region.

ZONOTRICHIA QUERULA, Gamb.—*Harris's Sparrow.*

A single specimen of this Sparrow was secured May 21, 1878, near the Post: its presence here I believe to be purely accidental, as in all my collecting here I have met with but this one bird.

CALAMOSPIZA BICOLOR, (Towns.) Bp.—*White-winged Blackbird.*

Appears on the prairie about July 14, in quite large flocks, and remains until July 24, in this vicinity. Appears quite a strange bird, and selects its feeding-grounds with considerable care, for it is not found on the high ground, but on the fertile grassy lower ground; but not on the low moist ground, however.

EUSPIZA AMERICANA, (Gm.) Bp.—*Black-throated Bunting.*

Is found here from June 9 until July 26 in considerable numbers, and I believe it breeds in this vicinity, but of this I have no positive evidence.

The specimens measure as follows:

No. 666, ♂, 10.00×6.50; wing 3.13; tail 2.27; tars. 0.87; m. t. & c. 0.95; bill 0.57.
No. 667, ♂, 9.90×6.25; wing 3.04; tail 2.10; tars. 0.80; m. t. & c. 0.86; bill 0.55.

GONIAPHEA LUDOVICIANA, (L.) Bowdich—*Rose-breasted Grosbeak.*

Usually arrives by the 10th of May, and is seen in small numbers, sometimes around the buildings at the post, but generally in the woods, until the first week in June, when it retires to the more heavily wooded ravines on the slopes of the coteaus. Departs during the early part of September. It is quite familiar during the early part of its stay here, and although I have observed it closely, I have never heard it sing at this season.

The specimen measures as follows:

No. 691, 13.00 × 8.10; wing 3.95; tail 3.35.

CYANOSPIZA CYANEA, (L.) Bd.—*Indigo-bird.*

The Indigo-bird is not common in this vicinity; a few are seen during the migrations each May, generally about the 25th, but the bird does not remain in this region during summer.

CARDINALIS VIRGINIANUS, (Briss.) Bp.—*Cardinal Grosbeak.*

The Cardinal Redbird is only of casual occurrence in this region. On May 25, 1877, while out collecting in the vicinity of Fort Sisseton, I saw a pair in the scattered trees on the outside of a thick growth of timber to the east of the post; they were in plain view, and as the more brilliantly plumaged birds are rare in this vicinity, the appearance of the male bird was the more striking, as it sat watching me from the highest tree-top; the female was perched upon a tree near by, intensely interested in my movements, but not more so than I was in theirs. Despite all my endeavors, I could not succeed in securing either bird; two or three times they took to wing and alighted in trees a little further from me each time, not seeking the thick woods, but keeping me in plain view all the while; they finally took to flight in a southerly direction, and were soon out of sight.

A male bird of this species was seen several times during the summer of 1877, in a deep ravine at the head of the Coteau. It would come in the early morning, and sit on the same tree, outside of the cabin, morning after morning, and if undisturbed would sing for ten or fifteen minutes, but would fly away on the slightest noise being made. I doubt not the female was well concealed in the woods near by. Many endeavors were made to capture it, but it eluded them all.

ICTERIDÆ.

DOLICHONYX ORYZIVORUS, (L.) Sw.—*Bobolink; Reed-bird; Rice-bird.*

Sexes are entirely different in color.

♂ in spring: black, usually more intense beneath; back of neck buff; shoulders, rump, and upper tail-coverts ashy-white; space between the shoulders streaked with black, buff, and ashy; outer quills edged with yellowish; bill blackish horn; feet brown.

♂ in fall, ♀, and young: yellowish-brown above, brownish-yellow below; crown and back conspicuously, upper part of neck, rump, and sides of body less broadly

streaked with black; crown with a middle and lateral light stripe; wings and tail blackish, pale-edged; bill brown. The male changing shows confused characters of both sexes. Length, 6½–7½ inches; wing 3½–4; tail 2½–3 inches.

The Reed-bird forms a delicate morsel for the table, and is generally distributed over Dakota.

At Fort Sisseton it arrives May 19, and remains until about July 24. Is found in considerable numbers scattered all over the "Coteau des Prairies," where it breeds, and soon after takes its departure. The Bobolink is in prime condition for the table on its arrival, and is justly esteemed a delicate morsel.

MOLOTHRUS ATER, (Gm.) Gr.—*Cowbird.*

Is seen from April 17 until October 28 in large numbers.

AGELÆUS PHŒNICEUS, (L.) V.—*Red-winged Blackbird.*

Arrives about April 17 and remains until October 28; is quite common around the sloughs and moist places, where it also breeds.

XANTHOCEPHALUS ICTEROCEPHALUS, (Bp.) Bd.—*Yellow-headed Blackbird.*

Arrives April 20, to remain until September 28; is found in large numbers. It will be observed that this bird arrives a little later and takes its departure long before the other Blackbirds do.

The specimens measure as follows:

No. 629, ♂, 17.00 × 10.25; wing 5.65; tail 4.27; tarsus 1.30; bill 0.80.
No. 630, ♂, 16.75 × 10.25; wing 5.25; tail 3.90; bill 0.85.

STURNELLA MAGNA NEGLECTA, (Aud.) All.—*Western Field Lark.*

Sexes are alike in color.

Prevailing ground-color gray; each feather of back and neck blackish, with terminal reddish-brown area and sharp brownish-yellow borders; crown streaked with black and brown, with a pale middle stripe; behind the eye is a blackish line, and over the eye is a pale stripe; several outer tail-feathers white; edge of wing, spot over eye, and under parts generally bright yellow; the sides flaxen-brown, with sharp blackish streaks; the breast with a large black crescent, which is obscure in the young. Length 10–11 inches; wing 5; ♀ a trifle smaller.

This is one of the earliest of our spring arrivals, making its appearance usually about April 13; it varies with the opening of spring, of which event, anxiously looked forward to by all as the relief from our long winter's confinement to closed houses and heated rooms, it is the sure harbinger. Very common; breeds here, and takes its departure about the middle of October.

ICTERUS SPURIUS, (L.) Bp.—*Orchard Oriole.*

Arrives usually by the 22d of May, and in considerable numbers; breeds in the woods, all over the Coteau, and departs about September 1.

ICTERUS BALTIMORE, (L.) Daud.—*Baltimore Oriole.*

Arrives about May 19, and remains until September 1. Is seen in small numbers about the woods all over the head of the Coteau; breeds here.

The specimens measure as follows:

No. 640, ♀, 11.75 × 7.75.
No. 660, ♂, 11.90 × 7.70.

QUISCALUS PURPUREUS, (Bart.) Licht.—*Purple Grackle.*

This bird arrives about April 17, and from that time until its disappearance at the end of October is found in large numbers all over the prairie and about buildings, as also in woods, where I have often found it particularly numerous, and under such circumstances as to lead me to believe that it was indulging in that carnivorous propensity observed by Mr. Gentry and mentioned on page 204 of Professor Coues's Birds of the Northwest.

CORVIDÆ.

CORVUS CORAX, Linn.—*Raven.*

The only Ravens I have ever seen on the "Coteau des Prairies" were a pair I procured from Indians July 9, 1876; I believe they had been bred in the immediate vicinity of the Post, to the north, as stated by the Indians, and also on account of their age; although it seems strange that their occurrence could have escaped my notice in the careful scrutiny I have given the region.

CORVUS AMERICANUS, Aud.—*Common Crow.*

The Common Crow is a rare visitor to this region. It is occasionally seen late in winter and in the early spring, but does not remain to molest the agriculturist. Much as elsewhere, the Crow appears as a very wary, I might almost say knowing, bird: it is exceedingly difficult to get within gun-shot range of it. At Fort Berthold, D. T., where I observed it in numbers in the spring of 1873, doing much damage to the young corn and other parts of the crop, it was quickly driven from that vicinity by poisoning corn and sprinkling it around the scene of their operations, and although only a few dead birds were discovered, it took the hint and left for a more agreeable abode.

CYANURUS CRISTATUS, (L.) Sw.—*Blue Jay.*

Is seen occasionally during the summer months in the heavily timbered ravines on the slopes of the Coteau; does not occur in any numbers. November 30, 1878, I saw a single Blue Jay in the woods at Fort Sisseton. This Jay was also in the vicinity of the Post as late as December 10.

TYRANNIDÆ.

TYRANNUS CAROLINENSIS, (L.) Bd.—*Kingbird.*

Arrives May 16, and departs about September 9; is very common during the period of its stay. Breeds here.

TYRANNUS VERTICALIS, Say.—*Arkansas Flycatcher.*

Is found from May 22 until September 9 in considerable numbers; is associated with the preceding species, but is not nearly so common. Breeds here.

CONTOPUS VIRENS, (L.) Cab.—*Wood Pewee.*

Arrives about the 15th of May in numbers, and is seen until June 6, when it takes its departure. Does not breed in this vicinity, to my knowledge.

CAPRIMULGIDÆ.

CHORDILES VIRGINIANUS, (Gm.) Bp.—*Night-hawk.*

The typical *C. virginianus* makes its appearance about May 25, and remains until September. Is seen in large numbers, and breeds here. This bird often builds its nest on the bare ground, with scarcely any protection from winds or rains. I have also observed it build in a shallow excavation in a large bowlder, just the place to get the full benefit of all the rain at that season of the year.

TROCHILIDÆ.

(?) TROCHILUS COLUBRIS, Linn.—*Ruby-throated Hummingbird.*

A single Hummingbird seen at Fort Sisseton, September 11, 1877, I place under this head with a doubt. The specimen was not secured, and I did not have an opportunity of observing it closely, as it was almost constantly in motion, flying from flower to flower.

CUCULIDÆ.

COCCYGUS ERYTHROPHTHALMUS, (Wils.) Bp.—*Black-billed Cuckoo.*

The Black-billed Cuckoo reaches this region by the end of May and remains until the end of September. Its notes are occasionally heard, but the bird is not common. It undoubtedly breeds here.

The specimen measures as follows:

No. 695, ♀, 16.00 × 11.90; wing 5.60; tail 6.40.

PICIDÆ.

PICUS VILLOSUS, Linn.—*Hairy Woodpecker.*

The typical *villosus* is a regular winter resident; it can be seen and heard on the coldest days pecking away at the trees. I have never observed it during the spring and summer months, and presume it departs on the approach of spring. I do not believe it breeds in this vicinity.

MELANERPES ERYTHROCEPHALUS, (L.) Sw.—*Red-headed Woodpecker.*

Appears early in May, and remains until the end of September; is found in small numbers; breeds here.

COLAPTES AURATUS, (Linn.) Sw.—*Golden-winged Woodpecker.*

During the winter of 1877–78, I sometimes met with this bird in my rambles, but it was not by any means common, and its presence here at that season is an event that only occurs in mild winters. Ordinarily the Golden-winged Woodpecker makes its appearance about the end of April, and from that time till the end of October, when it usually departs, is seen in considerable numbers; generally about the dead oaks, in which it breeds.

STRIGIDÆ.

BUBO VIRGINIANUS, (Gm.) Bp.—*Great Horned Owl.*

This Owl is a summer resident on the "Coteau des Prairies," where I have secured several specimens; it is not by any means common, however.

NYCTEA SCANDIACA, (L.) Newt.—*Great White Owl.*

Is occasionally seen during the winter on the prairie; not, however, in any numbers.

FALCONIDÆ.

CIRCUS CYANEUS HUDSONIUS, (L.) Coues.—*Marsh Hawk.*

Arrives May 2, and remains until about the middle of October; is seen in small numbers; breeds here.

ELANOIDES FORFICATUS, (L.) Coues.—*Swallow-tailed Kite.*

The following note is taken from Vol. 3, No. 3, p. 146, Bulletin of the Nuttall Ornithological Club: "I am informed by my valued correspondent Dr. C. E. McChesney, U. S. A., of the occurrence of *Elanoides forficatus* at Fort Sisseton, Dakota, during nearly the whole of last winter. The Indians also informed Dr. McChesney of the residence of the bird along the James River in the winter and early spring months, and of its giving them some trouble by springing their traps, occasionally, however, getting caught itself. This account tallies with Trippe's Minnesota record (north of Mille Sac, lat. 47°). While at Pembina, Dakota, lat. 49°, I was assured by an officer of the occasional appearance of the bird there.—Elliott Coues, Washington, D. C."

I made many attempts to secure a specimen, but the birds were very shy, and I could not succeed in getting within gun-shot range of any, as they would alight in the highest tree-tops, from which they could watch me and take to wing when necessary.

ACCIPITER FUSCUS, (Gm.) Bp.—*Sharp-shinned Hawk.*

Is found in small numbers from May 1 until about the end of October. Breeds here.

ACCIPITER COOPERI, Bp.—*Cooper's Hawk.*

Cooper's Hawk is a regular spring visitor, but does not remain any time in this vicinity; usually arrives May 18, and none are seen after the end of that month. Is not common.

FALCO COMMUNIS, Variorum.—*Peregrine Hawk.*

Arrives early in April, closely following the spring migration of the wild fowl, and the majority pass further north; but a few remain in this vicinity during the summer.

FALCO COLUMBARIUS, Linn.—*Pigeon Hawk.*

Is not of common occurrence on the Coteau. A few were observed during the last week in April, 1877, and quite a number were shot during the early part of the summer of 1878, but it does not remain through the summer.

FALCO SPARVERIUS, Linn.—*Sparrow Hawk.*

Is found here from April 15 to near the end of October; is at no time very common. Breeds here.

BUTEO BOREALIS CALURUS, (Cass.) Rigdw.—*Western Hen Hawk.*

The Western Hen Hawk arrives about the 1st of May, and remains until cold weather drives it to a more southern climate, usually about the 1st of October; is not common.

BUTEO SWAINSONI, Bp.—*Swainson's Buzzard.*

Arrives about May 10, and remains until October 30; is seen in considerable numbers. Breeds here.

AQUILA CHRYSAËTUS, Linn.—*Golden Eagle.*

Was seen during the spring of 1878; also on November 25, 1878, a single Golden Eagle was seen on the Coteau, about 20 miles east of Fort Sisseton.

HALIÆTUS LEUCOCEPHALUS, (L.) Savigny.—*Bald Eagle.*

Is only a casual visitor to this region. April 30, 1878, a single specimen was taken in the vicinity of the post.

CATHARTIDÆ.

CATHARTES AURA, (L.) Illiger.—*Turkey Buzzard.*

Is found here from May 24 until October 30 in considerable numbers. Breeds here.

COLUMBIDÆ.

ECTOPISTES MACRURUS, (L.) Coues.—*Wild Pigeon.*

Sexes are different in color.

♂ dull blue with olivaceous tinge on back; below, dull purplish-red, whitening on vent and under tail-coverts; sides of neck golden and ruby; some wing-coverts black-spotted; quills blackish, with slaty whitish and rufous edging; middle tail-feathers bluish-black, the others white or ashy, the inner webs black toward the base, with a chestnut patch; bill black; feet yellow. ♀ and young duller and more brownish or olivaceous above, below dull grayish, with a tawny tinge anteriorly, or quite gray; very young have the feathers skirted with whitish: 15 to 17 inches long; wing and tail 7–8 inches. Tail of 12 feathers.

During the fall of 1877, the Wild Pigeon was taken in some numbers about the head of the "Coteau des Prairies." I also observed it in July of 1878, but it is only an occasional visitor to this region.

ZENÆDURA CAROLINENSIS, (L.) Bp.—*Carolina Dove.*

Sexes are different in color.

♂ brownish-olive above, glossed with blue on the crown and upper part of neck; below, purplish-red, becoming tawny-white on the vent and under tail-coverts; neck metallic golden; a velvety black spot on the feathers covering the ear, and others on the wing-coverts and shoulders; middle tail-feather like the back, the rest ashy-blue at base, then crossed by a black bar, then white or ashy-white; bill very slender, black; feet carmine. ♀ and young differ, as in the Wild Pigeon. 11–13 inches long; wing 5–6; tail 6–7. Tail of 14 feathers.

Arrives about May 17, and remains until September 30; is found in considerable numbers; breeds here.

TETRAONIDÆ.

TETRAO OBSCURUS, Say.—*Dusky Grouse.*

Sexes are scarcely distinguishable by color.

♂ blackish, more or less variegated with slate-gray or a peculiar slaty-black; throat and sides marked with white; breast black; belly slaty; tail clouded with slate and black, and with a broad terminal slate bar: 18–20 inches long; wing 9–10; tail 7–8. ♀ smaller, not particularly different in color, but not so uniformly dark, having ochrey or reddish-brown variegations in places. Rocky and other mountains. United States to the Pacific. Tail normally of 20 feathers; no peculiar feathers on the neck; legs feathered to the toes.

CENTROCERCUS UROPHASIANUS, (Bp.) Sw.—*Sage Cock.*

The sexes are alike in color.

Tail very long, equalling or exceeding the wings, of twenty stiffened, graduated feathers tapering to a point; sides of lower neck with a patch of peculiar sharp scaly feathers, the shafts of which terminate in bristly filaments, sometimes 3 to 4 inches long in the ♂; legs full-feathered. Very large: 2 feet or more long; wing and tail each about a foot. ♀ much smaller; above variegated with black, gray, and tawny; below, a large black abdominal patch in the adult. Sage-brush tracts of Western United States.

Of all the birds of the Grouse family, the Sage Hen is perhaps the poorest for food; the young can be so cooked, by parboiling and stewing, up to about the 1st of October, as to furnish a fair article of diet; but after this date the flesh is too highly flavored with the wormwood to be rendered palatable by any means with which I am acquainted.

PEDIŒCETES PHASIANELLUS COLUMBIANUS, (Ord.) Coues.—*Common Sharp-tailed Grouse.*

Sexes are alike in color.

Neck without peculiar feathers; tail very short, of sixteen narrow, soft, true tail-feathers, and a middle pair, apparently developed coverts, projecting an inch beyond the rest (often worn off or not fully developed, so that there is but little, if any, projection of these coverts); legs fully feathered: length about 18 inches; wing 8–9; tail 5–6. The markings black, white, and especially tawny; below, the spots fewer, brown, U-shaped; throat buff.

This Grouse is found here in small numbers throughout the entire year. The region is not favorable for the increase of this bird, for, aside from those destroyed by the Indians in season and out of season, the destruction of the young by birds of prey and of the nests by prairie fires, the only food it can find during the winter consists of a few scattered rosebuds.

CUPIDONIA CUPIDO, (L.) Bd.—*Pinnated Grouse; Prairie Hen.*

The sexes are alike in color.

Neck with a peculiar tuft of loose, lengthened, tapering feathers, beneath which is a patch of bare, brightly colored skin, capable of great distention; tail short, rounded, of eighteen stiffish, non-tapering feathers; feet barely feathered to the toes. Length 16–18 inches; wing 8–9; tail about 5. Above, variegated with black, brown, tawny, or ochrey, and white, the latter especially on the wing; below, pretty regularly barred with dark brown, white, and tawny; throat tawny, a little speckled or not; vent and under tail-coverts mostly white; quills dark brown, with white spots on the outer webs; tail dark brown, with narrow or imperfect white or tawny bars and tips. ♀ smaller, with shorter neck-tufts.

Missouri River, above Fort Randall, and probably as high as Fort Sully, D. T.

During the fall of 1876, I observed the Pinnated Grouse here for the first time, and apparently it was more common than the preceding species, and in accordance with the history of the two birds I anticipated the speedy disappearance of the Common Sharp-tailed, but this has not occurred, and I saw only two or three specimens of the Pinnated Grouse during the season of 1877, and I am informed none were taken during the season of 1878, so that at the present time *C. cupido* is not found here, while *P. phasianellus* is the characteristic Grouse of this region.

This experience with the two Grouse is at variance with that of Surgeon J. F. Head, U. S. A., Minnesota record, as given in Professor Coues's "Birds of the Northwest," and also with that of many other good observers, and I can only explain the matter on grounds of the unfitness of the locality as regards shelter, and the fact that the country has not been settled and the soil sufficiently cultivated to furnish them their favorite food; when these conditions shall have been removed, I anticipate the appearance of *C. cupido* in this region to displace *P. phasianellus.*

BONASA UMBELLUS UMBELLOIDES, (Dougl.) Bd.—*Rocky Mountain Ruffed Grouse.*

Sexes are nearly alike in color.

The Eastern representative of this bird is known as the Partridge in New England and the Middle States, and as the Pheasant in the Southern States. Sides of neck with a tuft of numerous (15–30) broad, soft, glossy-black feathers; head with a full soft crest; tail about as long as the wings, amply rounded, of (normally) 18 soft broad feathers; feet naked below. Length 16–18 inches; wing 7–8. Slaty-gray is the prevailing color in this variety.

Rocky Mountain region.

ORTYX VIRGINIANA, (L.) Bp.—*Virginia Partridge; Quail.*

Sexes may be distinguished by color.

This is the Virginia Partridge or Quail: Bob White. Wherever the Ruffed Grouse is called "Partridge" in the New England and Middle States, this bird is there known as "Quail," and wherever in the Southern States the Ruffed Grouse is called "Pheasant," this bird is there known as "Partridge."

Head completely feathered, the crown ones somewhat lengthened and erectile, but hardly forming a true crest. Forehead, a line over the eye, and the throat white, bordered with black; crown, neck all round, and upper part of breast brownish-red; other under parts tawny-whitish, all with more or fewer doubly crescentic black bars; sides broadly streaked with brownish-red; upper parts variegated with chestnut, black, gray, and tawny, the latter edging the inner quills. ♀ known by having the throat buff instead of white, less black about the fore parts, and general colors less intense; rather smaller than the ♂: 9–10 inches long; wing 4½–5; tail 2½–3.

Eastern United States to high central plains; the characteristic game bird of this country. Missouri River as high as Fort Sully, Dakota, where I saw them in 1871.

CHARADRIIDÆ.

SQUATAROLA HELVETICA, (L.) Cuv.—*Black-bellied Plover.*

Sexes are alike in color.

A small hind toe, hardly ¼ inch long (this is the only 4-toed Plover treated of in this pamphlet); plumage speckled. Adult in breeding season (rarely seen in the United States): face and entire under parts black, upper parts variegated with black and white or ashy; tail barred with black and white; quills dusky, with large white patches. Adult at other times (and this is the plumage in which seen in Dakota) and young: below, white, more or less shaded with gray, the throat and breast speckled with dusky; above, blackish, speckled with white or yellowish; the rump white, with dark bars; legs dull bluish. Old birds changing show every grade, from a few isolated black feathers on the under parts to numerous large black patches. Length 11–12; wing 7 or more; tail 3; bill 1–1¼.

I have only observed this bird in Dakota Territory during the fall migration.

During the migrations I have kept a sharp watch for the Black-bellied Plover, but I have not yet discovered the bird passing this region during the spring; it arrives, however, on its southern flight, about October 25, and remains in this vicinity for four or five days, during which time it is seen in considerable numbers.

It may be that this Plover has succeeded in eluding my search during the spring, and that it does really pass this region. I have elsewhere mentioned in these notes of this bird being one of the two exceptions, falling under my notice here, of a migratory bird appearing in the fall that is not known to pass this region during the spring. The other exception is that of the Blue Goose, which, if a valid species, we should naturally expect to find passing this region, as being within the normal migratory spring range of its kind. But with the Black-bellied Plover the case is different: its normal spring line, so far as is now known, is not near as far inland as Dakota.

