DEPARTMENT OF THE INTERIOR.

REPORT

OF THE

UNITED STATES GEOLOGICAL SURVEY

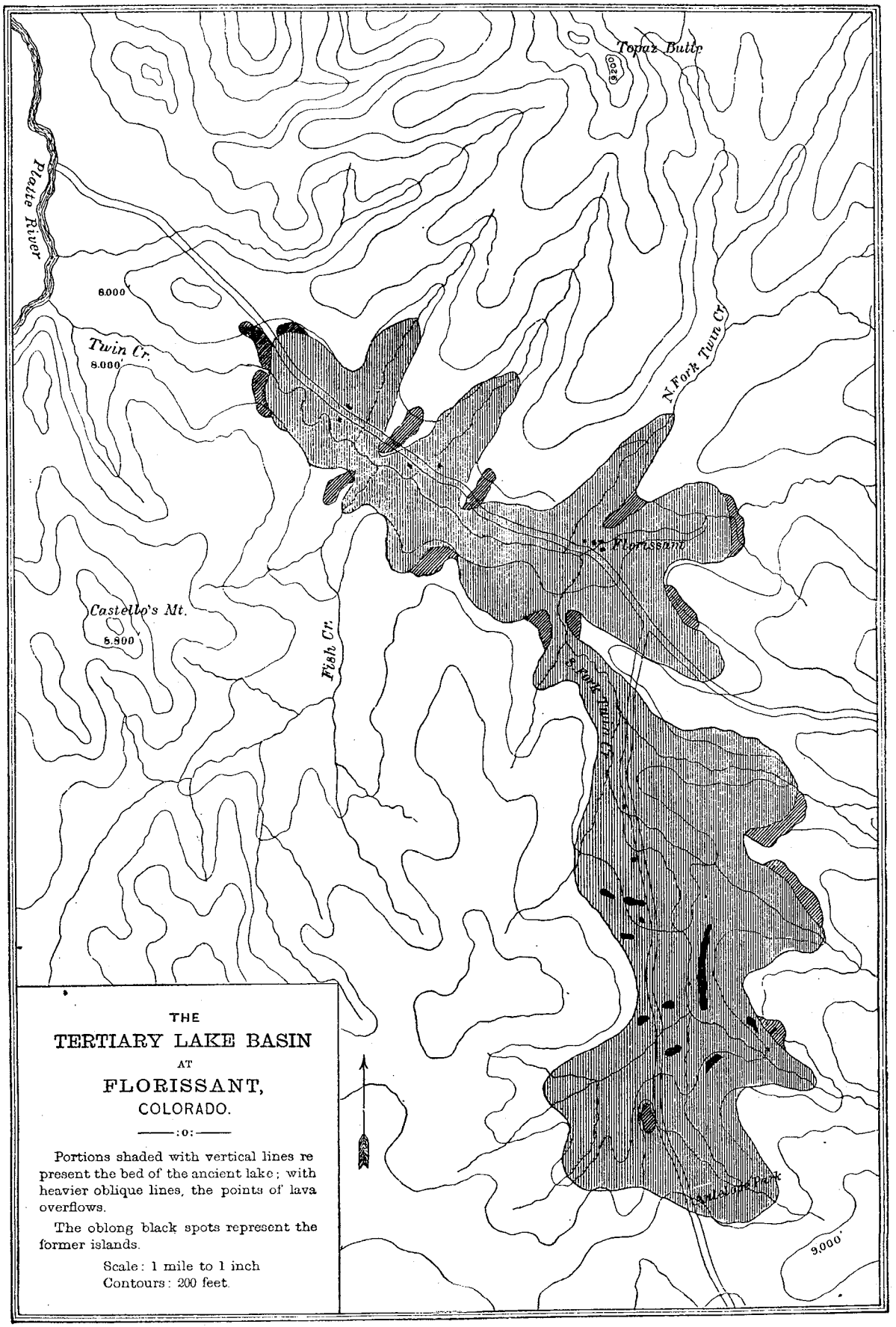
OF

THE TERRITORIES.

F. V. HAYDEN,
UNITED STATES GEOLOGIST-IN-CHARGE.

VOLUME XIII.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1890.



THE

TERTIARY LAKE BASIN

AT

FLORISSANT,

COLORADO.

——:o:——

Portions shaded with vertical lines re present the bed of the ancient lake; with heavier oblique lines, the points of lava overflows.

The oblong black spots represent the former islands.

Scale: 1 mile to 1 inch
Contours: 200 feet.

UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES.

THE

TERTIARY INSECTS

OF

NORTH AMERICA.

BY

SAMUEL H. SCUDDER.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1890.

NOTE.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY.
Washington, D. C., May 16, 1890.

On the 27th of September, 1882, at the request of Dr. F. V. Hayden, the completion of the publications of the United States Geological and Geographical Survey of the Territories, formerly under his charge, was committed to the charge of the Director of the Geological Survey by the following order from the honorable the Secretary of the Interior:

DEPARTMENT OF THE INTERIOR,
Washington, September 27, 1882.

Maj. J. W. POWELL,
Director U. S. Geological Survey:

SIR: The letter of Prof. F. V. Hayden, dated June 27, bearing your indorsement of July 20, relating to the unpublished reports of the survey formerly under his charge, is herewith returned.

You will please take charge of the publications referred to in the same, in accordance with the suggestions made by Professor Hayden.

It is the desire of this office that these volumes shall be completed and published as early as practicable.