On page 449 of his "Birds of the Northwest," Dr. Coues states that Dr. Suckley found it "moderately abundant" in Minnesota. I suppose reference is here made to the time (1853) when Dr. Suckley was on duty as surgeon and naturalist of the Survey of the Forty-seventh Parallel, under Governor I. I. Stevens. Although the party did not leave Saint Paul until June 8 of that year, Dr. Suckley was engaged for some time before in making collections in the neighborhood of Saint Paul, and was so engaged during the migration of the Golden Plover through that region; and as this bird is in full breeding plumage at this time, and much resembles the Black-bellied Plover, it is not improbable that Dr. Suckley mistook *C. fulvus virginicus* for *S. helvetica*. I believe Dr. Suckley's collection, to which reference is made above, was lost in the Ohio River, which is much to be regretted, as I know of no observations made since that time (1853) that would support Dr. Suckley's reference of this bird to Minnesota during the spring migrations. [*]

CHARADRIUS FULVUS VIRGINICUS, (Borck.) Coues.—*American Golden Plover.*

The sexes are alike in color.

No hind toe; plumage speckled above, and in the breeding season (generally so seen throughout Dakota and Montana during the spring migration) black below, as in the last species, but much of the speckling bright yellow, and the rump and upper tail-coverts like the back; forehead and a broad line over the eye to the nape white; tail-feathers grayish-brown, with imperfect white or ashy bars; feathers of the armpits gray or ashy. At other times, the under parts nearly as in the last species. Length 10--11; wing 7 or less; tail under 3; bill 1 or less. A highly-rated game bird, abundant in most parts of Dakota during the spring and fall migrations.

Early in May, the Golden Plover's migrations find him in this region. At this time, the birds are in full breeding plumage, and tarry but a few days. Early morning and evening appears to be the time selected for flight, and from the 1st to the 10th of May, they pass over in flocks, containing from thirty or forty to several hundreds, and sometimes thousands, of birds, and so constant is the flight that a person here could scarcely be blamed for thinking that he must stand on the only route leading to their northern summer resort. At this time, the birds are in prime condition for the table, and there is no trouble in taking all that are required. From about September 23 to October 26, it loiters here on its return to the South in considerable numbers.

Professor Coues, in his "Birds of the Northwest," page 451, states that he met with this bird between Fort Randall and Yankton on the Missouri River, in company with the Bartramian Tattler and Esquimaux Curlew, and that he found them not at all shy. Where the line of departure may be taken I know not, but the Esquimaux Curlew does not pass this region, and the Golden Plover has become a very shy bird by the time of its arrival here. When feeding, they are constantly on the lookout for danger, and post their pickets regularly, so that it is almost

[*This is doubtless a just observation. I have found the Golden Plover extremely numerous in Eastern Dakota during the spring migration.—C.]

impossible to get within gun-shot range of the flocks; when on the wing, however, they loose their shyness, and are then easily captured.

ÆGIALITIS VOCIFERA, (Linn.) Cass.—*Kildeer Plover.*

This bird, the most restless of all the Plover family, arrives April 13, and remains until about the 1st of September, and is found in large numbers around all the lakes, and to some extent in cultivated upland, which it seems to like for nesting purposes.

ÆGIALITIS SEMIPALMATA, (Bp.) Cab.—*Semipalmated Plover.*

I believe this Plover only occasionally passes this region during the spring migrations. On May 11, 1877, while out collecting, a flock containing thirty-five or forty birds passed high overhead, from which a single specimen was secured. I have never met with it in the fall.

The specimen measures as follows:

No. 690, 14.50 × 7.10; wing 4.60; tail 2.15.

HÆMATOPIDÆ.

STREPSILAS INTERPRES, (L.) Ill.—*Turnstone.*

Sexes are alike in color.

Adult in summer pied above with black, white, brown, and chestnut-red, the latter color wanting in winter and in young birds; below, from the breast (which is more or less completely black), throat, most of the inner quills, bases and shafts of outer quills, and bases and tips of tail-feathers white; bill black; feet orange: 8–9; wing 5½–6; tail 2½; bill ⅞, almost recurved, sharp-pointed: legs bare but a little way: no obvious basal webbing of toes.

I believe that the Turnstone will be found to occur throughout many parts of Dakota during the spring migration. Careful search should be made for the bird at this time, and its occurrence reported. It will be found usually along the beach turning over stones in search of its food, from which curious habit it derives its name.

The Turnstone regularly passes this region during May of each year. I have observed it for the last three years on several occasions, and the bird was always quite shy, and I found considerable difficulty in taking specimens. As I have observed it here, the Turnstone is not a gregarious bird, as I have never seen more than three or four together. This record constitutes the only Dakota notice of this bird, so far as I am aware.

The specimens measure as follows:

No. 649, ♂, 17.00 × 9.00; tarsus 1.00.
No. 693, ♀, 18.50 × 9.40; wing 5.90; tail 2.70; tars. 0.94; m. t. & claw 1.12; bill 0.93.

RECURVIROSTRIDÆ.

RECURVIROSTRA AMERICANA, Gm.—*Avocet.*

Sexes are alike in color.

White; back and wings with much black; head and neck cinnamon-brown in the adult, ashy in the young; bill black; legs blue; eyes red: 16–18 long; wing 7–8; tail 3½; legs very long. Bill recurved.

Arrives at the beginning of May, and breeds sparingly in this vicinity.

The majority pass further north, and return early in July, from which time the Avocet is quite a familiar shore bird around the preferred lakes, until the approach of winter drives it south, usually October 30.

PHALAROPODIDÆ.

STEGANOPUS WILSONI, (Sab.) Coues.—*Wilson's Phalarope.*

Is found here from about May 17 until July 24, by which time the young are well on the wing, and fully able to care for themselves. It is singular that this bird should leave this region so early, but close search has failed to reveal its presence after July.

SCOLOPACIDÆ.

PHILOHELA MINOR, (Gm.) Gr.—*American Woodcock.*

Sexes are alike in color.

First three outer quills incised and scythe-shaped; wings short, when closed the quills hidden by the coverts and tertiaries; legs feathered nearly to the joint in front, shorter than middle toe and claw, scaly before and behind; toe slender, free to the base; bill much longer than the head, stout and deep at base, grooved nearly its whole length, the tip knobbed; gape very short and narrow; ear under the eye, which is set in the back upper corner of the head; colors above variegated and harmoniously blended black, brown, gray, and russet; below pale warm brown of variable shade. ♂ 10–11; ♀ 11–12; extent 16–18; wing 4½–5; bill 2½–3; weight 5–9 ozs. Bogs, swamps, wet woodland, and fields. Occurs in the eastern, and probably southern, portions of Dakota.

The only Woodcock I have seen in this vicinity was one shot by my friend Capt. John Vander Horck, July 28, 1877; it was captured on a piece of low, marshy ground, some five miles north of the post, and from its manner of flight and behavior before being shot I mistook it for a Carolina Rail. It is quite probable that such has happened to me before, and that this bird may occur in small numbers on the "Coteau des Prairies" during July.

Since the above was written, and during my absence in the summer of 1878, several Woodcock have been taken in the vicinity of Fort Sisseton.

GALLINAGO WILSONI, (Temm.) Bp.—*American Snipe.*

Sexes are alike in color.

Bill much longer than the head, perfectly straight, soft to the end, where it is somewhat widened, and grooved on top; gape narrow, not reaching beyond the extreme base of upper mandible; ear under eye; legs feathered nearly to the joint, a little shorter than middle toe and claw; toes perfectly free; crown black, with a pale middle stripe; back varied with black, bright bay, and tawny, the latter forming two lengthwise stripes on the shoulders; neck and breast speckled with brown and dusky; lining of wings barred with black and white; tail usually of 16 feathers, barred with black, white, and chestnut; sides waved and dusky; belly dull white; quills blackish, the outer white-edged. Length 9–11; wing 4½–5¼; bill about 2½; whole naked portion of leg and foot about 3.

"This is the genuine Snipe, of all birds loosely so called; its name of English Snipe is a misnomer, as it is indigenous to this country, and distinct from any European species, though closely resembling one of them. Open wet places of North America at large; migratory."

Occurs in many portions of Dakota during the spring and fall migrations; a prime bird for the table.

Wilson's Snipe is seen here only during the spring migrations, which, for this bird, are generally from the 1st to the 6th of May, but sometimes there is a variation of a week either way. Whatever may be the time of its arrival, the bird does not seem to pass this region in any numbers, but the few taken are in prime condition for the table, showing that its migration has been by easy flights. Several careful searches for the bird, during the fall, have not been attended with successful results, and I believe it does not pass this way on its southern flight, or, if so, it certainly does not loiter.

The specimen measures as follows:

No. 621, ♀, 17.00 × 10.50; wing 5.21; bill 2.43; tarsus 1.21.

MACRORHAMPHUS GRISEUS, (Gm.) Leach.—*Red-breasted Snipe.*

Sexes are alike in color.

A very Snipe-like bird, with the bill exactly as in the last species, but readily distinguished generically; legs bare upwards of ¾ of an inch, longer than middle toe and claw; outer and middle toes connected by an evident membrane; tail of 12 feathers. Tail and its coverts at all seasons conspicuously barred with black and white (or tawny); lining of wings and armpits the same; quills dusky; shaft of first quill and tips of middle ones, except the long inner ones, white; bill and feet greenish-black. In summer, brownish-black above, variegated with bay; below, brownish-red, variegated with dusky; a tawny stripe over the eye and a dark one from bill to eye; in winter, plain gray above and on the breast, with few or no traces of black and bay; the belly, line over eye, and under eyelid white. 10–11; wing 5–5½; tail 2½; bill about 2½.

Occurs throughout a large portion of Dakota during the migrations, in flocks, and prefers the shores of the lakes instead of wet meadows.

This Snipe passes north usually about the end of April, but often it is delayed until the 10th of May. I have taken it in considerable numbers at this time, and have always found it a prime bird for the table, being often brought into requisition to supply the place of "quail on toast" for breakfast. It returns to this region about the 20th of September, from which time until the end of October, when it departs, it is the most familiar Wader around the shores of our lakes.

EREUNETES PUSILLUS, (Linn.) Cass.—*Semipalmated Sandpiper.*

Is seen here in large numbers from April 29th until about the 1st of June, when its numbers rapidly diminish, and from that date until near the end of July but few have been observed in this vicinity; returns in numbers early in August, and from that time forward until the lakes commence to close, about November 1, hundreds may be seen at a time around the shores of any of the lakes.

The specimen measures as follows:

No. 673, ♀, 12.00 × 6.40; wing 3.75; tail 1.70; tars. 0.77; m. t. & claw 0.83; bill 0.73.

TRINGA MINUTILLA, Vieill.—*Least Sandpiper.*

Shares much the same habits here as the preceding species; is very common.

TRINGA BAIRDI, Coues.—*Baird's Sandpiper.*

This Sandpiper appears about April 28, and remains until the beginning of June, after which time none are seen here during the remainder of the season. During the time of its sojourn here it is quite abundant. Its habits seem to differ greatly from its little congener, *T. bonapartii.*

The specimen measures as follows:

No. 626, ♀, 14.75 × 7.75; wing 5.00; tail 2.43; tarsus 0.82; bill 0.88.

TRINGA MACULATA, Vieill.—*Pectoral Sandpiper.*

Is found here from about the middle of July to the first of August in considerable numbers.

TRINGA BONAPARTII, Schl.—*Bonaparte's Sandpiper.*

Arrives about the 5th of May and remains until June 13. Is seen in considerable numbers during this time.

LIMOSA FEDOA, (L.) Ord.—*Great Marbled Godwit.*

Sexes are alike in color.

Color and size the same as the Curlew's, but the bill is usually slightly curved *upward,* while among the Curlews it is curved *downward;* this is the main point for the novice.

Tail barred throughout with black and rufous; rump and upper tail-coverts like the back; no pure white anywhere. General plumage rufous or cinnamon-brown; below, nearly unmarked and of very variable shade, usually deepest on the linings of the wings; above, variegated with black and brown or gray; quills rufous and black; bill flesh-colored, largely tipped with black; feet dark. Large, 16–22; wing about 9; tail about 3½; bill 4–5, grooved nearly to the end, usually slightly recurved.

Abundant through many portions of Dakota during the spring and fall migrations. The young birds are excellent food.

Is found here in great numbers from June 14 until September 22, with early arrivals in the latter part of April, and stragglers as late as the middle of October. Does not breed on the Coteau, but does so about forty miles to the east, in Minnesota, as also in parts of Dakota west of the Missouri River.

The specimen measures as follows:

No. 641, ♀, 31.50 × 19.50; wing 9.75; tail 3.00; bill 4.90; tars. 3.25; m. t. & claw 2.10.

LIMOSA HUDSONICA, (Lath.) Sw.—*Hudsonian Godwit.*

Sexes are alike in color.

Tail black, largely white at the base, its coverts mostly white; rump blackish; under parts in the breeding season (and this is the condition in which seen in Dakota) intense rufous, variegated (chiefly barred) with dusky; head, neck, and upper parts brownish-black, variegated with gray, reddish, and usually with some whitish speckling; quills blackish, more or less white at the base. Young and apparently winter specimens much paler, tawny whitish below, more gray above. Considerably smaller than the foregoing: about 15; wing 8 or less; bill 3½ or less.

Occurs as far south in Dakota as latitude 45° 30′ in small numbers; may be more common in the northern part of the Territory.

Several flocks of the Hudsonian Godwit were observed at Fort Sisseton from the 6th to the 26th of May, 1878, and a few were observed in the early spring of 1877, but not, however, in any such number as the suc-

ceeding spring. It does not breed anywhere in this region, and I was greatly surprised at meeting with the bird so far south in May; though it may spend the winters further south than this place, still it is essentially a bird of high northern latitudes, and usually only enters the northern portion of the United States during the winter.

TOTANUS SEMIPALMATUS, (Gm.) Temm.—*Willet.*

Sexes are alike in color.

Toes with two subequal webs; legs bluish or dark; bill straight, comparatively stout, grooved little, if any, more than half its length; toes with two conspicuous basal webs: 12–16; wing 7–8; tail 2½–3; bill 2–2¼. In summer, gray above, with numerous black marks, white below, the jugulum streaked, the breast, sides, and under tail-coverts barred or with arrow-shaped marks of dusky (in winter, and in young birds all these dark marks few or wanting, except on jugulum); upper tail-coverts, most of the middle quills, and basal half of outer quills white; ends of outer quills, their coverts, lining of wings, and armpits black; bill bluish or dark.

This bird arrives about April 29, and remains until September 13, in considerable numbers; breeds here; it seems to feed to some extent on fish, and the flesh is not particularly desirable as food. A strange habit the old birds have of pushing forward the young when there is danger; I remember once seeing a flock containing about a hundred birds, of which probably twenty-five were old ones, quietly feeding on the edge of a lake, but the instant the birds were approached they all took to flight; and the old ones immediately arranged themselves on the outside furthest from me, leaving the young between themselves and the source of danger, and in this order they were permitted to take their departure without molestation.

TOTANUS MELANOLEUCUS, (Gm.) Vieill.—*Greater Telltale.*

Sexes are alike in color.

Feet with very small web between inner and middle toes; legs yellow or green; bill straight or slightly bent upward, very slender, grooved half its length or less, black; legs long and slender. In summer, ashy-brown above, varied with black and speckled with whitish; below, white, lower throat streaked, and breasts, sides, and under tail-coverts speckled or barred with blackish; these latter marks few or wanting in winter and in the young; upper tail-coverts white, with dark bars; tail-feathers marbled or barred with ashy or white; quills blackish. Large: length over 12; wing over 7; tail 3 or more; bill 2 or more.

Arrives during the last week in April or the first part of May, and is seen in considerable numbers for a week or more while passing north. Returns in numbers in the fall, and departs about the same time as *T. flavipes.*

TOTANUS FLAVIPES, (Gm.) Vieill.—*Lesser Telltale.*

Sexes are alike in color.

A miniature of the last; colors precisely the same; legs comparatively longer; bill grooved rather further: length under 12; wing under 7; tail under 3; bill under 2.

These two Telltales occur throughout Dakota during the spring and fall migrations, and the Lesser certainly, if not the Greater also, breeds in the northern part of the Territory.

This bird arrives at Fort Sisseton early in May (sometimes in April),

and remains until October 28. During May and the early part of June it is very common; but from the latter time until near the end of July, but few are met with; but as fall comes on, its numbers increase, and from the 1st of September to the end of the season it is very abundant here. It breeds in this vicinity.

The specimen measures as follows:

No. 672, ♂, 20.50 × 10.96; wing 6.32; tail 2.50; tars. 2.26; m. t. & claw, 1.43; bill 1.53.

TRINGOIDES MACULARIUS, (L.) Gray.—*Spotted Sandpiper.*

Is found here in small numbers from about 1st of July to the 8th of September.

The specimen measures as follows:

No. 669, ♂, 13.00 × 8.10; wing 4.10; tail 2.30.

ACTITURUS BARTRAMIUS, (Wils.) Bp.—*Upland Plover.*

Sexes are alike in color.

Bill straight, about as long as the head, grooved ⅔ of its length, the gape very deep, reaching nearly to below the eyes, the feathers extending on the upper bill beyond those on the lower, which do not fill the space between the forks of the lower jaw; tail very long, more than half the wing, graduated; legs much longer than middle toe and claw; legs bare nearly the length of the latter: length 11–13; wing 6–7; tail 3–4; bill 1–1¼: above, blackish, with a slight greenish reflection, variegated with tawny and whitish; below, pale tawny, of varying shade, bleaching on throat and belly; lower throat with streaks; breast and sides with arrowheads and bars of blackish; armpits and lining of wings pure white, black-barred; quills blackish, with white bars on the inner webs; tail varied with tawny, black and white, chiefly in bars; bill and legs pale, former black-tipped.

North America; abundant; migratory; a highly esteemed game bird, usually found in flocks, in fields, not necessarily near water.

The Upland Plover is very abundant here from May 10 until near the end of August, and breeds nearly everywhere on the prairie. The bird is in good condition for the table from the time of its arrival, and is justly highly appreciated for its delicate flavor. About the middle of August, this Plover commences to congregate in large flocks, when it becomes quite shy, so that its capture is attended with considerable difficulty. Takes its departure about August 26.

TRYNGITES RUFESCENS, (V.) Cab.—*Buff-breasted Sandpiper.*

This strange Sandpiper is seen here a few times each year during the spring migration. On May 22, 1876, while out hunting on the open prairie, a flock containing thirty or forty passed near me, from which one was secured. Two or three others were taken later in the season, on as many different occasions. Of the habits of this bird I know nothing. I have only seen it in open country on the wing, and quick must be the sportsman who then brings it to bag, for it is a whiz-z-z, and the birds are gone.

NUMENIUS LONGIROSTRIS, Wils.—*Long-billed Curlew.*

Sexes are alike in color.

Bill of extreme length and curvature, measuring from 5 to 8 or 9 inches; total length about two feet; wing a foot or less; tail about 4 inches. Plumage very similar to

that of the Godwit; prevailing tone rufous, of varying intensity in different birds, and on different parts of the same bird, usually more intense under the wing than elsewhere; below, the lower throat streaked and the breast and sides with arrow-heads and bars of dusky; above, variegated with black, especially on the crown, back, and wing; tail barred throughout with black and rufous; middle quills rufous; outer quills blackish and rufous; no pure white anywhere; bill black, the under part flesh-colored for some distance; legs dark.

Occurs in many portions of Dakota and Montana.

NUMENIUS HUDSONIUS, Lath.—*Jack Curlew.*

Sexes are alike in color.

Bill medium, 3 or 4 inches long; length 16 to 18; wing 9; tail 3½. Plumage as in the last species in pattern, but general tone much paler; quills barred. Breeds in British America; United States, chiefly during the migrations.

I have never met with this bird in any part of Dakota or Montana.

NUMENIUS BOREALIS, (Forst.) Lath.—*Esquimaux Curlew.*

Sexes are alike in color.

Bill small, under 3 inches long; length 12–15 inches; wing under 9; tail 3. Plumage in tone and pattern almost exactly as in the last species, but averaging more rufous, especially under the wings, and outer quills not barred.

Occurs in parts of Dakota during the migrations.

ARDEIDÆ.

ARDEA HERODIAS, Linn.—*Great Blue Heron.*

Occurs regularly during the spring and fall migrations. It tarries but a few days in this vicinity in the spring time, but is observed in some numbers during September and October.

BUTORIDES VIRESCENS, (Linn.) Cab.—*Green Heron; Poke.*

Arrives the latter part of April or the beginning of May, and remains until October; breeds in the sloughs all over the Coteau, not, however, in any great numbers.

NYCTIARDEA GRISEA NÆVIA, (Bodd.) All.—*American Night Heron.*

Is seen here in considerable numbers from August 10 until October 25; is not seen during the spring migrations.

BOTAURUS MUGITANS, (Bartr.) Coues.—*American Bittern.*

Is found here from May 1 until October 1; is not at any time abundant; breeds here.

GRUIDÆ.

GRUS AMERICANA, (L.) Temm.—*White or Whooping Crane.*

Occurs only during the spring and fall migrations, and even then not in any numbers.

GRUS CANADENSIS, (L.) Temm.—*Brown Crane.*

Is much more frequently met with than the preceding, and a few remain and breed on the Coteau.

The Brown Crane can be very easily domesticated, and they make very docile pets, following a person about from place to place much the same as an antelope or deer would; they will take their night tramps, but are generally on hand the following morning.

RALLIDÆ.

PORZANA CAROLINA, (Linn.) Cab.—*Carolina Rail.*

Sexes are alike in color.

Above, olive-brown, varied with black, with numerous sharp, white streaks and specks; flanks, armpits, and lining of wings barred with white and blackish; belly whitish; under tail-coverts rufescent. Adult with the face and central line of throat black; the rest of the throat, line over eye, and especially the breast, more or less intensely slate-gray, the sides of the breast usually with some obsolete whitish barring and speckling; young without this black, the throat whitish, the breast brown. Length 8–9; wing 4–4½; tail about 2.

Occurs throughout a large portion of Dakota.

Is found at Fort Sisseton, in small numbers, from May 15 until October; breeds in the thick rushes around the margins of the lakes and sloughs.

The specimen measures as follows:

No. 681, ♂, 13.40×8.80; wing 4.25; tail 2.44; tarsus 1.30; middle toe and claw 1.75.

FULICA AMERICANA, Gm.—*American Coot; Mud Hen.*

Arrives about April 20 and remains until October 30; is moderately abundant during this time; breeds in the sloughs all over the Coteau.

ANATIDÆ.

CYGNUS BUCCINATOR, Rich.—*Trumpeter Swan.*

Is seen only during the migrations; in the spring, none stop in this vicinity. When passing south in the fall, I have observed a very few to loiter in the larger lakes.

ANSER HYPERBOREUS, Pall.—*Snow Goose; White Brant.*

Sexes are alike in color.

Bill smooth, the scales or plates very prominent, owing to arching of the edges of the bill. Adult plumage pure white, but in most specimens the head washed with rusty red; outer quills broadly black-tipped; bill lake-red, with white nail; feet the same, with dark claws. Length about 30; wing 17–19; tail 5½–6½; bill 2½.

About the 1st of April, this Goose commences to pass this region, and from then until the early part of May thousands are daily seen passing north; a very few remain and breed. About the middle of September it begins to return from the north, and by the 1st of October is very abundant, being found in flocks often containing several thousand old and young birds; finally departs at the end of October.

The specimen measures as follows:

No. 686, ♂, 59.00 × 29.00; wing 17.50; tail 6.25; tarsus 3.25; bill 2.40.

ANSER CŒRULESCENS, (L.) Vieill.—*Blue Goose.*

Sexes are alike in color.

With the size and exactly the form of the next species, but the plumage ashy, varied with dark brown; the head, upper neck, tail-coverts, and most of the under parts white; the wing-coverts silvery ash.

It is a singular fact that I have never observed this Goose during the spring migrations when the preceding one is so abundant, and with which it first makes its appearance here in the fall and is afterwards constantly found mixed with the flocks of that Goose, and associating with it on terms of such familiarity as to suggest to me the query whether there may not be a doubt as to its distinctness from a *hyperboreus*, and whether it may not in reality be the young of that Goose, or a semi-melanotic condition thereof. I have seen flocks of a *hyperboreus* covering acres of ground, with here and there a Blue Goose scattered apparently indiscriminately through the flock. I have also seen them associated on the wing. The case of this Goose and that of the Black-bellied Plover constitute the only exceptions falling under my notice of a migratory bird appearing in the fall that does not pass this region during the spring migrations. This Goose departs with the preceding about the end of October.

BRANTA CANADENSIS, (L.) Gary.—*Canada Goose; Common Wild Goose.*

Sexes are alike in color.

Tail normally 18-feathered. Grayish-brown, below paler or whitish-gray, bleaching on the under tail-coverts, all the feathers with lighter edges; head and neck black, with a broad white patch on the throat mounting each side of the head; tail black, with white upper coverts; bill and feet black. About 36 inches long; wing 18–20; tail 6½–7½; bill 1¾–2.

Passes this region from the 1st to the 30th of April in large numbers; it loiters but a few days at this season (a very few may breed near the head of the Coteau). Returns about the 15th of September, after which date it is very abundant until its final departure for the season, usually about October 31.

ANAS BOSCHAS, Linn.—*Mallard.*

Sexes are not alike in color.

This Duck and the seven next described are known as the "River Ducks," and are distinguished from the "Sea Ducks" by having the hind toe *simple.*

♂ with the head and upper neck glossy green, succeeded by a white ring; breast purplish-chestnut; tail-feathers mostly whitish; greater wing-coverts tipped with black and white, the middle quills with a violet marking, black-bordered; bill greenish-yellow; feet orange-red. ♀ with the wing as in the ♂; head, neck, and under parts pale ochrey, speckled and streaked with dusky. Length about 24; wing 10–12.

This Duck appears to enter this region about April 16, and remains until October 30; breeds sparingly in the sloughs; at first, the Mallard is not near as abundant as some of the other Ducks are, but as fall approaches it becomes very common.

DAFILA ACUTA, (L.) Jenyns.—*Pintail; Sprigtail.*

Sexes are not alike in color.

Tail with the middle feathers longest (female and young shorter and not so narrow), 4 to 9 inches long; wing 11; total length about 24. Bill black and blue; feet grayish-blue; head and upper neck dark brown, with green and purple gloss; sides of neck with a long white stripe; lower neck and under parts white; dorsal line of neck black, passing into the gray of the back, which, like the sides, is vermiculated with black; middle quill-markings greenish-purple, anteriorly bordered by buff tips of the greater coverts, elsewhere by black and white; inner quills and shoulders black and silvery. ♀ and young with the whole head and neck speckled or finely streaked with dark brown and grayish or yellowish-brown; below, dusky-freckled; above, blackish, all the feathers pale-edged; only a trace of the greenish markings between the white or whitish tips of the greater coverts and middle quills.

This Duck arrives April 8, and remains until October 22; breeds in small numbers in this vicinity. In the early spring, as also during September and October, it is very abundant, but during the summer only a few Pintails are seen here.

CHAULELASMUS STREPERUS, (L.) Gray.—*Gadwall; Gray Duck.*

Sexes are not alike in color.

♂ with most of the plumage barred or half-ringed with black and white or whitish; middle wing-coverts chestnut; greater coverts black; marking of middle quills white; ♀ known by these wing-marks: 19–22; wing 10–11.

Is seen here from April 8 until October 22, in large numbers; breeds here.

MARECA AMERICANA, (Gm.) Steph.—*American Widgeon; Baldpate.*

Sexes are not alike in color.

Head and neck grayish, dusky-speckled; top of head white (in full plumage), its sides with a broad green patch. Bill shorter than head, grayish-blue like the feet; fore breast light brownish-red; belly pure white; under tail-coverts abruptly black, middle and greater coverts white, the latter black-tipped; middle quill-markings green, black-bordered: 20–22; wing 11; tail 5; bill 1⅛–1¼. ♀ known by the wing-markings.

Enters this region about April 22, and the greater majority pass, in a few days, further north; it is probable, however, that a very few breed in this vicinity, as I have taken this Duck on several occasions during the summer months; about the 1st of September, it begins to return from the north, and by the middle of the month is very abundant; finally departs October 30.

The specimen measures as follows:

No. 668, ♂, 33.75 × 20.50; wing 10.40; tail 5.00.

QUERQUEDULA CAROLINENSIS, (Gm.) Steph.—*Green-winged Teal.*

Sexes are not alike in color.

Subcrested; head and upper neck chestnut, with a broad glossy green band on each side, whitish-bordered, uniting and blackening on back of neck; under parts white, the fore breast with circular black spots; upper parts and flanks closely waved with blackish and white; under tail-coverts black, varied with white or creamy; bill black; feet gray. A conspicuous white crescent on the side of the body just in front of the bend of the wing; shoulders plain; middle quill-marking rich green. No blue on the wings. ♀ differs especially in the head-markings, but those of the wings are the same. Small: 14–15; wing 7½; tail 3½; bill 1½.

Arrives April 24, and remains a few days in this vicinity before pass-

ing north for the summer; returns early in August in large numbers and remains until September 30.

QUERQUEDULA DISCORS, (L.) Steph.—*Blue-winged Teal.*

Sexes are not alike in color.

Wing-coverts in both sexes sky-blue, the greater white-tipped; middle quill-markings green, white-tipped; armpits and most under wing-coverts white; shoulders striped with tawny and blue (not in the ♀) or dark green; fore breast barred; rump and tail dark, plain; under tail-coverts dark or black; bill black; feet not dark. Head and neck of ♂ blackish-plumbeous, darkest on the crown, usually with purplish iridescence, a white crescent in front of the eye; under parts thickly dark-spotted; ♀ with head and neck altogether different; under parts much paler and obscurely spotted, but known by the wing-markings from any species here treated of, but difficult to distinguish from the ♀ of the species known as the "Cinnamon" Teal: 15–16; wing 7; tail 3; bill 1½–1¾.

Arrives about the 1st of May, but, like all the migratory birds, it varies with the season, being sometimes as early as the 1st of April, but is seldom later than the middle of May; is very common, and breeds in all the sloughs over the Coteau; takes its departure about October 10.

SPATULA CLYPEATA, (L.) Boie.—*Shoveller; Spoon-bill Duck.*

Sexes are not alike in color.

Bill twice as wide at the end as at the base, with very numerous and prominent plates. Head and neck of ♂ green; fore breast white; belly purplish chestnut; wing-coverts blue; middle quill-marking green, bordered with black and white; some shoulders blue, others green, all white-striped; bill blackish; feet red. ♀ known by bill and wings. 20; wing 9½; bill 2½–2¾.

This Duck is very abundant in all the lakes and sloughs on the "Coteau des Prairies" from April 18 until October 30; breeds throughout its range.

The specimen measures as follows:

No. 682, ♀, 27.25 × 17.75; wing 8.60; tail 3.50.

AIX SPONSA, (L.) Boie.—*Summer Duck; Wood Duck.*

Sexes are not alike in color.

Crested; head iridescent green and purple, with parallel-curved white stripes over and back of eyes, and a broad, forked, white throat-patch; ♀ with the head mostly gray: 18–20; wing 8½–9½; tail 4½–5; bill 1¼. Nests in trees.

A single specimen of this beautiful Duck was killed near the post in the summer of 1874 by Captain Pearson of the Seventeenth Infantry. This is the only Wood Duck I have seen among the many thousands annually killed at this post.

FULIGULA MARILA, (L.) Steph.—*Greater Scaup Duck; Big Blackhead.*

Sexes are not alike in color.

This and the following described Ducks belong to the subfamily *Fuliguline* (Sea Ducks), and are distinguished generally from the preceding by having the hind toe with a membranous flap depending therefrom, larger feet, shorter legs, &c. ♂ with the head, neck, and body anteriorly, black, the former glossy-green; lower neck, rump, tail and its coverts, blackish; below, white, with fine black waving on the sides and lower belly; bill dull blue with black nail; legs plumbeous; middle quill-marking white. ♀ with the head and anterior parts brown, with the face pure white or not, and other black parts of the ♂ rather brown, the black and white vermiculation less distinct. About 20 inches long; wing 9.

Arrives April 19, and resting a few days resumes its long northern flight. Returns about the 1st of October in some numbers, and finally disappears, for the season, October 31.

The specimen measures as follows:

No. 653, ♀, 29.00 × 18.00.

FULIGULA AFFINIS, Eyton.—*Lesser Scaup Duck; Little Blackhead.*

Sexes are not alike in color.

Extremely similar to the last: smaller, about 16; wing 8; gloss of head chiefly purple. ♀ as in the last species. It is very difficult to define this bird specifically, and it may be simply a small southern form; but it appears to preserve its characters, although constantly associated with the last.

For my own part, I am inclined to keep the two separate; for, as I have observed it, the Little Blackhead maintains its characters under all circumstances: I have seen it associated with the Greater in feeding, but when disturbed and put to flight the two species will be found separate.

Arrives about the same time and follows the same course as the preceding species does; is much more abundant, however, during October than that Duck is.

The specimen measures as follows:

No. 627, ♂, 27.75 × 17.00; wing 8.00; tarsus 1.47; bill 1.60.

FULIGULA FERINA AMERICANA, (Eyton) Coues.—*American Pochard; Redhead.*

Sexes are not alike in color.

Bill dull blue, with a black belt at the end, broad and depressed, shorter than head (2 or less), the nostrils within its basal half; color of head rich pure chestnut, with bronzy or red reflection, of back, mixed silvery-gray and black in about equal amount, the dark waved lines unbroken; body anteriorly, rump, and tail-coverts black. ♀ head and neck pale brown; body darker brown, with other markings of the back, sides, and shoulders less distinct than the ♂; middle quills bluish-ash. Length about 20; wing 9–10.

Arrives about April 15 and remains until October 30; breeds in considerable numbers in the deeper sloughs on the "Coteau des Prairies," at first not very abundant; it begins to receive accessions to its numbers from further north about the middle of September, and by the 1st of October large flocks of the Redheads are common; finally departs for the season about October 31.

The specimen measures as follows:

No. 635, ♂, 30.50 × 19.50; wing 9.50; tail 3.00; tars. 1.55; m.t. & claw 2.80; bill 1.95.

FULIGULA VALLISNERIA, (Wils.) Steph.—*Canvas-back Duck.*

Sexes are not alike in color.

Bill blackish, high at the base and narrow throughout, not shorter than head (2½ or more), the nostrils at its middle; head much obscured with dusky; black waved lines of the back sparse and much broken up into dots, the whitish thus predominating; ♀ varies as in the last species.

Many persons experience difficulty in distinguishing between the Redhead and Canvas-back Ducks; careful attention to the foregoing descrip-

tions will enable any person to identify all his specimens, with possibly the exception of some immature ♀ specimens; but as the two species are seen in Dakota, instances of this will be very rare indeed.

This Duck arrives about April 15, and I think it probable that a very few remain in this vicinity and breed, but the greater majority continue their northern flight with little more than a passing notice of this region at this season; returns in the early part of September and gradually increases in numbers until the middle of October; takes its final departure for the year about October 30.

The specimen measures as follows:

No. 676, ♀, 31.00 × 20.75; wing 9.10; tail 3.00.

BUCEPHALA CLANGULA, (L.) Coues.—*Golden-eye.*

Sexes are not alike in color.

♂ with the head and upper neck glossy dark green, and a white oval or rounded spot between the bill and eye, not touching the base of the bill throughout; white continuous on outer surface of wing; bill very high at base, black with pale or yellow end, and nostrils in anterior half; feet orange; webs dusky; eyes yellow; head uniformly puffy; lower neck all around, under parts including sides, most of the shoulders, wing-coverts, and middle quills white; lining of wings and armpits dark; most of upper parts black; no waving on back and sides. ♀ head less puffy, snuffy brown, no white patch in front of eye, and less white on the wings. Length 16–19; wing 8.

Arrives about April 15 and soon passes on to the north. About October 1 returns in considerable numbers, and remains until October 30.

BUCEPHALA ISLANDICA, (Gm.) Bd.—*Barrow's Golden-eye.*

Sexes are not alike in color.

Very similar to the last species; gloss of head purplish and violet, the spot between the bill and eye larger, triangular or crescentic, applied against the whole side of the bill at base; white on surface of wing divided by a dark bar: rather larger than the last; 19–22; wing 9–10; feathers at back of head lengthened into a slight crest; bill shorter. ♀ probably not distinguishable with certainty from that of the foregoing, unless by the dark bar on the wing.

Is seen here only during the spring migrations. Arrives about April 15 and remains for a few days; several specimens have been taken at this time. Does not appear to pass this region during the fall.

The specimen measures as follows:

No. 652, ♀, 27.50 × 17.00.

BUCEPHALA ALBEOLA, (L.) Bd.—*Buffle-head Duck.*

Sexes are not alike in color.

♂ with the head particularly puffy, of varied rich iridescence, with a large white ear-patch, confluent with its fellow on the nape: small, 14–16; wing 7–8; bill 1, with nostrils in basal half. ♀ still smaller, an insignificant-looking Duck, with head scarcely puffy, dark gray, with traces of the white ear-patch.

Arrives April 9 and in a few days departs; returns about the middle of September to remain until October 22. During the fall is quite common, but is not seen in any large numbers in the spring.

The specimen measures as follows:

No. 687, ♂, 23.25 × 14.50; wing 7.00.

ERISMATURA RUBIDA, (Wils.) Bp.—*Ruddy Duck.*

Sexes are not alike in color.

Remarkably distinguished from the other Sea Ducks (with the exception of the St. Domingo Duck) by the stiffened, narrow, tapering tail-feathers (16–20 in number), exposed to the base by reason of extreme shortness of the coverts; bill broad, flattened, the nail large, overhanging. The ♂ in perfect plumage, with the neck all round and the upper parts brownish-red, the lower parts silky silvery-white watered with dusky, the chin and sides of the head dead white, the crown and nape black, but not often seen in this condition in the United States as generally observed, and the ♀ at all times brown above, finely dotted and waved with dusky, paler and duller below, with darker undulations and sometimes a slight tawny tinge, as also occurs on the sides of the head; crown and nape dark brown; bill dusky; under tail-coverts always white. Length 14–17; wing 5–6.

A few specimens of this Duck in full plumage have been taken here during June. It is, however, rare, occurring only during the spring migrations.

The specimen measures as follows:

No. 662, ♂, 20.00 × 15.25.

MERGUS MERGANSER, Linn.—*Fishing Duck.*

At any time from April 10 until October 30, this Duck can be seen in the lakes and sloughs on the "Coteau des Prairies" in numbers.

The flesh of this and the following Duck are not fit for the table, as they feed to a great extent on fish.

MERGUS CUCULLATUS, Linn.—*Hooded Merganser.*

Is seen for about a week from April 10, and then passes further north to return about October 1 in small numbers; disappears October 30.

The specimen measures as follows:

No. 632, ♀, 25.00 × 18.00.

PELECANIDÆ.

PELECANUS TRACHYRHYNCHUS, Lath.—*White Pelican.*

Arrives April 20, and the greater majority pass north, but quite a number spend the summer here. During the fall migrations it again becomes quite common; finally departs for the season October 30.

PHALACROCORACIDÆ.

GRACULUS DILOPHUS, (Sw.) Gray.—*Double-crested Cormorant.*

Is found in the larger lakes in this vicinity from April 18 until October 30, in considerable numbers; breeds here.

LARIDÆ.

LARUS ARGENTATUS SMITHSONIANUS, Coues.—*American Herring Gull.*

Arrives about the 8th of April, to remain until October 30; is common and breeds here.

The specimens measure as follows:

No. 611, ♀, 51.25×20.75; wing 15.00; tail 6.25. Stomach loaded with worms.

No. 631, ♀, 50.50×21.08; wing 15.00; tail 6.00.

LARUS ATRICILLA, Linn.—*Laughing Gull.*

Is found in this region from April 8 until October 30, in large numbers; breeds here.

The specimen measures as follows:

No. 622, ♂, 35.30×15.50; wing 11.50; tail 4.61; bill 1.27, at base 0.40, at gonys 0.34; tarsus 1.76.

LARUS FRANKLINI, Rich.—*Franklin's Rosy Gull.*

Arrives April 8, and remains until the lakes in this vicinity close, which generally occurs by the end of October; is common, but not quite so abundant as the preceding species.

STERNA FORSTERI, Nutt.—*Forster's Tern.*

Arrives April 20, and remains until October 1; very common and breeds here.

STERNA HIRUNDO, Auct.—*Common Tern.*

Is found here in large numbers from April 20 until about the 1st of October; breeds here. Is ever on the wing hovering over the lakes in search of its food.

The specimens measure as follows:

No. 623, ♀, 29.25×15.25; wing 10.75; tail 7.20; tarsus 0.97; bill 1.39, at base 0.43, at gonys 0.43.

No. 624, ♂, 29.50 × 15.50; wing 10.75; tail 7.25; tarsus 0.93; bill 1.53, at base 0.42, at gonys 0.42.

HYDROCHELIDON LARIFORMIS, (L.) Coues.—*Black Tern.*

Is very common from April 20 until the beginning of October, about which time it departs south. Breeds here.

The specimen measures as follows:

No. 636, ♂, 23.00×9.75; wing 8.50; tail 3.17; tars. 0.65; m. t. & claw 0.95; bill 1.05.

COLYMBIDÆ.

COLYMBUS TORQUATUS, Brünn.—*Great Northern Loon.*

The Great Northern Loon or Diver passes north in the early spring. A very few remain in this vicinity during the period the lakes are open, but the great majority pass on, and, returning October 1, are then seen in large numbers until October 30.

PODICIPIDÆ.

ÆCHMOPHORUS OCCIDENTALIS, (Lawr.) Coues.—*Western Grebe.*

Is occasionally seen during the migrations, but not in any numbers. I have secured but a single specimen of this Grebe, as its flight is generally at a considerable height.

PODILYMBUS PODICEPS, (L.) Lawr.—*Pied-billed Grebe.*

Arrives about May 1, and remains until October 27; is common in all the smaller lakes, which it seems to prefer, and it breeds in the tall

grass surrounding them. This Grebe is certainly one of the clumsiest birds on the wing with which I am acquainted, appearing incapable of sustaining any prolonged flight, so much so, indeed, as to be a matter of surprise how it ever makes its extended migrations. The Indians do not believe this bird ever leaves any locality, stating that, as cold weather comes on and the lakes freeze over, this Grebe is transformed into a muskrat, and in that state passes the winter, returning to his Grebe condition when spring returns.

Recapitulation of Species Treated.

Family.	No. of species.	Family.	No. of species.
Turdidæ	4	Cathartidæ	1
Saxicolidæ	1	Columbidæ	2
Paridæ	1	Tetraonidæ	6
Troglodytidæ	2	Charadriidæ	4
Alaudidæ	1	Hæmatopidæ	1
Sylvicolidæ	12	Recurvirostridæ	1
Hirundinidæ	5	Phalaropodidæ	1
Vireonidæ	2	Scolopacidæ	19
Laniidæ	1	Ardeidæ	4
Fringillidæ	17	Gruidæ	2
Icteridæ	8	Rallidæ	2
Corvidæ	3	Anatidæ	22
Tyrannidæ	3	Pelicanidæ	1
Caprimulgidæ	1	Phalacrocoracidæ	1
Trochilidæ	1	Laridæ	6
Cuculidæ	1	Columbidæ	1
Picidæ	3	Podicipidæ	2
Stringidæ	2		
Falconidæ	11	Total	155

NOTE.—Information received from Dr. McChesney since the foregoing article was prepared, enables me to add two species to the list, namely:

PINICOLA ENUCLEATOR, (L.) Vieill., and
ÆGIOTHUS LINARIA, (L.) Cab.,

thus raising the number of *Fringillidæ* to 19, and the total to 157.—E. C.

Art. V.—Paleontological Papers No. 9: Fossils of the Jura-Trias of Southeastern Idaho.

By C. A. White, M. D.

In Southeastern Idaho and the adjacent portion of Wyoming, numerous exposures of strata are reported by the field-geologists, which are, or are assumed to be, equivalent with those which, in the Western Territories, have, by common consent, been assigned to the Jurassic period, or, more recently, they have received the designation of Jura-Trias, in consequence of the growing opinion that no paleontological plane of demarkation exists among those strata of the Western Territories which have hitherto been assigned respectively to the Jurassic and Triassic periods. At a part of the localities above mentioned, some species of fossils occur which have for many years been especially assigned to the Jurassic, but those particular species do not occur with other fossils at some of the other localities. The species referred to are, for example, *Pentacrinus asteriscus* Meek and Hayden, *Belemnites densus* M. & H., *Eumicrotis curta* Hall, *Camptonectes bellistriatus* M. & H., &c. At others of the localities above referred to, notably those which are especially considered in the following paragraphs, the fossils are mostly or entirely of new species.

Among the exposures of Jura-Trias strata in the district here indicated (and they are numerous and comparatively small in consequence of the great disturbance which they, together with their associated strata, have suffered), there are three localities which are especially interesting, because the strata there exposed contain not only a number of new forms, but because some of the types in which those forms are expressed are such as in Europe are regarded as characteristic of the Trias. For convenience of reference, these localities are designated as Nos. 1, 2, and 3.

Locality No. 1 is in Idaho, about sixty-five miles north of the boundary line between that Territory and Utah, about eighteen miles west of the boundary line between Idaho and Wyoming, and about five miles south of John Gray's lake. The region embracing this and neighboring localities has not yet been visited by myself, but Dr. A. C. Peale, geologist of one of the surveying parties, in whose district for 1877 the locality especially referred to occurs, has examined it briefly, and furnishes the data for the following section at locality No. 1, the member A being the highest of the series.

The strata at this locality have been much displaced, the dip being to the southwestward and at an angle of about 55°. At the southern portion of the exposures of the strata of this locality, however, the strike curves to the eastward, so that the dip is then to the southward and the angle lessened; but the details of this subject will be embraced in Dr. Peale's final report, and also briefly in Art. VI, pp. 119–123.

Section at Locality No. 1.

A.—Alternating limestones and arenaceous shales; outcrops obscure. The following fossils were obtained from near the top of this member: *Terebratula semisimplex* White, *T. augusta* Hall and Whitfield, *Aviculopecten idahoensis* Meek, *Gervillia* ——?, and an undetermined Conchifer.	1,000 feet.
B.—Limestones; outcrops somewhat obscure. The fossils are: *Eumicrotis curta* Hall and *Aviculopecten idahoensis* Meek.	
C.—Greenish and reddish fossiliferous sandstones, followed by arenaceous shales and limestones. The fossils are: *Aviculopecten pealei* White and three or four undetermined species of Conchifers.	850 feet.
D.—Bluish-gray limestones, with fossils near their base. The fossils are: *Meekoceras gracilitatis* White, *M. mushbachanus* W., *Arcestes? cirratus* W., *Arcestes?* ——?, *Arcestes?* (another species), and *Eumicrotis curta* Hall.	700 feet.
E.—Reddish and greenish laminated sandstones	400 feet.
F.—Very dark blue limestone	800 feet.
G.—White quartzite	
H.—Massive grayish-blue limestones	400 feet.

At locality No. 2, which is about fifteen miles a little east of south from locality No. 1, occurs another limited exposure of limestone strata, which are equivalent in part with those of locality No. 1, and which there occupy a synclinal axis. From these strata, *Meekoceras aplanatum* White and *M. gracilitatis* W. were obtained. The presence there of the latter species indicates the equivalency of those strata with member D of the foregoing section, because numerous examples of that species were obtained from that member of the section.

About the same distance as before (15 miles), almost due west from locality No. 1, is locality No. 3, the strata being calcareous sandstones. From these strata, Dr. Peale brings *Aviculopecten idahoensis* Meek and *A. altus* White, examples of the former species being somewhat abundant. This species occurs in both A and B of the foregoing section, with which members the strata of locality No. 3 are doubtless equivalent. Mr. Meek's types of this species, which he referred to the Jurassic, were obtained several years ago by Dr. Peale in Lincoln Valley, near Fort Hall, about fifty miles northwestward from locality No. 1. So far as I am aware, the species has not been discovered elsewhere, and it may therefore be regarded as a common associate of the Cephalopods herein described.

The relations of the strata of the three localities here discussed with those which precede and follow them in natural order have not been so completely studied as could be desired, but Dr. Peale regards members F,

G, and H of the foregoing section as of Carboniferous age, although he did not obtain any fossils from either of those three lower members at that locality, and he also thinks the horizon of these fossiliferous beds is beneath the so-called Red Beds. The fossiliferous strata of the three localities herein especially considered contain all the new fossil forms which are described in this paper, together with the three following identified species, namely, *Terebratula augusta* Hall and Whitfield, *Aviculopecten idahoensis* Meek, and *Eumicrotis curta* Hall. No other species besides these and the eight new ones, and no other localities except the three specially designated in foregoing paragraphs, will be considered in the present paper, but it is intended that these strata, together with their equivalents and associates in that region, shall be carefully studied at the earliest opportunity. One object in presenting these few species only in the present paper, is, that they embrace all the forms which are now known to be associated with these interesting Cephalopods of Triassic type.

From our present knowledge of the subject, it seems that the strata containing the fossils herein described and noticed belong at or near the base of the series which in the Western Territories has latterly been generally designated as the Jura-Trias, but it is noticeable that the Red Beds, which have been so generally assigned to the Trias, are wanting here, although Dr. Peale now thinks they are present not many miles away, and, as before said, that they occupy an immediately succeeding horizon. It is probable that we may yet find satisfactory data for separating the strata which carry the fossils described and noticed in this paper, together with their equivalent strata elsewhere, as distinctively Triassic, from the other strata which have been so generally regarded as representing the Jurassic of Europe; but until more detailed studies can be made, I prefer to use for all of them the provisional designation of Jura-Trias. It is worthy of observation in this connection that none of the well-known species which have been generally regarded as certainly of Jurassic age, except *Eumicrotis curta*, occur associated with any of the fossils embraced in this paper. It seems evident from Dr. Peale's observations that those well known Jurassic species occupy a higher horizon; and it also seems evident, from the frequent mention which *E. curta* has received from the various geologists of the Western surveys and explorations, that this species has a wide geographical and great vertical range; and, furthermore, that it is associated with both Jurassic and Triassic types. It should also be remarked that the *Terebratula*, here identified, not without some doubt, as *T. augusta* Hall and Whitfield, is referred by those authors to the Jurassic.

According to European standards, the Cephalopods here described are unquestionably of Triassic types, and, as pointed out by Professor Hyatt in following remarks, they have more resemblance to certain Cephalopods of the Muschelkalk of Europe than to any other. This is an interesting and somewhat unexpected circumstance, since the only other

Cephalopod forms from strata of the Western Territories which have been assigned to the Trias as distinct from the Jura have been regarded as especially representing the horizon of the St. Cassian, Aussee, and Hallstadt deposits of Europe. The fossils referred to are those which were obtained from the West Humboldt Range, Nevada, and described by Gabb in Vol. I of the Paleontology of California, and by Meek and Hyatt in Vol. IV of the United States Geological Survey of the Fortieth Parallel.

Having recognized the unique character and Triassic type of these Cephalopods, and the fact that, although closely related to typical *Ceratites*, they presented some important generic modifications, I desired the opinion of Prof. Alpheus Hyatt, whose excellent and exhaustive labors upon this class of fossils are so well known. I therefore forwarded them to him for examination, and have received from him the notes which, on the following pages, appear in quotation-marks above his initials. Professor Hyatt proposes one new genus, which has not only important and significant relations with other genera, but the fact is an interesting one that with its first and only discovery three strictly conforming, but well-differentiated species, were found associated together, indicating thereby the permanent establishment of that generic form.

BRACHIOPODA.

Genus TEREBRATULA Llhwyd.

TEREBRATULA SEMISIMPLEX White.—Shell small, obovate or subelliptical in marginal outline; width less than the length; cardinal slopes gently convex or faintly angular; margins of the shell obtuse; both valves somewhat regularly and nearly equally convex; beak of ventral valve moderately prominent, with the usual curvature over that of the ventral valve, and with the usual apical perforation. Shell-structure minutely punctate. Surface of both valves marked by numerous small radiating plications, sometimes slightly irregular in size, with about equally wide spaces between. These plications never reach the beaks, and sometimes extend only a short distance from the margins; the remainder of the surface being plain, or marked only by faint lines of growth.

Length, 14 millimeters; breadth, 11 millimeters; thickness, 9 millimeters.

The form and more especially the plications of this shell give it the appearance of a *Rhynchonella*, but its punctate structure forbids its reference to that genus. Perhaps it is really a *Waldheimia;* but as the internal structure is not yet known, it is at present referred to *Terebratula.*

Position and locality.—Jura-Trias strata, member A of the foregoing section; at locality No. 1, Southeastern Idaho. Collected by Dr. A. C. Peale.

TEREBRATULA AUGUSTA, Hall and Whitfield.—Among the collections

made at locality No. 1 there are several examples of another species of *Terebratula* which were obtained from member A of the foregoing section, the same member from which *T. semisimplex* was obtained, but it comes from a different, although near layer. These possibly belong to a new species, but they answer too closely to the figures and description of *T. augusta*, as given by Hall and Whitfield in Vol. IV of the United States Geological Survey of the Fortieth Parallel, to make it advisable at present to propose a new name. The original locality of *T. augusta* is at Shoshone Springs, Augusta Mountains, Nevada; and the strata from which it comes are assigned to the Jurassic in the reports just cited. Collected by Dr. A. C. Peale.

CONCHIFERA.

Genus AVICULOPECTEN McCoy.

AVICULOPECTEN PEALEI White.—Shell, exclusive of the ears, subovate in marginal outline; obliquity of the axis to the hinge-line backward, and forming with it an angle of about 70 degrees; hinge-margin not quite as long as the greatest transverse diameter of the body of the shell. Left valve moderately convex, the convexity being nearly uniform, except in the umbonal region, where it is, as usual, greatest; beak moderately prominent, incurved, and elevated slightly above the hinge-margin; anterior ear moderately large, prominent, extending as far forward as the front margin of the shell, distinct from the body of the shell, but not separated from it by a distinct auricular furrow; its antero-inferior border convex, sloping backward to a moderately deep, angular, byssal notch; front margin of the valve regularly convex; antero-basal margin convex, but not quite so much so as the front; postero-basal margin somewhat abruptly rounded up to the nearly straight posterior margin. Posterior ear moderately large, but not quite so prominent as the anterior ear, moderately distinct from the body of the shell, its posterior margin forming nearly a right angle with the hinge-margin, and a very obtuse one with the posterior margin of the body of the shell. Surface marked by numerous raised radiating lines and small costæ, the latter being less numerous than the former, and differing from them only in being larger, all of them being slightly undulating in their direction from the umbo toward the margin. Near the margins three or four of the lines occupy each of the spaces between the costæ. Both ears are marked by radiating raised lines similar to those on the body of the shell, but they are more numerous and finer on the posterior ear than on the anterior. Crossing these radiating lines and costæ, there are numerous fine, but distinct, concentric lines, and some larger wrinkles of growth. Right valve unknown.

Height from base to beak, 37 millimeters; antero-posterior diameter of the body of the shell, 33 millimeters; length of hinge-margin, 28 millimeters.

Position and locality.—Jura-Trias strata, member C of the foregoing section; Southeastern Idaho. Collected by Dr. A. C. Peale.

AVICULOPECTEN ALTUS White.—Shell, exclusive of the ears, subovate in marginal outline; axis almost perpendicular to the hinge-margin, or having a very slight backward obliquity; hinge-margin shorter than the greatest transverse diameter of the body of the shell. Right valve depressed-convex, the convexity being nearly uniform in all parts, except the umbonal region, where it is, as usual, greatest; beak small, moderately narrow, pointed, and projecting very slightly above the hinge-margin; anterior ear moderately large, its anterior point extending about as far forward as the front of the shell, not very distinctly separated from the body of the shell, its anterior border broadly and not deeply notched; front margin nearly straight from the shallow notch of the anterior ear to a point a little below the mid-height of the shell, from which point the margin is rounded with considerable regularity to the posterior side; from that side the margin is a little more abruptly rounded to the base of the posterior ear, the outer margin of which forms nearly a right angle with the hinge-margin. Posterior ear small, distinct from the body of the shell, but not separated from it by an auricular furrow. Surface marked by numerous radiating raised lines and costæ, which are irregularly undulating in their direction, the latter being more numerous than the lines, the two differing from each other only in size. The surface of the anterior ear is faintly marked by numerous fine radiating raised lines, but the surface of the posterior ear is apparently unmarked except by fine lines of growth. Crossing these radiate markings, there are concentric lines and wrinkles of growth. Left valve unknown.

Height from base to beak, 55 millimeters; antero-posterior diameter, 43 millimeters; length of hinge-margin, 28 millimeters.

This species bears considerable resemblance to the one just before described; but it differs from it in its much greater proportionate height, its almost perpendicular axis, its shorter hinge-margin, smaller posterior ear, and in having the heavier radiating lines or costæ more numerous in proportion to the smaller lines.

Position and locality.—Jura-Trias strata; locality No. 3 of the introductory portion of this paper, Southeastern Idaho. Collected by Dr. A. C. Peale.

AVICULOPECTEN IDAHOENSIS, Meek.—Associated with the species last described; and also from members A and B of the section at locality No. 1, a number of examples of *A. idahoensis* were obtained. The type-specimens of this species, as before stated, were obtained at a locality in Lincoln Valley, about 50 miles northwestward from locality No. 1. Meek's description of it is in Ann. Rep. U. S. Geol. Surv. Terr. for 1871, p. 374.

This species and the two herein described as new much resemble each

other in their surface-markings, and are evidently all strictly congeneric; but it is probable, as Meek has suggested in relation to *A. idahoensis*, that neither of them will be found to conform strictly with the typical examples of *Aviculopecten*. Their reference to that genus is therefore to be regarded as provisional only in this instance.

CEPHALOPODA.

Five species of Cephalopods, and perhaps six, are represented among the collections brought in from localities No. 1 and No. 2, three of which belong to the genus here proposed by Professor Hyatt, and the others probably to *Arcestes*. The following are Professor Hyatt's diagnostic remarks upon the proposed new genus.

Genus MEEKOCERAS* Hyatt.

"These species, so far as they go, are unlike the *Ceratites* of any foreign locality, but have more resemblance to the Muschelkalk than to the St. Cassian or Hallstadt faunas. They possess in common one characteristic which separates every species from the typical forms of European *Ceratites*. There are but three distinct lateral cells and two lateral lobes besides the finer auxiliary lobes and cells. This occurs in the most involute species—"C" [*M. gracilitatis*], as well as in the least involute—"A" [*M. aplanatum*]. This characteristic would be of no small value in any group, but in this one it is unusually constant in spite of the great differences of form and the variations in breadth of the sides of the whorls between the different species. The typical *Ceratites*, the *C. nodosus* and *C. semipartitus*, have at least four distinct lateral cells and lobes besides the auxiliary ones, and the distinction is slight between the two series. In this genus, on the contrary, the auxiliary series, when present, is not divided from the third lateral cell by a distinct lobe as in *Ceratites*, and the aspect of the third lateral cell is often like that of a *Goniatites*. The auxiliary series is of course not present in the less involute and narrower sided forms, such as "A" [*M. aplanatum*], and *Amm. parcus*, *Amm. boydianus*, and *Amm. ottonis*, as figured by von Buch; and *Ceratites carbonarius* Waagen. These and the *Goniatites lævidorsatus* Gabb (which I have in Meek's report on the Paleontology of the Geol. Expl. 40th Parallel erroneously referred to *Clydonites*) are quite distinct, but the adult sutures of the latter are not known and its position is therefore uncertain.

"The compressed whorls of all the species is of course a characteristic which is obvious when they are contrasted with typical *Ceratites*, as is also the absence, or merely transient appearance, of heavy nodes and ribs, except perhaps in the least involute species, if *lævidorsatus* be found to belong to this genus. The young shells appear to be quite distinct from the young shells of the true *Ceratites* so far as these have

* "Dedicated to the memory of my friend F. B. Meek as some slight testimony of my respect for his works and regret for his loss."—(A. H.)

been compared, though no exact observations could be made for want of good specimens of the young of true *Ceratites*."—(A. H.)

MEEKOCERAS APLANATUM White.—Shell compressed-discoidal, having the peripheral or siphonal side of the outer volution flattened, that of the inner volutions being a little rounded, and although narrow, its breadth is considerable as compared with the slight transverse diameter of the volutions; umbilicus open, shallow, its width in the adult being about equal to that of the greatest vertical diameter of the outer volution, but it appears to have been proportionally wider in young examples; volutions flattened-convex on their sides, but their inner edges are abruptly rounded inward to meet the next volution; all the volutions slightly embracing, the inner ones apparently more slightly than the outer. Siphonal cell of the septa, near the outer portion of the largest example obtained, small; the outer, middle, and inner lateral cells larger, regularly and plainly rounded and of about equal size; the outer lateral lobe of about the same size as the lateral cells, bearing at its rounded extremity five or six small digitations of uniform size; inner lateral lobe smaller than the outer, bearing about four digitations like those of the outer one; ventral lobe very small, about equal in size with the ventral or siphonal cell, and apparently simply notched at the end; no auxiliary lobes or cells apparent in the examples yet discovered. Surface of the outer volution nearly plain, but the sides of the small inner volutions marked by moderately distinct transverse ridges.

Diameter of the coil of the largest example in the collection, 60 millimeters; extreme vertical diameter of the outer volution, 22 millimeters; tranverse diameter of the same, 12 millimeters.

Position and locality.—Jura-Trias strata; locality No. 2 of the preceding pages, Southeastern Idaho. Collected by Dr. A. C. Peale.

Professor Hyatt makes the following remarks upon this species:

"This species belongs to that group of this genus in which the shells have but a slight amount of involution, and possess also the narrow and numerous whorls which are the invariable accompaniments of this characteristic in all the Ammonitoids and Nautiloids. The resemblance to *Amm. parcus* von Buch* is very close so far as the outlines of the sutures are concerned, but the sides are too flat, the umbilical shoulder very abrupt, and the siphonal side flattened. There is an equally close resemblance to *Ceratites carbonarius* Waagen,† but here again the siphonal side is flatter and the involution greater, the last whorl at the same size as in the largest one figured being broader on the side. The septal sutures are, however, very similar.

"The young, when of the same size, are very similar to the figure of *Goniatites lævidorsatus* Gabb,‡ but when larger, as in Meek's figure,§

* Ueber Ceratiten. Abhand. Akad. d. Wissensch. 1848, pl. 4.

† Memoirs Geol. Surv. India, Pal. vol. ix, art. 4, pl. 1.

‡ Pal. Geol. Surv. California, vol. 1, pl. 3.

§ Geol. Expl. 40th Parallel, vol. iv, pl. x.

very considerable differences appear. The *lævidorsatus* being a heavily ribbed shell, even when quite large, with a rounded abdominal side; though here again I doubt if the sutures differ much.

"The young shell of species "A" [*Meekoceras aplanatum*] has rounded, smooth whorls, which increase very slowly by growth, and are full half an inch in diameter before the sides and abdomen (siphonal side) begin to show the flatness which characterizes the adult. At about this size also the whorls grow perceptibly broader in proportion on the sides, and the amount of involution increases gradually until it covers about one-third of the side, in a specimen about two and a half inches in diameter; the umbilical shoulder also changes at the same time, becoming abrupt and subangular.

"In some specimens there are indications of nodes on the sides, and in some the young until a late period are distinctly ribbed, the ribs being thick straight folds, reaching across the sides, but not up on to the siphonal side (abdomen).

"The age at which the serrations of the lobes appear could not be seen, but great caution should be exercised in this group in describing these characteristics, since they are liable to disappear with the removal of the shell, on account of their shallowness. Thus a full-grown shell may be readily mistaken for a Goniatite; or the young, before the serrations appear, for one of that genus."—(A. H.)

MEEKOCERAS MUSHBACHANUS* White.—Shell compressed-discoidal, having the peripheral side abruptly rounded; umbilicus open, shallow, about two-thirds as wide as the breadth of the outer volution in the adult, and proportionally narrower in the young; volutions flattened-convex on their sides, the convexity merging gradually into that of the peripheral side, but upon the umbilical side the volutions, especially the outer one, are abruptly shouldered; volutions in the young distinctly embracing, but the amount of involution increasing with the growth of the shell, so that the outer one embraces nearly one half of the next adjacent; siphonal cell of the septa, at or near adult size of the shell, small, wedge-shaped, narrowing toward the front end, where it is slightly notched; middle and outer lateral cells of nearly equal size, larger than any of the lobes, except in some cases the outer lateral one, somewhat abruptly rounded in front; inner lateral cell smaller than either of the other lateral ones, its inner anterior border a little more abruptly rounded than elsewhere; ventral and outer lateral lobes nearly equal in size, or the former a little the larger than the latter; their sides nearly straight and their ends subtruncate, that of the ventral lobe bearing six or seven narrow, prominent digitations, and that of the outer lateral lobe eight or nine; the inner lateral lobe about half as wide as the outer lateral, but otherwise similar; auxiliary lobes and cells between the inner lateral cell and the inner edge of the volution four

* The specific name is given in honor of Mr. J. E. Mushbach, assistant topographer, who first discovered the species.

each, irregular in size and shape, but all much smaller than the lateral lobes and cells; the auxiliary lobes much resembling the digitations of the lateral lobes. Surface in adult shells showing the usual lines of growth and strong transverse wrinkles, some of which assume a slight degree of regularity as transverse ridges; but in the case of the young these ridges, although not prominent, are distinct, and almost the same as in the young of *M. aplanatum*.

Diameter of the coil of the largest example in the collection, 118 millimeters; that of a smaller, but more perfect one, 95 millimeters; breadth or vertical diameter of the outer volution of the same, 43 millimeters; transverse diameter of the same, 22 millimeters.

Position and locality.—Jura-Trias strata; member D of the foregoing section at locality No. 1, Southeastern Idaho. Collected by Dr. A. C. Peale and J. E. Mushbach.

The following are Professor Hyatt's remarks upon this species:

"This species differs from "A" [*Meekoceras aplanatum*] in never having a flattened abdomen. This is rounded. The sides in the young and the aspect of the shell are precisely the same as in "A" [*M. aplanatum*], but the increase of the whorls by growth is much more rapid, so that at the diameter of an inch, or even somewhat less, they begin to flatten on the sides, show an abrupt umbilical shoulder, and cover up one-third of the whorl by involution. In consequence of the rounding of the abdomen, however, the sides actually appear in the full-grown to be more gibbous than in "A" [*M. aplanatum*]. One specimen at the total diameter of two and a half inches has one-half of the adjacent internal whorl covered by the outer one, an amount of involution which occurred much earlier in the history of the shell than at the diameter measured. Large, coarse folds are present in some of the specimens.

"This species in some cases has a strong resemblance to *Arcestes? perplanus* Meek, but is less involute." (A. H.)

MEEKOCERAS GRACILITATIS White.—Shell depressed-discoidal or sublenticular; siphonal side of the volutions flattened, the flattening being very distinct upon the inner volutions, even upon the smaller ones, but sometimes less so upon the living-chamber of full-grown specimens; umbilicus shallow in consequence of the slight transverse diameter of the shell, but it is somewhat open, although narrower than that of either of the preceding species, its width in the adult being not more than one-half the greatest vertical diameter of the outer volution, and in the young it is proportionally much less; volutions flattened-convex on their sides, rounded somewhat abruptly inward to meet the next volution within, but they are not so distinctly shouldered there as in the two preceding species, except perhaps in the younger of the volutions; the amount of involution being so great in the young shell that the earliest volutions are nearly or quite covered, but it so diminishes with the growth of the shell that in fully adult specimens the outer volution does not embrace more than one-half the width of the next

within; siphonal cell of the septa near the outer chamber of the largest examples rather broad, shallow, and broadly rounded, occupying sometimes a little less and sometimes rather more than the whole of the flattened portion of the siphonal side; the outer and middle lateral cells about equal in size and regularly rounded; inner lateral cell shallower than the others and broadly rounded, its inner border being defined by a short abrupt curve backward; the ventral and the outer and inner lateral lobes all, except perhaps the outer lateral one, smaller than the cells; the ventral one being smallest, wedge-shaped, and bearing two slender digitations, the inner lateral next in size, with four or five digitations, and the outer lateral largest, with six or seven digitations; the auxiliary lobes and cells occupying a space adjacent to the next inner volution about as wide as that of the outer lateral lobe, and constituting a finely serrated suture, the lobes being minute and pointed, and the cells a little larger and rounded at their ends; the one adjacent to the suture being a little larger than the others. Surface of young examples nearly or quite plain, but in fully adult shells there is a tendency to form nodes or ribs, the latter sometimes crossing the periphery; but they do not appear to assume that regularity which we find in typical *Ceratites*.

Diameter of the coil of the largest example in the collection, 100 millimeters; vertical diameter of the outer portion of the living-chamber, 45 millimeters; transverse diameter of the same, 20 millimeters.

Position and locality.—Jura-Trias strata, member D of the foregoing section; at locality No. 1 and also at locality No. 2, Southeastern Idaho. Collected by Dr. A. C. Peale.

The following are Professor Hyatt's remarks upon this species:

"This species differs from "B" [*Meekoceras mushbachanus*] in about the same way that "B" differs from "A" [*M. aplanatum*] except in so far as it approximates more closely to "A" in having a similar flattened abdomen. This flattened abdomen appears at a much earlier age than in the less involute form, "A." In fact, before the shell reaches the diameter of three-sixteenths of an inch not only is the abdomen flattened, but the sides also; and the increase by growth is so rapid that the sides of the internal whorls, even before this period, are almost entirely hidden. This is therefore similar to those forms among *Ammonites*, which I have so often described as accelerated types, those which display in the earlier periods of growth and developement, in quick succession, characteristics which come out in slower* succession in other species. Like many of those forms also, a kind of premature degeneration appears, even before the animal can be said to have reached its adult condition. Thus, at the diameter of an inch and a half, or even less sometimes, the sides of the whorls no longer increase by growth with the same rapidity as in the young. The amount of involution consequently is not maintained

* "This expression, of course, is relative; applying not to the absolute amount of time occupied in the growth, but to the age at which the characteristics appear."

at the same rate, and the sides of the internal whorls become more exposed, until in some old specimens they are only about half covered up.

"Thick folds or ribs are present in some old specimens, and a tendency to form nodes. In some large specimens, the ribs cross the abdomen, and in one fragment a curious effect is produced by the retention of the constrictions formed by the transient mouths of the shell. These make depressions with swellings between, which give the abdomen a scalloped appearance, amply sufficient to found a new genus upon if economically used. There may be two rows of slight nodes on either side of the abdomen, giving this shell a slight resemblance to *Trachyceras* in some cases.

"The forward part of the living-chamber seems to be more rounded or gibbous than the after part, which has the square abdomen, even in old specimens; though I think that in extreme old age the whole shell would exhibit a round abdomen and more gibbous sides. These peculiarities, and its flattened abdomen, might readily mislead an observer to identify this species with *Amm. semipartitus* von Buch, but a glance at the septa would satisfy any one that they are distinct."—(A. H.)

MEEKOCERAS GRACILITATIS var.—Among the examples of *M. gracilitatis* which were obtained at locality No. 1 is one which shows a considerable modification in the character of the septa. These appear to be in all respects like those of the typical forms except as regards the inner lateral cell and the auxiliary lobes and cells. The inner lateral cell is smaller than in the typical forms, and its inner border is not so abruptly defined from the auxiliary series. This series occupies a wider space, and consists of more numerous serrations than in the typical forms; appearing, indeed, to consist of a finely serrated, nearly straight suture. The umbilical shoulder is also less abrupt than in the typical forms. Professor Hyatt thinks it may possibly prove to be a distinct species when better known.

Genus ARCESTES Suess.

ARCESTES? CIRRATUS White.—In his notes upon this collection of Cephalopods, Professor Hyatt refers this form provisionally to the genus *Arcestes* with the following remarks:

"The specimens are too fragmentary to tell with any certainty the species; and even the genus ought perhaps to be considered doubtful, because the whole outline of the suture was not seen. The 'runzelschicht,' however, was so marked that this appeared to show them to be identical with *Arcestes*. The septal sutures are, however, not entirely unlike those of *Gymnotoceras*."

There are only two specimens of this species in the collection, both of which, it is true, are too imperfect to afford the means for the satisfactory characterization of the species. The characters which are shown, however, are quite sufficient for its identification; and for the conve-

nience of future reference, and the characterization of the strata from which it comes, I have applied the above specific name.

This shell, like those of the three species of *Meekoceras* which have already been described, is depressed-discoidal; the siphonal side rounded in the young and apparently a little angular in the adult, but the latter feature is not plainly shown in the examples; umbilicus open, but comparatively narrow; sides of the volutions flattened, those of the outer one of adult shells almost flat, or only slightly convex except near the outer and inner sides; the latter abruptly shouldered; involution very great in the young, but so lessening with growth that the outer portion of the living-chamber of adult shells does not embrace by more than one-fifth of its own width that next within. The examples do not show the character of the sutures satisfactorily, but the lobes and cells are both seen to be constricted about the middle, the ends of the former oblique, but digitate, as in *Meekoceras*, and the latter plain, as in that genus and *Ceratites*. Surface conspicuously marked by numerous longitudinal, abruptly raised lines, which enlarge into ridges in the adult, and which are separated by spaces a little wider than themselves; being also apparently continuous from the young state to the fully adult, so that the ridges and spaces, especially the latter, increase in width with the growth of the shell.

This species is much larger than either of the other species of Cephalopods which are described in this paper; the extreme diameter of the coil at fully adult size being not less than 180 to 200 millimeters; and the vertical diameter of the outer portion of the living-chamber about 80 or 85 millimeters.

Position and locality.—Jura-Trias strata, member D of the foregoing section; at locality No. 1, Southeastern Idaho. Collected by Dr. A. C. Peale.

ARCESTES ?———?—Three or four young examples only of this species were obtained by Dr. Peale from member D of the section at locality No. 1, shown on a previous page, all of which are too imperfect for specific determination. They are, however, so very like *A. gabbi* Meek, Vol. IV, Geol. Expl. 40th Parallel, p. 121, pl. x, figs. 6, 6^a, and 6^b, as to leave upon the mind a strong impression of their identity.

ARCESTES? ———?—Associated with the foregoing, a single specimen of another species, also very young, was obtained, which differs from the last in having a much more open umbilicus, and in the proportionally greater transverse diameter of the volutions.

Art. VI.—Jura-Trias Section of Southeastern Idaho and Western Wyoming.

By A. C. Peale, M. D.

In connection with Paleontological Papers No. 9, published in this Bulletin (Art. V, pp. 105–117) by Dr. C. A. White, in which a number of new and specially interesting species of fossils are described, I have thought it may be both interesting and useful to give briefly a few notes on the section of the Jura-Trias of the region from which these organic remains were obtained.

The rocks under consideration are exposed in considerable areas in the district assigned me for examination during the field-season of 1877, especially between the Wyoming and Portneuf Ranges. The former is in longitude 110° 48′ and the latter in approximate longitude 112°.

The region thus indicated is one of complicated folds and great displacements, and the Jura-Trias rocks, with the conformably underlying Carboniferous, enter largely into the structure of the mountains; entire ranges, indeed, being carved from them.

The Triassic Red Beds are found on the summit and on the western slopes of the Wyoming Range, in the former occupying a broad synclinal depression, and in the latter dipping westward into the valley of John Day's River. An immense fault extends along the eastern front of the Wyoming Range, giving it a monoclinal structure at this place, and when we cross the fold, which forms the western side of the range, we find another similar fault along the eastern side of the Salt River Range, which is parallel to the Wyoming Range, and only from eight to ten miles west of it. These faults are several thousand feet in extent.

In the Salt River Range, the Jura-Trias rocks are found entering into the complicated folds that form its central portions.

Twenty-five miles farther west, we reach the Blackfoot Basin, in which the Jura-Trias forms a large portion of the surface, the ridges having a comparatively low elevation, and the folds not being so greatly eroded as in the higher mountains. It is in this locality that the interesting collection of fossils, described by Dr. White, was found, and to which his paper is confined. The following is the general section of the Jura-Trias, beginning at the top:

General Section of Jura-Trias in Southeastern Idaho and Western Wyoming.

JURA-TRIAS.	JURASSIC.	*Belemnites Beds.*	5. Red and gray shales with green sandstones and irregular greenish arenaceous limestones at the top. Thickness, 700 feet.
		Pentacrinus Beds.	4. Laminated limestones, blue at base, passing into gray at top, succeeded above by grayish, calcareous shales; many of the layers are probably arenaceous. Thickness, 800 feet.
	TRIASSIC?	*Red Beds.*	3. Red quartzitic sandstones with shaly arenaceous and calcareous layers at the base of the section. These are probably the equivalent of the typical "Red Beds" of the Eastern Rocky Mountains. Thickness, 1,000+ feet.
		Meekoceras Beds.	2. Alternations of reddish and greenish sandstones and arenaceous and calcareous shales with blue and gray limestones, generally laminated. Thickness, 3,000+ feet. These with No. 1 are the beds of the section given in Dr. White's paper (as that of locality No. 1). The beds are fossiliferous at four horizons, containing species of a new Triassic? genus named *Meekoceras* by Professor Hyatt, together with forms that have been heretofore regarded as of Jurassic age.
CARBONIFEROUS?			1. Massive grayish-blue limestone, overlaid by quartzite and dark blue laminated limestones. Thickness, 1,200+ feet.

The thicknesses in this section are estimated, and when the region is more thoroughly studied may have to be somewhat modified.

The fossils described in Dr. White's paper came from No. 2, which I have called the "Meekoceras Beds," from the new genus named by Professor Hyatt. They are the following:

Meekoceras aplanatum White.
Meekoceras mushbachanus White.
Meekoceras gracilitatis White.

Besides these, the following were obtained:

Arcestes? cirratus White.
Arcestes? sp.?
Arcestes? sp.?
Terebratula semisimplex White.
Terebratula augusta Hall and Whitfield?
Eumicrotis curta M. & H.
Aviculopecten idahoensis Meek.
Aviculopecten altus White.
Aviculopecten pealei White.
Gervillia sp.?

No. 3 yielded no fossils.

No. 4 yielded the following:

Pentacrinus asteriscus.
Camptonectes bellistriatus.
Trigonia sp.?
Myacites sp.?

From No. 5 I obtained:

Belemnites densus.
Aviculopecten idahoensis?
Gryphæa sp.?
Undetermined bivalves.

At no one point was the entire section, as given above, exposed. The evidence for the section is as follows:

Nos. 1 and 2 were determined by the section at and near Station 66, south of John Gray's Lake (section at locality No. 1 in Dr. White's paper).

Near Station 56 in the Salt River Range, about 28 miles east of Station 66, beds lithologically similar to those of No. 2 in the general section just given, and containing *Aviculopecten pealei* and *Gervillia*, were seen in position above limestones similar to those of No. 1, which here contained quantities of *Productus multistriatus*. On this ground I have referred No. 1 to the Carboniferous.

Above the arenaceous and calcareous bed (which correspond lithologically and paleontologically with No. 2 of the section) in the Salt River Range are the red sandstones (No. 3). They are also probably in place above the section of Station 66, as is evident from the following:

Descending the ridge leading southwest from Station 66, southwesterly dips are noted in the strata last seen (the upper ones of section at locality No. 1, White's paper). After passing through the timber, which conceals the remainder of the section, we come to red sandstones, in all respects like those of the Salt River Range, having a northeasterly dip. We have therefore crossed a synclinal.

These facts, therefore, appear to justify me in connecting the sections.

Nos. 4 and 5 are determined by sections made in John Day's Valley, where they rest conformably on the "Red Beds." The entire section is conformable. Above the "Belemnites Beds" is a quartzite followed by a series of shales and sandstones several thousand feet in thickness, which has been referred to the Cretaceous.

It is not my intention to enter into any paleontological discussion; but there are some points based on the paleontological contents of the section to which I wish to refer briefly.

Pentacrinus asteriscus was found at a number of localities, other than those of the section, throughout the district, and always in beds above the horizon of the Red Beds. The following were the associated fossils identified by Dr. White:

Camptonectes bellistriatus.
Ostrea strigulecula.
Trigonia sp.?
Tancredia sp.?
Modiola sp.?

Myalina sp.?
Myacites sp.?
Neritina sp.?

Undetermined Conchifers and Gasteropods.

I believe the only instance in which *P. asteriscus* has been found associated with Triassic forms is the one mentioned in the Reports of the Fortieth Parallel Survey,* in which it is stated that it was found associated with what are regarded as unmistakable Alpine Trias fossils, and a *Spirifera*, a palæozoic type. Mr. Emmons says:† "It should be stated also that these disks of *Pentacrinus* found in the Dun Glen limestone vary somewhat from the type-specimens, and are all of larger size, reaching one-fourth of an inch in diameter, while those of Jurassic age scarcely reach one-fifth of an inch. Professor Whitfield suggests that the Dun Glen variety may possibly be a new species."

Eumicrotis curta was not found associated with *Pentacrinus* anywhere in our district, but at several localities where the section was obscure it was found with

Aviculopecten idahoensis,
Lingula brevirostris,
Myalina sp.?,
Myacites sp.?, and

several undetermined species of *Aviculopecten*.

The beds from which they were collected were above the "Red Beds," but I was unable to determine their relation to the "Pentacrinus Beds."

In other areas, *Eumicrotis curta* has been found associated with species of Jurassic aspect. In the areas surveyed by the Fortieth Parallel Survey, it occurs with

Belemnites,
Gryphæa.

Terebratula augusta Hall & Whitfield,‡ as Dr. White remarks, has been considered by the authors as a Jurassic species.

The Cephalopods (from No. 2 of the section described) by Professor White are, according to his identifications, unquestionably Triassic according to European standards, resembling certain Cephalopods of the Muschelkalk of Europe.

The only other Cephalopods from our Western Trias are those obtained by the Fortieth Parallel Survey from the Star Peak Group, which have been considered the faunal equivalents of the St. Cassian and Hallstadt beds of the Austrian Alps. The Star Peak Group is referred by King to the Upper Trias, and is supposed to correspond to the Upper Red Beds of the Eastern Seas (*Rocky Mountain Region, &c.*). If this be so, we may perhaps consider the "Meekoceras Beds" of the section as the

*Descriptive Geology, vol. ii, p. 711. Systematic Geology, vol. i, pp. 279, 280.
†Descriptive Geology, vol. ii, p. 711.
‡Report U. S. Geol. Expl. 40th Parallel, Systematic Geology, vol. i, p. 292.

equivalent of King's Koipato Group, which is below the Star Peak Group. The localities, however, are too widely separated, and too imperfectly known, as regards the one in my district, to attempt to correlate the two sections more definitely.

We cannot be too cautious in predicating the age of these beds before a detailed study of the stratigraphy is made, and a careful paleontological examination of the whole region undertaken and completed.

The "Meekoceras Beds," when first seen by us, were referred to the Upper Division of the Carboniferous.

There are numerous circumstances that appear to indicate that in the Jura-Trias, as in other formations, we have at either end of the formation a plane of paleontological indefiniteness, as it may be called; and the probability is that in the immediate vicinity of the lines separating the formations the strata should be considered as transition series. When the deposition of sediments is continuous from one formation to another, it is not so strange, as Dr. White has frequently remarked, that forms of life should continue uninterruptedly from one to the other, and that we should find, as in New Mexico,* Triassic plants at the top of the Jura, and as in our district and many other localities Jurassic invertebrates near the base of the Trias, and as in Nevada palæozoic types in the Lower Mesozoic.

In predicating the age of any group of beds, the organic contents of all descriptions, *vertebrate*, *invertebrate*, and *vegetable*, should be considered.

With the accumulation of data, many of the points that are now obscure and doubtful will assume the certainty of facts.

Until we know more of the rocks under consideration, I shall retain the name Jura-Trias for the formation.

To recapitulate, the investigations of 1877 in Southeastern Idaho and Western Wyoming indicate—

1. The lithological separation of the Jura-Trias into three divisions,—the upper and lower calcareous, and the middle mainly silcieous.

2. The presence of Jurassic forms in the upper division, the absence of organic remains in the middle group, and the presence in the lower of Triassic types associated with what have heretofore been regarded as Jurassic species.

* See Report U. S. Geol. Surv. for 1875, 1876, pp. 84–87.

Art. VII.—Fossil Forests of the Volcanic Tertiary Formations of the Yellowstone National Park.

By W. H. Holmes.

The prevalence of extraordinary volcanic activity throughout that part of the Tertiary age represented by the post-Cretaceous rocks of the Yellowstone region has given to them a most unique and interesting character. So destitute of animal remains are they, and so unlike the formations of the age in other parts of the Rocky Mountain region, that, notwithstanding the frequent visits of geologists, no divisions into sub-groups have been made, and no more definite appellation for the whole group has been found than the "*Volcanic Tertiary*"; this name, although so general, is singularly appropriate, and, in the absence of specific determinations, may be used to designate the entire group of Tertiary strata in the Park district.

It is not my intention in this brief notice to attempt the classification or correlation of these strata, but to give a brief account of some very remarkable features brought to light by last year's explorations.

In the valley of the East Fork of the Yellowstone River, where this peculiar group of rocks is typically developed, they have a thickness of upwards of 5,000 feet. The prevailing materials which enter into their composition are fragmentary volcanic products, which have been apparently redistributed by water, and now form breccias, conglomerates, and sandstones. It has been noticed by nearly all visitors that these strata contain a great abundance of silicified wood, and in a few cases trunks of trees *in situ* have been reported. The lowest observed occurrence of the strata of this group is in the valley of the main Yellowstone, between the first and second cañons, at an elevation of about 5,000 feet above the sea. They are also finely developed in the Gallatin Range to the west of this valley, and about the sources of Cañon and Boulder Creeks reach a thickness of between 3,000 and 4,000 feet. At a number of points covering this entire thickness, masses of silicified wood occur, and near the divide at the head of Boulder Creek silicified trunks, many feet in height, and of gigantic proportions, stand in the identical strata in which they grew, the crumbling conglomerates having withered away, leaving them standing upright along the steep slopes of the mountain. In general, these strata are horizontal. The bedding is often heavy, and in places not well marked; sub-aërial volcanic deposits apparently alternate to some extent with the sub-aqueous.

Three miles above the mouth of Gardiner's River, in similar strata, there

are a number of silicified trunks *in situ*, most of which occur in a stratum of sandstone that lies directly upon the eroded surface of a series of mica-schists that belong to the metamorphic range north of the Yellowstone River. This is at an elevation of 6,000 feet.

On the south side of the third cañon, opposite the mouth of Hell Roaring Creek, is a massive promontory composed of conglomerates, in which are very numerous intercalated beds of sandstones and shales. In the steeper faces of this promontory, many fine trunks are exposed. In 1872, Dr. Peale obtained some very perfect specimens of fossil leaves from these beds, on the Elk Creek side, which were determined by Professor Lesquereux to be of Eocene types. The walls of the cañon in the vicinity of Hell Roaring Creek are formed of the same series of rocks, which occur also at a number of points on the river between Elk Creek and the lower falls.

In the valley of the East Fork, the sedimentary formations of the Volcanic Tertiary reach their maximum developement. Here they rest upon the unevenly eroded surfaces of the palæozoic and granite rocks, and form a great part of the mountain ranges that enclose the valley. They are horizontal and apparently conformable throughout the entire thickness of 5,500 feet. The greater part of this immense group of strata is filled with the silicified remains of a multitude of forests.

The section given in the accompanying plate occurs in the north face of Amethyst Mountain, opposite the valley of Soda Butte Creek, and includes upwards of 2,000 feet of strata. The bed of the river is at an elevation of 6,700 feet above the sea, and the summit of Amethyst Mountain, 9,400. On the north side of the valley, near the mouth of Soda Butte Creek, there are between 300 and 400 feet of Carboniferous strata exposed along the base of the mountain slope. On the south side, occasional ledges of limestone appear above the detrital deposits. Thin sheets of basalt cover the flat part of the valley, which is here less than a mile in width.

The north face of Amethyst Mountain does not present as abrupt a profile as that given in the section, the middle part only being so precipitous. At the base and top there are comparatively gentle slopes; nevertheless, the actual stratigraphical conditions are truthfully represented.

As we ride up the trail that meanders the smooth river-bottom, we have but to turn our attention to the cliffs on the right hand to discover a multitude of the bleached trunks of the ancient forests. In the steeper middle portion of the mountain face, rows of upright trunks stand out on the ledges like the columns of a ruined temple. On the more gentle slopes farther down, but where it is still too steep to support vegetation, save a few pines, the petrified trunks fairly cover the surface, and were at first supposed by us to be the shattered remains of a recent forest.

In ascending one of the steep spurs that project from the main wall, the strata were found to consist, toward the base, of shales and fine-

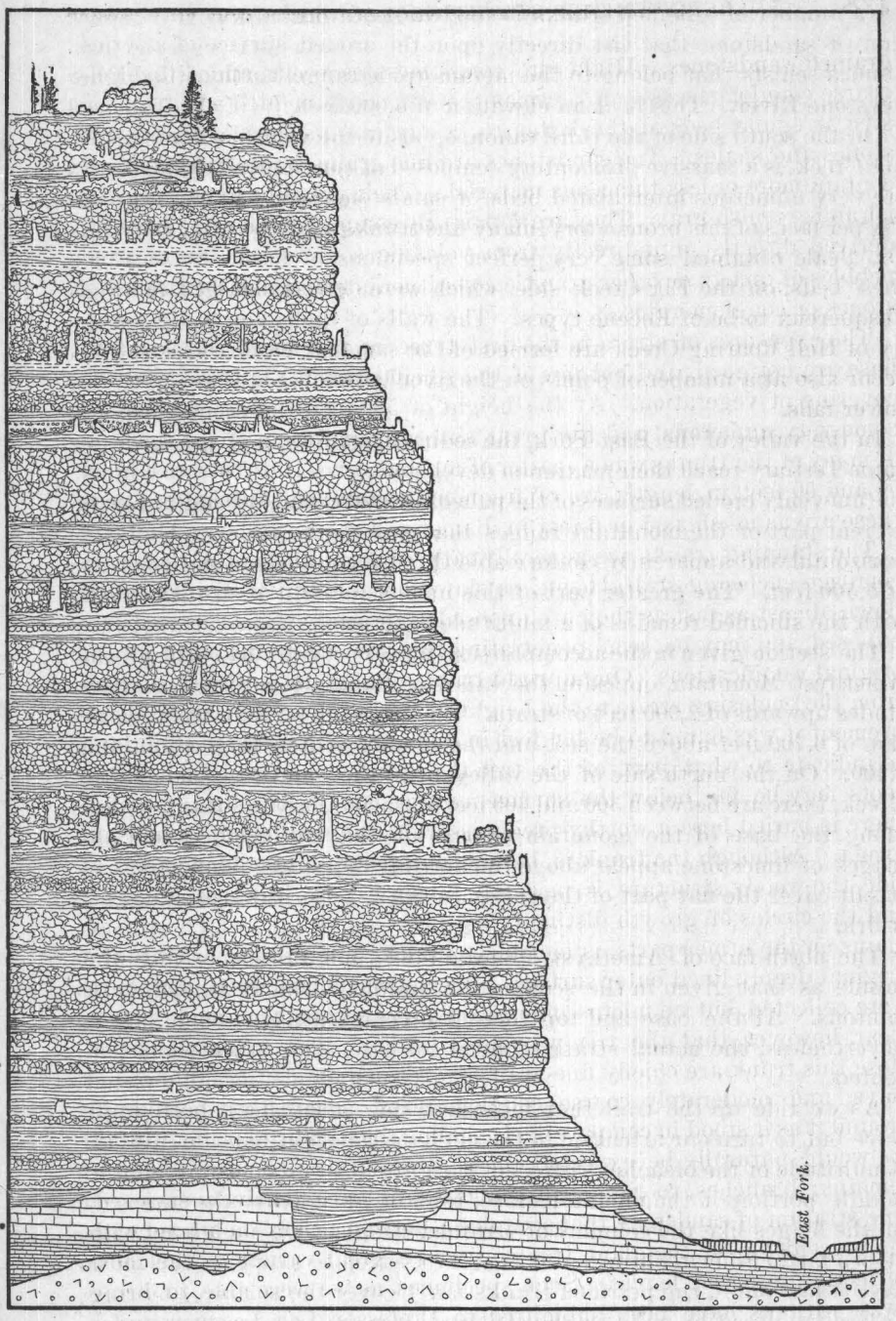

FIG. 1.—Section in the north face of Amethyst Mountain.

grained sandstones. Higher up conglomerates occur, and still higher coarse conglomerates and breccias prevail. Interbedded with the massive, irregular beds of the latter rocks are always thin layers of sandstones and shales. The sandstones are fine-grained, thinly bedded, and contain more or less tufaceous material. Their prevailing color is greenish and greenish-gray. They are apparently composed chiefly of materials derived directly or indirectly from volcanic sources. In no case are pebbles of quartz or other granitic constituents found in either the sandstones or conglomerates.

The exposures of strata in the first three or four hundred feet at the base are not good, and but few of the silicified trunks appear above the covering of vegetation. At the height of 500 feet, the occurrences become very numerous, and the great size and fine state of preservation of many of the trunks was a matter of much surprise. Prostrate trunks, 50 and 60 feet in length, are of frequent occurrence, and not a few of these are as much as 5 or 6 feet in diameter.

The standing trunks are generally rather short, the degradation of the compact enclosing strata being so slow that the brittle trunks break down almost as fast as they are exposed. In many cases the roots are exposed, and may be seen penetrating the now solid rock with all the original ramifications One upright trunk, of gigantic proportions, rises from the enclosing strata to the height of twelve feet. By careful measurement it was found to be ten feet in diameter, and as there is nothing to indicate to what part of the tree the exposed section belongs, the roots may be far below the surface, and we are free to imagine that there is buried here a worthy predecessor of the giant *Sequoias* of California. Although the trunk is hollow, and partly broken down on one side, the woody structure is perfectly preserved, the grain is straight, and the circles of growth distinctly marked. The bark, which still remains on the firmer parts, is four inches thick, and retains perfectly the original deeply lined outer surface. Specimens of the wood and bark were collected, but no microscopic examinations have been made. It is clear, however, that the tree was not a conifer. The strata which enclose this trunk are chiefly fine-grained greenish sandstones, indurated clays, and moderately coarse conglomerates. They have been built around it as it stood in comparatively shallow, but doubtless quiet waters. As would naturally be expected, these strata contain many vegetable remains: branches, rootlets, fruits, and leaves are extensively enclosed. One stratum of sandstone that occupies a horizon nearly on a level with the present top of the giant tree contains a great variety of the most perfectly preserved leaves. Such specimens as we were able to bring away with us have been submitted to Professor Leo Lesquereux for identification. They are found by him to belong to the Lower Pliocene or Upper Miocene, and correspond in a number of their species with the Chalk Bluffs specimens of Professor Whitney. They include—

Aralia Whitneyi,
Magnolia lanceolata,

Laurus canariensis,
Tilia (new sp.),
Fraxinus (new sp.),
Diospyros (new sp.),
Cornus (new sp.),
Pteris (new sp.),
Alnus (new sp.), and a
Fern (new sp.).

It will be observed that most of these species are new, which was also the case with the collection of Professor Whitney. It is also worthy of remark that none of the genera are identical with those of the Elk Creek locality previously mentioned. The stratigraphical relations of the two localities cannot easily be made out, as they are separated by fifteen miles of broken country in which the strata are obscured by igneous flows and Quaternary drift. The Elk Creek strata are lower by fully one thousand feet.

As far above the leaf-bearing horizon as I was able to ascend, the silicified trunks were very numerous and well preserved, and, by the aid of a field-glass, others could be detected in all parts of the cliff to the highest stratum.

At another point, nearly a mile farther east, I climbed the rugged walls of the mountain for the purpose of examining a number of large trees that were visible from below. Trunks and fragments of trunks were found in great numbers and in all conceivable positions. In most cases the woody structure is well preserved, the trunks have a tendency to break in sections, and on the exposed ends the lines of growth, from center to circumference, can be counted with ease. In many cases the wood is quite completely opalized or agatized, and such cavities as existed in the decayed trunks are filled with beautiful crystals of quartz and calcite. Our party was so fortunate as to procure some very handsome specimens of amethyst and ferruginous quartz. It is a matter worthy of observation that nearly all of the beautiful crystals that occur so plentifully in this region have been formed in the hollows of silicified trees. The same fact has been noticed in regard to similar crystals in many parts of the West, and notably in the case of the smoky quartz of the Pike's Peak region in Colorado.

The silicifying agents have been so unusually active in the strata of the Volcanic Tertiary that not only are all organic remains thoroughly silicified, but all cavities in the loosely bedded rocks and all fracture-lines in the strata are filled with chalcedony or other forms of quartz.

On reaching the heavily bedded conglomerates of the upper third of the cliff, I found the trees still more perfectly preserved. Many of the trunks are twenty and thirty feet in height. Their roots are in most cases imbedded in the layers of finer-grained materials, in which they grew, while the battered and branchless trunks are encased in the coarse conglomerates and breccias. These latter rocks are composed chiefly of

basaltic fragments, many of which are of great size; there is, however, always enough tufaceous and other fine-grained material to fill in the interstices and act as a cement. These beds are massive and irregular, and seem to have accumulated too fast to be thoroughly redistributed by the waters. Only the stronger trees of the forest seem to have withstood the fierce storms of rocks that must have prevailed at the period of their entombment, as the smaller trunks and branches are prostrate or totally destroyed. In most cases where upright trunks penetrate the entire thickness of an enclosing bed, the tops may be seen to terminate with the upper surface of that bed, as if causes had acted at the beginning of the deposition of the succeeding stratum to plane down the irregularities of the old surface. In due course of time, this succeeding stratum produced its growth of forest, which followed its many predecessors into the subterranean depths, and in its turn was buried by the rapidly accumulating conglomerates. This remarkable alternation of events seems, in a general way, to have been kept up from the beginning to the end of the period.

The very precipitous character of the cliffs prevented me from reaching the upper part of the wall at this point, but I succeeded in making my way to the summit of the mountain at two other points, and found that everywhere the section was practically the same.

On the opposite side of the valley the same conditions were observed: the fossil trees occur at the highest point reached, 3,000 feet above the river. The ranges that form the rim of this valley on the north and east reach an elevation of 11,500 feet, and as the conglomerates may be seen reaching and forming the loftiest summits without perceptible break or change of character, it is probable that they will be found to enclose the remains of forests throughout.

On some of the higher summits to the east of Yellowstone Lake, similar stratified conglomerates contain silicified wood in a very fragmentary state. These conglomerates are composed mainly of basaltic and trachytic materials, but contain large quantities of fragments of sandstones and quartzites, which leads to the conclusion that portions of the earlier Tertiary strata have been broken up and ejected with the igneous products. It is quite probable that these strata were among the later products of the Volcanic Tertiary age proper. They are generally found abutting against masses of unstratified igneous materials that probably mark the sites of islands which were doubtless volcanic centers. I find that as we recede from these centers of eruption the strata diminish very perceptibly in thickness and coarseness of materials, and have at the same time a very perceptible dip toward the surrounding valleys. One is at times led to suspect that portions, at least, of these beds are of subaërial formation, as is the case with extensive strata about the cones of modern volcanoes, but there are a multitude of facts that go to prove that the greater part of the formations of this age were rearranged or sedimented in water.

As to the character of the seas or lakes in which the Volcanic Tertiary beds were laid down, it is clear that their waters were fresh, but as to their extent or distribution little is known. The formations cover or have covered an area of not less than 10,000 square miles, but they lie at a much greater elevation above the sea than the formations of synchronous lakes of neighboring provinces, and, so far as is known, have no actual connection with them.

It has been suggested by some one that these coarse volcanic strata may have been formed in very restricted bodies of water held high amongst the mountain ranges; but lakes cannot exist without barriers, and as has already been shown, the conglomerates, although naturally disintegrating more rapidly than any of the older rocks, now form the summits of many of the highest peaks that face the eastern plains, and the basins in which they were formed must have had free communication with the lowlands to the west, from the beginning to the end of the period.

For my present purpose it is sufficient to know that the bodies of water of this period were of sufficient extent not to be greatly affected in level by the filling-in of volcanic products or by the oscillations of the district under discussion, since we can have no correct measure of those oscillations of the surface which define the thickness and decide the character of strata without the barometer-like records of a sea-level.

The change of level produced by the great oscillation that preceded the Volcanic Tertiary period, and brought the lofty ranges of this region into existence, cannot fall far short of 20,000 feet. In order to reach these figures, we have but to add to the full thickness of the palæozoic and mesozoic strata the present elevation of the granitic ranges above the lowest observed stratum of the Tertiary rocks. At the beginning of the deposition of the Volcanic Tertiary rocks, however, the upward movement had ceased. The land had undergone enormous erosion, and subsidence had commenced. The great ranges that had lifted their crests to such lofty heights were again sinking beneath the sea. This subsidence did not cease until all, or nearly all, of the mountain peaks were submerged. It is in the strata deposited during this great subsidence that we must look for evidences of conditions and events that made the entombment and preservation of a vertical mile of forests possible.

The Yellowstone Valley, from the head of East Fork to the Lower Cañon, is carved out of strata which were formed along the west and south bases of the main eastern range of mountains. In many places the river has penetrated the full thickness of Tertiary strata, and has cut down into bodies of metamorphic rocks that at the beginning of the age were promontories or islands. It is plain, therefore, that those parts of the tree-bearing strata examined, were deposited along a shore-line, or, at least, near the borders of the Tertiary lake. Over large districts there must have been, during the period of general subsidence, a frequent alternation of land and sea. Land would have to exist while

the forests grew and matured; water would have to cover the same area to deposit the succeeding stratum; and again this stratum would have to rise above the water before a second forest could grow. There are two ways in which this result could be brought about. In a district subject to such intense volcanic action as this must have been, a succession of minor oscillations might have been associated with the general subsidence, so that large areas of the lake border districts would be alternately above and beneath the sea, or, as was doubtless often the case, the shallow portions of the sea became filled up with the rapidly accumulating ejecta, and sub-aërial deposits of sufficient depth were laid down to allow the growth of forests, which, in time, were depressed by the general subsidence, to be buried by a succeeding stratum of the volcanic débris. But this latter method was not the ordinary one, as is attested by the fact that many of the forests have grown in beds of fine-grained material that must have been formed beneath the surface of the water.

I shall, however, not attempt to pursue this matter farther until all the data and materials collected have been examined. A thorough study of the various volcanic rocks will probably throw much light upon this very interesting group of strata.

Art. VIII.—Paleontological Papers No. 10: Conditions of Preservation of Invertebrate Fossils.

By C. A. White, M. D.

During the prosecution of his field-work, the paleontologist often observes certain interesting relations, not only between the lithological character and composition of the different kinds of fossiliferous rocks and the condition in which their contained fossils are preserved, but also between the lithological composition of those strata and the faunal characteristics of their fossils. In the latter instances, the case is largely one of original character and condition of the sea-bottom sediments as the ground of the habitat of those animals, while they were living, whose fossil remains they as rocky strata now inclose. It is proposed to make this latter subject the basis of a future paper, but the present one will be devoted to a discussion of some of the conditions of fossilization and preservation of invertebrate remains as they are found in the various kinds of stratified rocks of the different geological ages, and to institute some comparison of their mineral composition as fossils with that which they possessed in the living state, assuming that of the latter by the known composition of their present living representatives. It would add greatly to the interest and scope of this subject if a series of careful chemical analyses of these substances, both fossil and recent, could form a part of the basis of its discussion, but no opportunity has yet occurred for accomplishing such a task. Although detailed chemical analyses do not enter into the data for these discussions, a consideration of the mineral composition of the fossil remains as they now exist, and a comparison of that composition with what it was in the living state, necessarily forms the basis of a considerable part of the present paper. Such comparisons, while they show a close similarity in a very large proportion of cases, always exhibit at least some degree of contrast; and in some cases, a total change of mineral composition is found to have taken place. Many of the facts herein stated are patent to every collector of fossils, but the subject to which they relate is seldom discussed in paleontological writings, and the few references that are made to it are usually of a special or local character. Therefore in view of the somewhat extended field observations of the writer in the median portion of North America, it has been thought advisable to embody some general observations upon this subject in the present paper.

In a general way we may divide the substances which in life constituted the skeletal parts of invertebrate animals, which parts alone have

been preserved in a fossil state, into the chitinous, siliceous, and calcareous. Chitinous skeletal substances are almost wholly, if not entirely, confined to the Articulata (including the lyopomatous brachiopods) and certain Acalephs; the siliceous, excepting the teeth of certain mollusks, to the Protozoa; while, with the exception of all but a few of the Articulata, all other invertebrates possess skeletal parts, if any, which are composed of calcareous substance only as their mineral constituent. These remarks, of course, apply to the composition of those skeletal parts in their living state. The mineral change which some of them have undergone after their first fossilization will be considered in following paragraphs. In fact, then, we find that the original mineral composition of far the greater part of invertebrate fossils was, in the living state, lime-carbonate combined with a greater or less proportion of animal substance; having been the same indeed as that of the shells and corals which constitute their present living representatives. Since the animal substance of these bodies, as is also the case with bones, was displaced during the process of fossilization, usually by the infiltration and precipitation of additional lime-carbonate, it would seem that the chances for, and the condition of, the preservation of all kinds of these calcareous skeletal remains would be equal in identical circumstances of environment. But there is, as we shall see, a greater variety of condition among fossil forms of this kind than is referable to either their original mineral composition or the environing circumstances of their fossilization and preservation.

Three divisions may be made of the manner in which fossil forms are preserved, namely: (1) fossilization proper of the substance of the skeletal parts; (2) moulds; (3) casts; (4) pseudomorphs. In the first case, the original substance, as well as the external form of the object, is more or less completely preserved. In the second, the whole substance of the object, at some time subsequent to its rocky entombment, has been removed by decomposition or solution, and its consequent escape through the porous imbedding matrix, leaving a cavity which is the exact counterpart of the external form of the formerly inclosed object. In the third case, the more or less complete external form of the object has been restored by the refilling of the mould with a substance similar to that of the matrix, or the deposition of some mineral either wholly or in part different from the matrix; such as calcite, pyrite, &c. In the fourth case, that of pseudomorphs, the substance of the fossil in its original condition has been exchanged, atom by atom, for another mineral substance, usually silex.

Pseudomorphs thus resemble casts, and in one sense they are such, but they differ from casts, which consist merely of the filling-substance of previously formed moulds, by the manner of their production, and in many cases, at least, by having the texture and even the microscopic structure of the original body preserved. This method of preservation is perhaps more clearly exemplified in the case of silicified

wood than in any other, where not only the character and appearance of the woody fibre is perfectly retained, but the microscopic structure is often so perfectly preserved as to distinguish the botanical division to which it belongs. In the case of pseudomorphic silicification of invertebrate fossils, the microscopic structure is seldom, if ever, so perfectly preserved as it is in the case of wood, but their true pseudomorphism, nevertheless, occurs, the more common cases of which consist of the silicification of shells, corals, &c., in limestone. In these cases, the objects were without doubt first fossilized as calcareous substances, and as such they could not have been removed by solution, leaving their moulds in the matrix, because that matrix was of essentially the same composition as themselves and nearly or quite equally soluble. Therefore it is evident that the change of substance must have been effected by the process of pseudomorphism which has just been explained, and which was initiated by a movement and segregation of the siliceous atoms that were previously distributed in the substance of the imbedding rock, which movement and segregation were much the same as took place in the formation of flint-nodules in chalk and similar siliceous nodules and masses that are often met with in limestones. That this pseudomorphism of calcareous fossils by silicification began long after they had become perfectly fossilized, is indicated by the fact that the process has, in most cases at least, taken place in connection with the weathering of the strata which contain the fossils. For example, it is very common to find shells, corals, crinoid fragments, &c., wholly or partly silicified upon and near the surfaces of certain paleozoic limestone strata, as well as in the interstices which are filled with the débris of their decomposition; while fossils of the same kinds which are imbedded in the solid and unweathered portions of the same strata, are wholly calcareous. Although fossilization proper of calcareous remains is more complete in limestones than in other rocks, it is in limestones also that most of the cases of silicious pseudomorphism of invertebrate remains, as just defined, takes place, the latter cases as compared with the former being very few.

Casts and moulds are more common in sandstones than in other rocks, although they are not uncommon in magnesian limestones, and in both sandy and argillaceous shales. The common occurrence of moulds in sandstone is easily accounted for by the porous character of the rock, which admits of the percolation of water charged with solvents of lime-carbonate. Such percolation is, of course, necessary in the production of moulds in all kinds of rock, but it is more complete in sandstones than in any other rocks. Some of the finest moulds of both fresh-water and marine species, those which preserve not only the form, but also the delicate surface-markings of the fossils most perfectly, are found in hematite; but such instances are very rare compared with the occurrence of moulds in sandstones. While ordinary limestones are, as a rule, more fossiliferous than any other rocks, magnesian limestones notably

contain very few fossils. There are some exceptions to the latter rule, but in all cases, so far as I am aware, when the rock approaches a true dolomite, the contained fossils are all and of all kinds in the form of moulds, the inner surfaces of which usually have a drusy lining.

Casts of the more perfect kinds are formed by the infiltration of foreign mineral matter into complete moulds which were previously formed in the manner already explained, and by its precipitation there until the cavities became completely filled. Such casts are sometimes composed of iron pyrite, some of which are often very perfect and beautiful. More frequently, however, the casts are such as have been formed by a filling of the spaces which the fossils formerly occupied by the substance of the rocky matrix in which they were imbedded, the fossils themselves having gradually passed away by solution, while the substance of the adjacent matrix followed closely upon it in consequence of the pressure of the superincumbent strata. It is in the form of such casts as these alone that many fossils, especially the shells of several families of Conchifers, have been preserved; and single valves of such shells are often very well preserved in that manner.

The manner of preservation of invertebrate fossils which is here designated as fossilization proper consists of the minimum of change in the mineral constituents of the skeletal parts. As already stated, some change is always effected in the mineral composition of the object fossilized, but almost all molluscan as well as certain other shells, and also corals, being composed almost wholly of lime-carbonate, when preserved in limestone strata, or in such strata as contain any considerable amount of lime-carbonate, still retain in the fossil state much the same composition which they had while living. In most of these cases, the change has been so slight that even the microscopic texture of the shells and the minute and intricate details of the corals are as perfectly preserved as they were in the living state. Thus, the fibrous shell-structure of certain families of Brachiopods, and the punctate structure of others, the pearly shell-structure of certain Cephalopods, Gasteropods, and Conchifers, and the prismatic shell-structure peculiar to certain families of Conchifers, are often, indeed generally, as easily studied in the fossils as they are in their living representatives.

The siliceous skeletal parts of fossil invertebrates, when such were produced, seem to have been so purely siliceous that they have apparently not changed at all by fossilization. Chitinous substances, however, seem always to have undergone more or less alteration, although they are among the more permanent of fossil forms. For the purposes of this discussion, under the head of chitinous fossils are included the shells of lyopomatous brachiopods (such as those of *Lingula*, *Discina*, &c.), the crusts of trilobites and other crustaceans, and stipes of graptolites. In limestones, chitinous fossils seem to have become quite calcareous in some instances, and in all cases they are more brittle and mineral-like than living chitine is, and yet in all cases they are readily recognized as

of chitinous origin when they are compared with fossils of calcareous origin. Chitinous fossils are also among the most permanent of fossil forms, and they are often found in a perfect condition, when all their associated fossils, which were originally calcareous, exist only in the form of casts or moulds. This is especially noticeable in the case of lyopomatous brachiopods in sandstones and some magnesian limestones.

Although the mineral composition of calcareous fossil shells and corals is usually that of almost pure calcite, it is seldom, if ever, the case that, upon fracture, they show the planes of cleavage of that mineral; but they generally, as before stated, preserve their original microscopic structure. On the contrary, in almost all cases, all parts of every fossil echinoderm shows upon fracture the true crystallized form of calcite. The mineral is evidently nearly pure, but it is never transparent and seldom translucent, except in thin flakes along the cleavage planes. It is also an interesting fact in this connection that while the substance of every one of the numerous and often minute pieces which compose the body and appendages of fossil echinoderms of all kinds, may be so perfectly crystallized as to allow free cleavage upon all sides of the fundamental rhombohedron of calcite, none of the planes of cleavage ever pass from one joint or piece to another, even though the parts may be not only in their natural position of contact, but solidly mineralized together. The perfect mineralization of echinodermal bodies, and almost invariably in the form of calcite, appears the more remarkable when it is remembered that the substance of those bodies in the living state is much less solid than that of any molluscan shell. Possibly this porous character, admitting the addition of a greater proportion of calcite in solution by percolation or saturation than could enter the more solid shells, affords the true ground for explaining the phenomenon just noted, but it still remains unexplained why the granular texture of the original substance of the echinodermal body is always obliterated, and why the sutures between the parts always form perfect barriers to the continuation of the planes of cleavage. These planes are not only interrupted by the sutures, but their direction is always different in each piece, showing that the process of crystallization was independent in each piece, however small it may have been.

Although calcareous fossils are fully preserved in the purer and ordinarily compact limestones, they have in such cases become so compacted with the stone itself that it is always difficult and usually impossible to arrive at a full knowledge of their structure and characteristics. It is, therefore, in strata which are only partly calcareous that invertebrate fossils are, as a rule, the most completely preserved. In these cases, the fossils seem to have served as *nuclei* to which was attracted a sufficient amount of lime-carbonate in solution to solidify them by its precipitation within their substance. and interstitial cavities, while the imbedding rock was not greatly hardened either by that or any other process. Therefore, the most perfect calcareous fossils are found in the clayey

and shaly partings of limestone strata and in sandy and clayey shales which are also calcareous.

It seems difficult to explain why the segregation of lime-carbonate should have ceased at the full solidification of the fossil itself, and why it did not continue until at least the immediately surrounding portions of the imbedding matrix were also hardened, with the fossil as a nucleus. This latter condition does sometimes occur; but, as a rule, to which there are only rare exceptions, the matrix is no more fully charged with lime-carbonate, and no harder from any cause, in immediate contact with the fossils, than it is in other parts of the same stratum, even when the rock contains enough of lime-carbonate to have thus preserved many more fossils than it has ever contained. So completely are the fossils thus preserved, and so distinctly separate are they from the matrix, that it is often the case that not only their delicate surface-markings, but their minute and fragile appendages also, are so perfectly preserved that they may be as easily studied as the corresponding parts of living forms.

That there should be a difference in the manner and completeness, or otherwise, of the preservation of fossils which were originally different in their mineral composition is too evident to excite remark; but one would not *a priori* expect to find any material difference in the completeness of the preservation of shells and other fossils which were originally nearly or quite identical in the original composition of their mineral constituent, and that were fossilized under identical circumstances of environment. Such differences, however, do occur, and they are moreover as great between certain forms which are zoölogically nearly related, as they are between certain others which are distantly related. Thus, for example, the difference in this respect is greater in some instances between the shells of different families of the same class of mollusks than it is between those of some mollusks and the shells of certain worms. These remarks will be closed by citing a few examples of this unequal condition of preservation of invertebrate fossils under identical circumstances of environment.

Argillaceous shales which are also more or less calcareous prevail in all the paleozoic formations of the eastern portion of North America; and for our present purpose we may select the Hamilton Shales of New York as furnishing an example of uniformity of circumstances of environment during the fossilization of an invertebrate fauna. In these shales, the abundant and diverse forms of arthropomatous brachiopods are beautifully and perfectly preserved in almost all cases, and the calcareous character of the fossils is uniform and perfect. The same may be said of the Corals and Polyzoa; while in the same layers which contain these fossils, the associated shells of all the Conchifers, without exception so far as I am aware, exist only in the form of moulds and casts, the substance of the shells having entirely disappeared. Associated chitinous fossils, as represented by the crusts of trilobites and shells of

lyopomatous brachiopods and Ostracoids, are well preserved, and in such condition as to plainly indicate their chitinous origin. In these shales also the crinoidal and other echinodermal remains exist in their usual condition of crystallized lime-carbonate.

In some of the shales of the coal-measures of Illinois and the adjoining States, however, certain species of Conchifers are as perfectly preserved in a calcareons condition as any of the arthropomatous brachiopods are; but, as a rule, the shells of Conchifers are not so well preserved in these shales, nor in the paleozoic rocks generally, as those of the brachiopods are. It is also noticeable that the shell-substance of the Cephalopods of the paleozoic rocks is not so completely preserved as it is in those of the mesozoic strata.

Well preserved mesozoic fossils appear to have undergone, in some respects, a less complete change than those of the paleozoic rocks. For example, the shells of Cephalopods, and some other mollusks, usually retain their original pearly lustre and iridescence, and the fossils generally have a less mineralized aspect than those of the paleozoic rocks. There is, of course, much difference in these and other respects to be observed in the different strata of that age and in different regions. The following remarks relate mainly to the mesozoic strata and their fossils in the western portion of the national domain, and principally to the Cretaceous strata there.

The mesozoic rocks of the Western Territories consist very largely of sandstones and sandy shales, with occasionally clayey layers, which are usually also more or less sandy. Limestones are rare among those rocks, but the sandstones and shales all contain more or less lime-carbonate, usually in comparatively small proportion, but sometimes enough to be detected without a chemical test. In the mesozoic sandstones it is often the case that all the contained fossils are in the form of casts and moulds, with the not infrequent exception of the *Ostreidæ* alone. It is often the case also that all the fossils of a sandstone are preserved by fossilization proper, and all in essentially the same calcareous condition, including the shells of Cephalopods, Gasteropods, and Conchifers among mollusks, as well as the few Radiates and Articulates which occur there; but it is often noticeable, especially in the Cretaceous sandstones, that the shells of the *Ostreidæ* resist the solvents, to which they have all been exposed, better than those of any other mollusks. Indeed, it sometimes occurs that in sandstones which carry a great variety of molluscan shells in the form of casts and moulds, the *Ostreidæ* alone are completely preserved in their natural calcareous condition, having evidently never been materially affected by the solvents which reduced all their associated molluscan shells to the condition of moulds and casts. In the Cretaceous rocks of the Western Territories, all other fossils than the shells of mollusks are very rare; and when the latter are well preserved by fossilization proper, so far as the writer's observations have gone, there appears to be very little difference in the condition in which those

of the different classes and families have been preserved. That is, in such cases all the Conchifers appear to be nearly or quite as well preserved as any of the other mollusks. In other words, when the circumstances were very favorable, all molluscan shells are well preserved and, when unfavorable, the *Ostreidæ* are found to have been the last of molluscan shells to yield to their adverse influence.

A collection of invertebrate fossils that has been sent to the Office of the Survey from the Cretaceous strata of Bell County, Texas, unlike the collections from the Western Territories before referred to, shows a very decided deficiency of preservation of the shell-substance of the Gasteropods as well as of all the Conchifers (except the *Ostreidæ*) as compared with their associated fossils, although the soft strata from which they came is largely composed of lime-carbonate. In that collection, the *Ostreidæ* are abundant and varied, embracing nearly all the known generic and subgeneric forms of that family, and all are most perfectly preserved. Their condition in this respect is even better than that of the few associated arthropomatous brachiopods, although, as already shown, their paleozoic representatives are among the best preserved of all paleozoic fossils. Among those Texan Cretaceous fossils it was observed that the Corals, Echinoderms, Rudistæ, and Serpulæ, as well as the Ostreidæ, were thoroughly calcified and well preserved, showing a marked contrast in this respect with the Conchifers and Gasteropods, and in part with the Cephalopods. In the case of the fossils of this collection, the power of the Ostreidæ to resist solution seems to have been shared with several other, but distantly related, fossils; while the want of such resistance on the part of the Conchifers was shared by the Gasteropods and Cephalopods, instead of being peculiar to the first-named class alone, as it seems to have been in the Hamilton Shales and some other paleozoic strata.

Since the condition of the marine Tertiary fossils will not be considered in the present paper, it remains only to make a few remarks upon the condition of preservation of the brackish- and fresh-water fossils of the Laramie Group and the succeeding Tertiary groups of the West. The invertebrate faunæ of these formations are far less diversified than those of the marine formations, being confined almost entirely to the two molluscan classes, Gasteropods and Conchifers. These shells are found mostly in sandstones and shales which are more or less sandy. They are very often found in the condition of moulds and casts, and sometimes occur as siliceous pseudomorphs; but they are commonly calcareous and properly fossilized. No material difference in the condition or perfection of their preservation has been observed among the different kinds of these fossils. The environing influences seem to have affected all the families and classes alike, but it was observed that some examples of certain species of Conchifers, which were found in some argillaceous shales of the Laramie Group in Wyoming, had a much thinner test than those of the same species which were found in some sandy

shales of the same formation only a few miles distant. This may have been the result of a deficiency of lime in the water in the first-named instance, but it is not unlikely that the difference was produced by a diminution of the substance of the shells during the process of their fossilization.

Briefly reviewing the subject of the manner of preservation of invertebrate fossils, it appears that those of the various kinds whose original composition was calcareous and apparently identical, or nearly so, have resisted unequally the solvents with which they have been brought in contact in the circumstances of their fossilization. It thus seems that, as a rule, the shells of certain families of the Conchifers have resisted solution less effectually than any others, and that among paleozoic fossils the arthropomatous brachiopods, and among mesozoic fossils the Ostreidæ, have resisted solution most effectually. It also appears that chitinous substances, although not originally so completely mineral-like as shells and corals, are even more permanent as fossils than those which were originally calcareous, since they have resisted solution more effectually.

No explanation is at present offered of the reason why certain fossils are much more perfectly preserved than others under the same environing circumstances; and, indeed, it seems difficult to suggest an explanation. As already remarked, it might *a priori* be expected that substances so different as chitinous and calcareous shells are would differ in the condition of their preservation under the same environing circumstances, but it could not thus have been expected that so great a difference as we have seen should exist in that respect between the calcareous shells of the different families of mollusks.

Art. IX.—Supplement to the Bibliography of North American Invertebrate Paleontology.

By C. A. White and H. Alleyne Nicholson.

PART I.

PUBLICATIONS MADE IN THE UNITED STATES.—By C. A. White.

PREFACE TO PART I.

The Bibliography of North American Invertebrate Paleontology, which was published last year as Miscellaneous Publications No. 10 of the U. S. Geological Survey, was brought down to the close of 1877. The following Supplement embraces the publications which have been made during the year 1878, and also all the omissions pertaining to the first publication which have been detected.

The year 1878 has not been productive of many publications of North American Invertebrate Paleontology, and the larger part of the entries in this Supplement are, therefore, such as supply the omissions referred to. As to these entries of previously omitted publications, some of them ought to have been included in the original work, in accordance with the plan announced in its Preface; but a considerable proportion of them were intentionally excluded from it, as not being within its then proposed scope. It was then intended to prepare the work mainly as an annotated catalogue of the publications which would be constantly needed by the working paleontologist, rather than as a finished Bibliography, such, for example, as Dr. Coues's Bibliography of North American Birds.

The difficulty then experienced in fixing a limit to the scope of such a work has increased rather than diminished since the original work was published, by the expressed desire of some of those who are interested in the work to see its scope extended. I have, therefore, admitted some entries of mere catalogues of fossils, and some, also, of works which, according to the rules recognized by naturalists, are not regularly published. In these cases, however, those facts are stated in the entry, and they may be easily discriminated by the working paleontologist who is in search of other matter. Many persons have assisted me, but I am under especial obligations to my friend Mr. S. H. Scudder in this respect.

C. A. W.

Anon. List of Fossils belonging to the Several Formations alluded to in the Report; arranged according to localities. <*Nicollet's Rep. Hydrog. Basin U. Miss. River* (Appendix C), pp. 167–170. 1843.

Atrypa lingulata is described on p. 167, and *Ostrea congesta* on p. 169; the latter by Conrad.—There is, apparently, nothing in the book to tell who is the author of the catalogue, or of the first-named species, but it is probably attributable to T. A. Conrad.

Anon. [**Hall, James,** *and* **R. P. Whitfield.**] Preliminary Notice of the Lamellibranchiate Shells of the Upper Helderberg, Hamilton, and Chemung Groups; with others from the Waverly Sandstone. 80 pp. 8vo. 1869.

This memoir was noticed in the *Am. Journ. Sci.*, vol. xlix, 2d series, p. 276, and attributed to James Hall, although the work itself bears the name of no author. It does not appear that Prof. Hall has anywhere claimed sole authorship; but, on the contrary, Prof. Whitfield has claimed the authorship to be jointly with Prof. Hall and himself. See *Ann. Rep. Wisconsin Geol. Sur.* 1878, p. 51, and *Paleontology of Wisconsin* (now in press), pp. 136, 137, and 138.—Genera *Palœaneilo*, *Limoptera*, *Mytilarca*, *Pholadella*, *Cimetaria*, *Phthonia*, and *Modiomorpha*.

Barrett, S. T. The Coralline or Niagara Limestone of the Appalachian System. <*Am. Journ. Sci.*, vol. xv, 3d ser., pp. 370–372. 1878.

Dr. Barrett in this geological paper describes and names provisionally *Proetus pachydermatus* and *Strophodonta nearpassii*.

Barrett, S. T. Descriptions of New Species of Fossils from the Upper Silurian Rocks of Port Jervis, N. Y.; with notes on the occurrence of the Coralline Limestone at that locality. <*Ann. N. Y. Acad. Sci.*, vol. i, pp. 121–124. 1878.

Barris, W. H. New Fossils from the Corniferous Formation at Davenport. <*Davenport Acad. Nat. Sci.*, vol. ii, pp. 282–288, 2 plates, and 1 woodcut. 1878.

This paper contains descriptions of six new species of invertebrate fossils, and a new genus of Crinoids is proposed, namely, *Stereocrinus*.

Calvin, Samuel. On some Dark Shale recently discovered beneath the Devonian Limestones, at Independence, Iowa; with a notice of its fossils and description of new species. <*Bull. U. S. Geol. and Geog. Surv. Terr.*, vol. iv, pp. 725–730. 1878.

Collett, John. List of Fossils found in the Keokuk Group at Crawfordsville, Ind. <*7th Ann. Rep. Geol. Surv. Indiana*, pp. 376–381. 1876.

This is a catalogue only, but it is systematically arranged, and valuable for comparison of the Indiana fauna of the Keokuk epoch with that of the typical locality.

Conrad, T. A. [Description of Ostrea congesta.] <*Nicollet's Rep. Hydrog. Basin U. Miss. River* (Appendix C), p. 169. 1843.

Conrad, T. A. Fossils of the Vicksburg Eocene Beds. <*Wailes's Rep. Agric. and Geol. of Miss.*, pp. 287–289, 4 plates. 1854.

No descriptions are here given, but a part of the species catalogued are illustrated on the plates.

Conrad, T. A. Descriptions of new Mollusks from Cretaceous Beds of Colorado. <*Ann. Rep. U. S. Geol. Surv. Terr. for* 1873, pp. 455, 456. 1874.

In this paper, Mr. Conrad removes his genus *Haploscapha* from the family *Rudistæ*, where he first placed it, and refers it to an "unrecognized family" near *Inoceramus*.

Dale, T. N., *jr.* A Contribution to the Paleontology of the Vicinity of Poughkeepsie [New York]. <*Proc. Poughkeepsie Acad. Nat. Sci.*, p. 2. 1878.

Mr. Dale announces the discovery of well-known species of fossils of the Trenton period in rocks at Poughkeepsie and on the west side of the Hudson River immediately opposite that place.

This two-page 8vo slip appears as an extract from the *Proc. Pough. Acad. Nat. Sci.*, under date of December 4, 1878, but it bears no pagination or reference to the number of the volume. I am informed by Mr. Dale that it will appear in "Part I of Vol. II, 1878–79." The same facts are embodied in an article by the same author in the January (1879) number of *Am. Journ. Sci.*

Dyer, C. B. *See* **Miller, S. A.,** *and* **C. B. Dyer.**

Emmons, Ebenezer. American Geology: Vol. I, Part I. 194 pp. 8vo. Albany, 1855.

Part II, pp. 251 (minus 40 pp. by error of pagination); 2 double lithograph-plates of fossils and 17 plates of woodcuts of the same size; mostly of well-known New York fossils. Also many woodcuts distributed in the text. A number of new species are described and also the following genera: *Monograpsus*, *Cladograpsus*, *Glossograpsus*, *Staurograpsus*, *Nemagrapsus*, and *Microdiscus*.

Emmons, Ebenezer. Manual of Geology. 297 pp. 8vo. 1860.

Contains many woodcut illustrations.

Ford, S. W. Two New Species of Primordial Fossils. < *Am. Journ. Sci.*, vol. xv, 3d ser., pp. 124–127, 1 woodcut. 1878.

Genus *Protocyathus*.

Ford, S. W. Note on Lingulella cœlata. < *Am. Journ. Sci.*, vol. xv, 3d ser., pp. 127–129. 1878.

Ford, S. W. Note on the Developement of Olenellus asaphoides. < *Am. Journ. Sci.*, vol. xv, 3d ser., pp. 129, 130. 1878.

Ford, S. W. On Certain Forms of Brachiopoda occurring in the Swedish Primordial. < *Am. Journ. Sci.*, vol. xv, 3d ser., pp. 364–366. 1878.

Comparison is made of the opercula of *Hyolithes* of the Troy, N. Y., Primordial rocks, with the valves of *Acrothele* of Linnarsson from the Swedish Primordial.

Gabb, William M. On the Topography of Santo Domingo. < *Trans. Am. Phil. Soc. Phila.*, vol. xv, pp. 49–259. 1873.

Chapter XIII, comprising pp. 200–259, is devoted to the paleontology of the island under the heading, "Descriptive Catalogue of the Mollusca." No statement is made as to the age of the numerous fossils which he enumerates and describes, but they are apparently all Tertiary.

Genera *Planorbella, Metulella, Glyphostoma, Ectracheliza, Plochelœa, Iopsis, Orthaulax, Dolophanes, Cylichnella*, and *Bothrocorbula*.

Gabb, William M. Description of a Collection of Fossils made by Doctor Raimondi in Peru. < *Journ. Acad. Nat. Sci.*, vol. viii, pp. 263–336, 9 plates. 1877.

Tertiary and Mesozoic.—Genera *Perisconatica* and *Petropoma*.—To these descriptions is added a Notice of a few Carboniferous Fossils, a Bibliography of South American Paleontology, and a Synopsis of South American Paleontology.

Grote, A. R., *and* **W. H. Pitt.** New Specimen from the Water-lime Group at Buffalo, N. Y. < *Proc. Am. Asso. Adv. Sci.*, vol. xxvi, pp. 300–302, 1 woodcut. 1878.

Upper Silurian.—This is a notice of a ramus of *Pterygotus cummingsii*, previously described by those authors, which, according to their estimate, indicates a length of five feet for the whole animal.

Gurley, William. Notice of the Discovery of the Position of the Crural Processes in the genus Atrypa. < *Proc. Am. Phil. Soc. Phila.*, vol. xvii, pp. 337, 338, and one plate. 1878.

Mr. Gurley shows that the "loop," which has been regarded as a continuous band connecting the spiral cones of *Atrypa*, is really divided in the middle by a suture, or even broader parting or hiatus.

Hall, James. The Louisville Limestones. Note on the hydraulic beds and associated limestones at the Falls of the Ohio. Pamphlet. 4to. 16 pp. Advance sheets of vol. v, part 2, Paleontology of New York. Nov., 1877.

In these notes, Prof. Hall gives a tabulated list of the fossils found in the Hydraulic, and Encrinal beds at Louisville, and shows that they are properly the equivalent of the Hamilton Group of New York, and not of the Upper Helderberg, as formerly supposed. He also shows in the same memoir that the "Black Slate" of Ohio and adjoining States carries many fossils identical with those of the Genesee Slate of New York, and claims that the supposed two formations are one and continuous.

Hall, James, *and* **R. P. Whitfield.** Notice of three new species of fossil shells from the Devonian of Ohio. < 23*d Ann. Rep. Regents N. Y. Univ. on Condition of State Cabinet*, pp. 240, 241. 1873.

Hall, James, *and* **R. P. Whitfield.** Notice of two new species of fossil shells from the Potsdam Sandstone of New York. < 23*d Ann. Rep. Regents Univ. on Condition of State Cabinet*, pp. 241, 242. 1873.

Genus *Palœacmœa*.—This article was issued in pamphlet form, together with other matter from the same volume, in 1872. See, also, these authors' names in connection with the second entry under the head of "**Anon.**"

Horn, G. H. Notes on some Coleopterous remains from the Bone-cave at Port Kennedy, Penn'a. < *Trans. Am. Entom. Soc.*, vol. v, pp. 241–245. 1876.

Hyatt, Alpheus. Report on the Cretaceous Fossils from Maroïm, Province of Sergipe, Brazil, in the collection of Professor Hartt. < *Geology and Physical Geography of Brazil*, 8vo, 606 pp. Boston: Fields, Osgood & Co., 1870. pp. 385–393.

In this paper Prof. Hyatt says: "All the Brazilian Ammonites are either identical with, or so closely allied to, species already described from the Texas beds by Rœmer and others, that they cannot be safely separated."

James, U. P. Descriptions of newly discovered species of fossils from the Lower Silurian Formation:—Cincinnati Group. < "*The Paleontologist*" (published in 8vo pamphlet form, at irregular intervals, at Cincinnati, Ohio, by U. P. James), No. 1, pp. 1–8. 1878.

This article contains descriptions of the following species: *Astylospongia tumidus, Stromatopora papillata, Chætetes crustulatus, C.* ——*?, C.* ——*?, Heliolites Shepardi, Fistulipora? multipora, Agelacrinus holbrooki, Helopora dendrina, H. tenuis, H. meeki, H. parvula, Ptilodictya hilli, P. plumaria, P. flexuosa, P. granulosa, P. parallela, Ceramopora? beani, C.? irregularis, C. alternata, C. concentrica, Hippothoa delicatula, Orthoceras hindei, Cyclonema? minor, Strophomena? ulrichi, Orthis (Platystrophia) acuminata, Zygospira modesta* var. *kentuckyensis, Spirorbis? lovelandensis, Ptilodictya fimbriata*, and *P.* ——*?*. The two last species are from the *Upper* Silurian of Ohio.

James, U. P. Description of newly discovered species of fossils, and remarks on others, from the Lower and Upper Silurian rocks of Ohio. < "*The Paleontologist*," No. 2, pp. 9–16. 8vo. 1878.

The following species are described: *Buthotrephis filiciformis, Sphenothallus latifolius* Hall?, *Trachyum undosum, Stromatopora lunata, S. hindei, Lyellia striata, L. americana* Milne-Edwards, *Chætetes subrotundatus, C. lycoperdon, C. petropolitanus* Pander, *Callopora milfordensis, Ceramopora whitei, C. radiata, Pleurotomaria ohioensis, P. dryope* Billings, and *Pterinea subquadrata.*

Marcou, Jules. On the Terebratula Mormonii. < *Trans. St. Louis Acad. Sci.*, vol. iii, pp. 252–255. 1875.

In this note Prof. Marcou claims priority of his names *Terebratula uta, Orthis pecosii*, and *Terebratula mormonii*, over *Rhynchonella osagensis* and *Orthis carbonaria* of Swallow, and *Retzia punctilifera* of Shumard.

Mazyck, Wm. G., *and* A. W. Vogdes. Description of a new fossil from the Cretaceous Beds of Charleston, S. C. < *Proc. Acad. Nat. Sci. Phila. for* 1878, p. 272, 1 woodcut. 1878.

The fossil described is *Anomia andersonii* M. & V.

Meek, F. B. Description of fossils from the Auriferous Slates of California. < *Geol. Surv. California, Geology*, vol. i (Appendix B), pp. 477–482, 1 plate. 1865.

Jurassic.—This article is in the volume of *Geology*, and not in either of those devoted to Paleontology exclusively.

Mickleborough, John, *and* A. G. Wetherby. A classified list of Lower Silurian fossils, Cincinnati Group. < *Journ. Cincinnati Soc. Nat. Hist.*, vol. i, pp. 61–86. 1878.

A classified catalogue only, but a full and useful one.

Miller, S. A. Description of a New Genus and Eleven New Species of Fossils, with remarks upon others well known, from the Cincinnati Group. < *Journ. Cincinnati Soc. Nat. Hist.*, vol. i, pp. 100–108, 1 plate. 1878.

Mr. Miller proposes the genus *Angellum* for a small shell of doubtful relations; and also announces the discovery of a perforated foramen in the ventral valve of *Pholadops cincinnatiensis* Hall.

Miller, S. A. Description of Eight New Species of Holocystites from the Niagara Group. < *Journ. Cincinnati Soc. Nat. Hist.*, vol. i, pp. 129–136, 1 plate. 1878.

Part of the plate is devoted to Prof. Whitfield's article in the same volume.—Based on collections from the Upper Silurian of Ripley and Jefferson Counties, Indiana.

Miller, S. A., *and* C. B. Dyer. Contributions to Paleontology. < *Journ. Cincinnati Soc. Nat. Hist.*, vol. i, pp. 24–39, 2 plates. 1878.

Lower and Upper Silurian.—Genera *Blastophycus. Trichophycus, Microspongia*, and *Walcottia.*

Miller, S. A., *and* C. B. Dyer. Contributions to Paleontology, No. 2. 8vo pamphlet. 11 pp. 2 plates. "Printed by James Barclay, 269 Vine street, Cincinnati, O." 1878.

This appears to be a continuation of the foregoing paper. It is not, however, published as a part of the *Journ. Cincinnati Soc. Nat. Hist.*, but appears to have been printed privately.—Genera *Dactylophycus, Heliophycus, Dystactophycus, Chloephycus, Aristophycus,* and *Bythopora.*

Ordway, Albert. On the supposed identity of Paradoxides harlani Green with the Paradoxides spinosus Bœck. <*Proc. Boston Soc. Nat. Hist.*, vol. viii, pp. 1–5, 2 woodcuts. 1861.

Ordway, Albert. On the Occurrence of other Fossil Forms at Braintree. <*Ibid.* pp. 5, 6. 1861.

Packard, A. S., *jr.* Results of Observations on the Drift Phenomena of Labrador and the Atlantic Coast Southward. <*Am. Journ. Sci. for* 1866, pp. 30–32.

This article has references to the post-Tertiary fossils of the region discussed.

Packard, A. S., *jr.* Observations on the Glacial Phenomena of Labrador and Maine; with a view of the recent Invertebrate Fauna of Labrador. <*Mem. Boston Soc. Nat. Hist.*, vol. i, pp. 210–303, 2 plates. 1865.

Dr. Packard in this memoir gives much valuable matter relating to zoology and post-Tertiary geology. With this he gives a long list of species which are found fossil in the post-Glacial deposits of Labrador, Anticosti, New Brunswick, and Maine, most of which are of living species, but the following are described as new: *Bela robusta* and *Fusus (Neptunea) labradorensis.*

Pitt, W. H. *See* **Grote, A. R., *and* W. H. Pitt.** 1878.

Rafinesque, Constantine Smaltz. The Complete Writings of Constantine Smaltz Rafinesque on Recent and Fossil Conchology. Edited by Wm. G. Binney and George W. Tryon, Jr. New York, London, Paris & Madrid. 8vo. 96 pp. 3 plates, 8 woodcuts. 1864.

This is a collection of the writings of Rafinesque, a part being in French (one article in Spanish) and a part in English; originally published partly in the United States and partly in Europe, and embracing descriptions of fossil and recent mollusks from North and South America and Asia. It contains many descriptions, both generic and specific, only a part of the names of which have been adopted by naturalists.

Rogers, William B. *and* Henry D. Contributions to the Geology of the Tertiary Formations of Virginia. <*Trans. Am. Philos. Soc. Phila.*, vol. v, (n. s.), pp. 319–341. 1835.

This article contains remarks on the "Geology of a portion of the peninsula between the James and York rivers," and descriptions of four species of shells. It is the first part of a work, of which the second is mentioned in the 6th entry, p. 58, of *Bib. N. A. Invert. Pal.*

Say, Thomas. [Descriptions of Productus spinosus and P. incurvus.] <*Long's First Exped.*, vol. i. 8vo. Philadelphia, Carey & Lea, publishers. 1823.

These descriptions are in the form of footnotes to p. 106.

Say, Thomas. [Description of Gryphæa corrugata.] <*Long's First Exped.*, vol. ii. Footnote to pp. 410, 411. 8vo. 1823.

Scudder, S. H. Remarks on some Fossil Insects from the Carboniferous Formation of Illinois and from the Devonian Rocks of New Brunswick. <*Proc. Boston Soc. Nat. Hist.*, vol. x, pp. 95, 96. 1865.

Scudder, S. H. Results of an examination of a small collection of fossil Insects obtained by Prof. Wm. Denton in the Tertiary beds of Green River, Colorado. <*Proc. Boston Soc. Nat. Hist.*, vol. xi, pp. 117, 118. 1867.

Only one species is named in this paper. The author subsequently corrected the title to make it read, "White River, Colorado," instead of "Green River, Colorado."

Scudder, S. H. Remarks on Mormolucoides articulatus, a fossil Neuropteron, from the Conn. River Sandstone. <*Proc. Boston Soc. Nat. Hist.*, vol. xi, p. 140. 1867.

Triassic?

Scudder, S. H. Notice of Fossil Insects from the Devonian Rocks of New Brunswick; and of Haplophlebium barnesii. <*Proc. Boston Soc. Nat. Hist.*, vol. xi, pp. 150, 151. 1867.

Abstract of the same in *Am. Naturalist*, vol. i, pp. 445, 446.

Scudder, S. H. Remarks on two new Fossil Insects from the Carboniferous Formation in America. <*Proc. Boston Soc. Nat. Hist.*, vol. xi, pp. 401–403. 1868.

Reprinted in *Scudder's Entomological Notes*, 1, pp. 7–9.

Scudder, S. H. Notes on the fossil Insects found at the "Petrified-fish Cut", Green River. <*Hayden's Sun Pictures*, 4to, pp. 150; 30 photograph-plates, p. 98. Julius Bien, New York. 1870.

Describes without name fossil insects from the Green River Group, near Green River City, Wyoming.

Scudder, S. H. Fossil Insects from the Rocky Mountains. <*Am. Naturalist*, vol. vi, pp. 665–668. 1872.

The fossils here referred to are from the Green River Tertiary beds. No species are described.

Scudder, S. H. On an English fossil Insect, supposed to be Lepidopterous. <*Proc. Boston Soc. Nat. Hist.*, vol. xvi, p. 112. 1874.

Geological horizon, Stonesfield Slate.

Scudder S. H. Remains of Insects occurring in Carboniferous Shale at Cape Breton. <*Proc. Boston Soc. Nat. Hist.*, vol. xviii, pp. 113, 114. 1875.

Reprinted in *Scudder's Entomological Notes*, 5, pp. 2, 3.—Geological horizon near that of the Millstone Grit.

Scudder, S. H. Fossil Orthoptera from the Rocky Mountain Tertiaries. <*Bull. U. S. Geol. and Geog. Surv. Terr.*, vol. ii, pp. 447–449. 1876.

Scudder, S. H. Supplementary Note on Fossil Myriapods. <*Mem. Boston Soc. Nat. Hist.*, vol. ii, pp. 561, 562. 1876.

These fossils are from the Sigillarian stumps at the Joggins, Nova Scotia.

Scudder, S. H. On the Post-Pliocene fossils and the Geology of Sankoty Head, Nantucket. <*Proc. Boston Soc. Nat. Hist.*, vol. xviii, pp. 182–185. 1876.

See note on the same subject, *Am. Journ. Sci.*, vol. x, 3d series, p. 365, in connection with an article by A. E. Verrill.

Scudder, S. H. Note on the close affiliation of the Insects of Europe and America in the Carboniferous Epoch. <*Proc. Boston Soc. Nat. Hist.*, vol. xviii, pp. 358, 359. 1876.

Scudder, S. H. Note on the wing of a Cockroach from the Carboniferous Formation of Pittston, Penn'a. <*Proc. Boston Soc. Nat. Hist.*, vol. xix, pp. 238, 239. 1877.

Reprinted in *Scudder's Entomological Notes*, 6, pp. 35, 36, 1878.—The title of this paper is not given in the *Proc. Boston Soc. Nat. Hist.*, and it is not mentioned in the table of contents of that volume; doubtless by inadvertence.

Scudder, S. H. An Insect-wing of extreme simplicity from the Coal Formation. <*Proc. Boston Soc. Nat. Hist.*, vol. xix, pp. 248, 249. 1878.

Reprinted in *Scudder's Entomological Notes*, 6, pp. 37, 38.

Scudder, S. H. Rachura, a new genus of fossil Crustacea. <*Proc. Boston Soc. Nat. Hist.*, vol. xix, pp. 296–300, pl. 9, figs. 3, 3*a*. 1878.

Reprinted in *Scudder's Entomological Notes*, 6, pp. 50–54, with the same plate.

Springer, Frank. *See* **Wachsmuth, Charles,** *and* **Frank Springer.**

Ulrich, E. O. Observations on Fossil Annelids, and description of some new forms. <*Journ. Cincinnati Soc. Nat. Hist.*, vol. i, pp. 87–91, 1 pl. 1878.

Part of the plate relates to the next following article.—Lower Silurian.—Genera *Protoscolex* and *Eotrophonia*.

Ulrich, E. O. Descriptions of some new species of fossils from the Cincinnati Group. <*Journ. Cincinnati Soc. Nat. Hist.*, vol. i, pp. 92–100, 1 pl. 1878.

Lower Silurian.—Part of the plate relates to the next preceding article.—Genera *Anomaloides* and *Protasterina*.

Verrill, A. E. On the Post-Pliocene Fossils of Sankoty Head, Nantucket Island; by A. E. Verrill; with a note on Geology by S. H. Scudder. <*Am. Journ. Sci.*, vol. x, pp. 364–375. 1875.

It is shown in this article that the fossils occupy two limited but distinct layers only a few inches apart; the lower layer containing only such species as now inhabit the coasts of Southern New England and further south; and the upper containing such as now live in the colder waters further north. Mr. Scudder gives a long list of the fossils.

Vogdes, A. W. A Monograph of the genera Zethus, Cybele, Encrinurus, and Cryptonymus. 8vo pamphlet. 35 pp., 4 photograph-plates. Charleston, South Carolina. 1878.

This memoir consists of a discussion and rearrangement of previously published species of the genera indicated.

Vogdes, A. W., William G. Mazyck *and.* *See* **Mazyck, William G., *and* A. W. Vogdes.**

Wachsmuth, Charles, *and* **Frank Springer.** Transition forms in Crinoids and description of five new species. <*Proc. Acad. Nat. Sci. Phila. for* 1878, pp. 224–266, with 2 photograph-plates. 1878.

Wallace, Samuel J. On the "Geodes" of the Keokuk Formation, and the genus Biopalla. <*Am. Journ. Sci.*, vol, xv, 3d ser., pp. 366–370. 1878.

The author takes the ground that the well-known geodes of the Keokuk Limestone (Subcarboniferous) are of organic origin—sponges; for which he proposes the genus *Biopalla*, and describes eight species from that formation.

Wetherby, A. G. *See* **Mickleborough, John,** *and* **A. G. Wetherby.**

White, C. A. Descriptions of New Species of Invertebrate Fossils from the Carboniferous and Upper Silurian Rocks of Illinois and Indiana. <*Proc. Acad. Nat. Sci. Phila. for* 1878, pp. 29–37. 1878.

White, C. A. Paleontological Papers No. 6: Descriptions of New Species of Invertebrate Fossils from the Laramie Group. <*Bull. U. S. Geol. & Geog. Surv. Terr.*, vol. iv, pp. 707–719. 1878.

White, C. A. Paleontological Papers No. 7: On the Distribution of Molluscan Species in the Laramie Group. <*Bull. U. S. Geol. & Geog. Surv. Terr.*, vol. iv, pp. 721–724. 1878.

In this paper the author shows that Molluscan species are so distributed as to show the identity of the following groups of strata as members of the great Laramie Group: Judith River beds, Fort Union beds, Lignitic series of Eastern Colorado, Bitter Creek series of Southern Wyoming, and the Bear River Valley series of Western Wyoming.

White, C. A. Paleontological Papers No. 8: Remarks on the Laramie Group. <*Bull. U. S. Geol. & Geog. Surv. Terr.*, vol. iv, pp. 865–876. 1878.

In this paper the author discusses the geographical and vertical range of the fossils of the Laramie Group, besides other questions concerning its extent, geological age, &c.

Whitfield, R. P. Preliminary Descriptions of New Species of Fossils from the Lower Geological Formations of Wisconsin. <*Ann. Rep. Geol. Surv. Wisconsin for* 1877 (Chamberlin, 8vo pamphlet, 93 pp. Madison, Wisconsin, 1878), pp. 50–89. 1878.

Genus *Scævogyra*, with three species. Professor Whitfield also describes a species each of *Ellipsocephalus*, *Bellerophon*, and *Triplesia* from the Potsdam Sandstone, showing an antiquity for these genera not hitherto known.

Whitfield, R. P. Remarks on some Lamellibranchiate Shells of the Hudson River Group, with descriptions of four new species. <*Journ. Cincinnati Soc. Nat. Hist.*, vol. i, pp. 137–141, one plate. 1878.

Part of the plate is devoted to the article of Mr. Miller in the same volume.

Whitfield, R. P. *See* **Hall, James,** *and* **R. P. Whitfield;** *and also under head of* **Anon.**

A six-page pamphlet has been received from the author, bearing the following title:

"Kent Scientific Institute. (Miscellaneous Papers No. 3.) Notes upon the Fossil Remains of the Lower Carboniferous Limestone exposed at Grand Rapids, Michigan. By E. A. Strong."

It is without date or place of publication, and probably ought not to be regarded as regularly published; but it is noticed here at the suggestion of those who think a work of this kind ought to contain a notice of all printed matter relating to its subject, leaving the question of validity of publication to be settled by the practice of naturalists. The following species are described as new: *Cladodus irregularis*, *Phillipsia longispina*, *Nautilus ellipticus*, *N. kentensis*, *Allorisma elongata*, and *A. quadrata*.

PART II.

PUBLICATIONS MADE IN BRITISH NORTH AMERICA, WEST INDIES, AND EUROPE.*—By H. ALLEYNE NICHOLSON.

Barrande, Joachim. État actuel des connaissances acquises sur la faune primordiale. [The actual condition of our knowledge as to the Primordial Fauna.] <*Bull. de la Soc. Géol. de France*, 2e sér., t. xvi, pp. 516–546. 1859.

A portion of this memoir refers to the Primordial Group and its fossils in North America.

Barrande, Joachim. Observations sur l'existence de la faune primordiale dans la Chaine Cantabrique. [On the existence of the Primordial Fauna in the Cantabrian Mountains.] <*Bull. de la Soc. Géol. de France*, 2e sér., t. xvii, pp. 542–554. 1860.

Refers to and describes a *Paradoxides* found by Prof. W. B. Rogers near Boston, U. S.

Barrande, Joachim. Assentiment de Prof. James Hall, et autres documents nouveaux au sujet de la faune primordiale en Amérique. [Assent of Prof. James Hall, and other new documents on the subject of the Primordial Fauna of America.] <*Bull. de la Soc. Géol. de France*, 2e sér., t. xix, pp. 721–745. 1862.

Bigsby, J. J. Thesaurus Devonico-Carboniferus: The Flora and Fauna of the Devonian and Carboniferous Periods. The genera and species arranged in tabular form, showing their horizons, recurrences, localities, and other facts. 8vo. 1878.

Relates in large part to the Devonian and Carboniferous fossils of North America.

Brady, Henry B. Description d'une nouvelle espèce de Foraminifère des conches Miocène de la Jamaïque. <*Ann. de la Soc. Malacologique de Belgique*, t. xi, p. 15, [original pagination not known to the writer]. 1876.

Describes, under the name of *Tinoporus pilaris*, a new Foraminifer from the Miocene Tertiary of Jamaica.

Dawson, J. W. New Facts relating to Eozoön Canadense. <*Canad. Naturalist*, new ser., vol. viii, pp. 282–285. 1878.

From the *Proceedings of the American Association for the Advancement of Science, Buffalo meeting*, August, 1876.

Desor, G. Note sur l'existence de coquilles marines des mers actuels dans le bassin du lac Ontario (Canada) jusqu'à l'altitude de 310 pieds. [Note on the existence of marine shells of existing species in the basin of Lake Ontario, up to elevations of 310 feet.] <*Bull. de la Soc. Géol. de France*, 2e sér., t. viii, pp. 420–423. 1851.

Etheridge, Robert. Palæontology of the Coasts of the Arctic Lands visited by the late British Expedition under Captain Sir George Nares, R. N., K. C. B., F. R. S. <*Quart. Journ. Geol. Soc. Lond.*, vol. xxxiv, pp. 568–636, pls. xxv–xxix.

A large number of invertebrate fossils from the Silurian, Devonian, and Carboniferous rocks of the Arctic regions are described in this important paper. The new species and varieties described are *Receptaculites arcticus*, *Monograptus convolutus*, his var. *coppingeri*, *Halysites catenulatus*, var. *feildeni* and var. *harti*, *Syringopora parallela*, *Zaphrentis offleyensis*, *Amplexus feildeni*, *Pentamerus coppingeri*, *Strophodonta feildeni*, *Murchisonia latifasciata*, *Helicotoma naresii*, *Platyceras naticoides*, all from the Silurian, and *Spirifera aldrichi* from the Devonian. Mr. R. Etheridge, Jun., appends a valuable bibliography of the Arctic fossil *Polyzoa*; and there is also a table showing the geographical distribution of the Polar Palæozoic fossils.

Geinitz, H. B. Sur les Graptolites. [On Graptolites.] <*Bull. de la Soc. Géol. de France*, 2e sér., t. ix, pp. 186–188. 1851.

Graptolithus gracilis, Hall, and *G. hallianus*, Prout, with some other forms, are regarded by the author as being Sertularians rather than true Graptolites.

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*The writer takes this opportunity of returning his best thanks to his friends R. Etheridge, Esq., Jun., and R. Bullen Newton, Esq., from whom he has received kind assistance in the preparation of the following list. Dr. Scudder has also been good enough to supply references to additional publications of his own, either omitted in the Catalogue or not published at the time of its appearance, and the help thus afforded is here gratefully acknowledged.

Jones, T. Rupert, *and* W. K. Parker. Notice sur les Foraminifères vivants et fossiles de la Jamaïque. <*Annales de la Soc. Malacologique de Belgique*, tome xi, pp. 15. 1876. [Original pagination not known to the writer.]

The authors give lists of the *Foraminifera* of the Tertiary deposits of Jamaica. One species, which is found both in the fossil and living condition, is described and figured as new under the name of *Textularia barrettii*. A list of the Miocene fossils of Jamaica, compiled from memoirs by Mr. Guppy and Mr. Etheridge, is appended to the paper.

Logan, [*Sir*] William. Sur la formation Silurienne des environs de Québec, Canada. <*Bull. de la Soc. Géol. de France*, 2e sér., t. xii, pp. 504–508. 1855.

Records the occurrence of a large number of species of fossils.

Marcou, J. Liste additionnelle des fossiles du terrain taconique de l'Amérique du Nord. [Additional list of the fossils of the Taconic Formation of North America.] <*Bull. de la Soc. Géol. de France*, 2e sér., t. xix, pp. 746–752. 1862.

Marcou, J. Notice sur les gisements des lentilles trilobitifères taconiques de la Pointe Lévis, Canada. [Note on the geological position of the nodules with Trilobites at Point Lévis, Canada.] <*Bull. de la Soc. Géol. de France*, 2e sér., t. xxi, pp. 236–255.

Marcou, J. La faune primordiale dans le pays de Galles, et la géologie Californienne. <*Bull. de la Soc. Géol. de France*, 2e sér., t. xxiii, pp. 552–559. 1866.

Mentions a number of fossils met with in California.

Marcou, J. Le Dyas au Nébraska. <*Bull. de la Soc. Géol. de France*, 2e sér., t. xxiv, pp. 280–300. 1867.

The author gives lists of fossils.

Nicholson, H. Alleyne, *and* J. Murie. On the Minute Structure of Stromatopora and its Allies. <*Journ. of the Linnean Soc.*, vol. xiv, pp. 187–246, pls. i–iv.

In this memoir the authors deal with the history and literature, the mode of occurrence, minute structure, classification and types, and zoological affinities of the Stromatoporoids. The material dealt with is largely drawn from American formations. The genera *Clathrodictyon*, *Stylodictyon*, and *Pachystroma*, are founded upon specimens from the Devonian and Silurian deposits of North America.

Scudder, S. H. Letter to C. F. Hartt on the Devonian Insects of New Brunswick. <*Observations on the Geology of Southern New Brunswick*, by L. W. Bailey, pp. 140–141. 1865.

Reprinted in *Amer. Journ. Sci. and Arts*, ser. 2, vol. xxxix, pp. 357–358, and in *Trans. Entom. Soc. Lond.*, ser. 3, vol. ii, Proc. pp. 117–118.

Scudder, S. H. [Descriptions of Palæozoic Insects.] *See* Dawson's "*Acadian Geology*," pp. 387–388 and 524–526; also by the same author, "On some Remains of Palæozoic Insects recently discovered in Nova Scotia and New Brunswick," in the *Geological Magazine*, Decade I, vol. iv, pp. 385–388, pl. xvii, figs. 1–5.

Scudder, S. H. [Extract from a letter to Selys-Longchamps on Bryeria; translated into French.] <*Comptes Rendus Soc. Entom. Belg.*, [2], No. 21, p. 2.

Mr. Scudder herein claims that the nervation of *Bryeria* shows that it cannot be a Neuropteron, as it was described to be.

Scudder, S. H. New and Interesting Insects from the Carboniferous of Cape Breton. <*Canad. Nat.*, new ser., vol. viii, pp. 88–90. 1876.

Reprinted from the *Proc. Am. Assoc. Adv. Sci.*, vol. xxiv, pp. 110–111.

Scudder, S. H. Description d'un nouveau papillon fossile (Satyrites Reynesii), trouvé à Aix en Provence. <*Rev. et Mag. de Zool.*, vol. xxiii, pp. 66–72, pl. vii. 1872.

Translated in the *Geol. Mag.*, vol. ix, pp. 532–533, pl. xiii, figs. 2 and 3.

Scudder, S. H. The Insects of the Tertiary Beds at Quesnel. <*Report of the Geological Survey of Canada for* 1875–76, pp. 266–280. 1877.

The new species of insects determined from the Tertiary beds of Quesnel, in British Columbia, are as follows:—Among the *Hymenoptera: Formica arcana*, *Hypoclinia obliterata*, *Aphenogaster longæva*, *Pimpla saxea*, *P. senecta*, *P. decessa*, and *Calyptites* (gen. nov.) *antediluvianum*; among *Diptera: Boletina sepulta*, *Brachypeza abita*, *B. procera*, *Trichonta dawsoni*, *Anthomyia inanimata*, *A. burgessi*, *Heteromyza senilis*, *Sciomyza revelata*, *Lithortalis* (gen. nov.) *picta*, *Lonchæa senescens*, and *Palloptera mortiana*; among *Coleoptera: Prometopia debilis*; and among *Hemiptera: Lachnus petrorum*.

Scudder, S. H. Additions to the Insect-fauna of the Tertiary Beds at Quesnel, British Columbia. <*Report of Progress of the Geological Survey of Canada for* 1876–77, pp. 457–464. 1878.

The new species described are *Sciara deperdita* (*Diptera*), *Enschistus antiquus* and *Lachnus quesneli* (*Hemiptera*), and *Bothromicromus* (gen. nov.) *lachlani* (*Neuroptera*). Some egg-cocoons of Spiders are described under the name of *Aranea columbiæ*.

Shumard, B. F. Existence du Terrain Permien au Nouveau Mexique. [Existence of the Permian formation in New Mexico.] <*Bull. de la Soc. Géol. de France*, 2e sér., vol. xv, pp. 531–533. 1857.

Whiteaves, J. F. On some Jurassic Fossils from the Coast Range of British Columbia. <*Canad. Naturalist*, new series, vol. viii, No. 7, pp. 400–410.

These fossils are interesting as forming the first instance of the occurrence of a well-marked fauna in British Columbia. They were collected by Mr. G. M. Dawson, and consist of 27 species of *Mollusca* and one of *Annelida*. Their state of preservation is, however, so bad that generic characters are sometimes doubtful. A provisional list is given of the species, with brief descriptions of those that appear to be new, and critical remarks on others. The new species recorded are: *Pinna subcancellata*, *Grammatodon? itasyoucoensis*, and *Trigonia dawsoni*.

Whiteaves, J. F. Notes on some of the Fossils collected during Mr. Selwyn's Expedition in British Columbia. <*Report of Progress Geological Survey of Canada for* 1875–76, pp. 96–106. 1877.

The fossils described are Jurassic or Cretaceous, Triassic, Carboniferous or Permian, Devonian or Carboniferous, from undoubted Devonian deposits, and from strata of unknown age. No new species are named.

Whiteaves, J. F. Notes on some Jurassic Fossils, collected by Mr. G. M. Dawson, in the Coast Range of British Columbia. <*Report of Progress of the Geological Survey of Canada for* 1876–77, pp. 150–159. 1878.

Twenty-eight forms of *Mollusca* and a species of *Serpula* are noted and more or less fully described, from the Jurassic deposits of British Columbia. *Pinna subcancellata* and *Trigonia dawsoni* are described as new.

Woodward, Henry. Notes on some Arctic Silurian Fossils from Beechey Island, brought home by the S. Y. "Pandora," 1875, and from Port Dundas, Lancaster Sound, by an Earlier Expedition in 1853. <*Geological Magazine*, new ser., Decade II, vol. v, pp. 385–390, pl. x. 1878.

Describes some Corals, *Alveolites? arctica* being new.