Very respectfully,

H. M. TELLER,
Secretary.

Of the publications thus placed in charge of the Director of the United States Geological Survey the accompanying volume is the third to be issued, the preceding being "The Vertebrata of the Tertiary Formations of the West," by Edward D. Cope, and "Contributions to the Fossil Flora of the Western Territories," by Leo Lesquereux.

J. W. POWELL,
Director.

CONTENTS.

ILLUSTRATIONS.

ERRATA.

Page 15, eleventh line from bottom, *for* specimen *read* individual.

Page 28, line eighteen, *for* specimens *read* species.

Page 71, under Aranea columbiæ, *for* Pl. 11 *read* Pl. 2.

Page 202. The two paragraphs immediately preceding Forficulariæ belong on page 203, immediately preceding Labiduromma.

Page 203, line three, *for* cricket *read* crickets.

Page 203, before Labiduromma, insert the two paragraphs on page 202, immediately preceding Forficulariæ.

Page 225, line one, *for* interspaces *read* interspace; line two, *insert* that *before* above.

Page 244, in table, *for* 3. Geranchum *read* 3. Gerancon; *for* 13. Amalanchum *read* 13 Amalancon; *for* 15. Anconotus *read* 15. Anconatus.

Page 245, under C. absens, the third line *should read*: Fore wing nearly three times as long as broad. First oblique vein nearly straight, etc.

Page 248, in three headings, *for* Geranchon *read* Gerancon.

Page 249, in heading, *for* Geranchon *read* Gerancon.

Page 256, line twenty, *before* parts *insert* except at base.

Page 316, lines 5 and 6, *for* possibly luminiferous *read* highly decorated.

Page 343, line 4, *for* in the to-day *read* to-day in the.

Page 362, line 20, *for* referred *read* referable.

Page 446, line 15, and in several places on succeeding pages, *for* punctæ *read* puncta.

Page 610, lines 13 and 14, *for* abdomen *read* thorax.

LETTER OF TRANSMITTAL.

U. S. GEOLOGICAL SURVEY,
DIVISION OF FOSSIL INSECTS,
Cambridge, March 14, 1890.

SIR: It is a source of great regret to me that the volume herewith transmitted could not have been published during Dr. Hayden's life. It contains the first fruits of an undertaking inspired by him and encouraged by his aid. The extent of the task he intrusted to me more than a dozen years ago has been, with the interference of other duties, the occasion of the delay in its execution. The material has grown beyond all expectation, far beyond anything that could have been anticipated.

As originally planned, when the Florissant beds were first carefully exploited, the fossil insects other than those from Florissant were first to be disposed of, and the latter were then to be taken up by orders. The plates were accordingly executed (before the completion of the text) with that plan in view, and the first ten plates herewith transmitted contain very nearly all the extra-Florissant insects known ten years ago. Since then their number has perhaps doubled. The succeeding plates contain the lower orders of Florissant arthropods, ending with the Hemiptera.

The text has been made to conform in large measure to the same plan, except that the insects of different localities and of different horizons have been arranged in one systematic series. Descriptions of a considerable number of species have been introduced for completeness' sake which are not figured, but of every one of these drawings have been finished and will be given in some future publication. The early portion of the text was written many years ago—the Arachnida and Termitina in 1881, most of the Odonata in 1882, the Ephemeridæ and Planipennia in 1883, and the Trichoptera and Orthoptera in 1884; and, as the general remarks prefixed to each group were written on the completion of the study of that group, and would now have to be modified in some slight particulars, I have thought best to let these remarks remain as written, and to append at the

end of each general paragraph the date of writing. To rewrite the whole would unnecessarily delay the appearance of the work, and the dates will explain otherwise unaccountable, though generally very slight, omissions of later material.

The new portions of the Coleoptera, Diptera, and Hymenoptera were mostly written a year ago, and during the past year the Hemiptera, much the most extensive group in the volume, have been elaborated. In the four later orders the general remarks and summaries attached to the genera, families, etc., of the earlier groups are omitted, because these orders will form the subject of future separate consideration, and the basis for generalization will then be greatly increased; the representation of these orders in the present volume is very meager, including next to no species from Florissant.

The publication of this volume will give the first opportunity for any good comparisons between the long known Tertiary insects of Europe and those of any other country; so far as the lower orders of insects are concerned—the only ones here at all fully elaborated—they show that the material already gathered within the last two decades in America is at least as rich as that of the well gleaned fields of Europe. The present volume contains descriptions of 1 species of Myriapoda, 34 of Arachnida, 66 of Neuroptera, 30 of Orthoptera, 266 of Hemiptera, 112 of Coleoptera, 79 of Diptera, 1 of Lepidoptera, and 23 of Hymenoptera, in all 612 species. For the lower orders, that is, those here fully treated, these numbers are already slightly in excess of those obtained from the European Tertiaries, if the rich amber fauna of the Baltic is excluded; for the corresponding numbers for the European species from the rocks would be approximately as follows: Myriapoda, 1; Arachnida, 24 (recently, however, nearly doubled); Neuroptera, 59; Orthoptera, 36; and Hemiptera, 218; a total of 338 species against 397 for the American rocks. There is no doubt that this excess would be found even greater in the higher orders by the material already many years in hand; and the extent of the insect-bearing rocks of the West, which as yet have been touched only here and there, is so immeasurably greater than that of similar European strata that only the lack of students in this field of American paleontology can prevent our deposits from assuming a commanding position in the world.

Very respectfully, yours,

SAMUEL H. SCUDDER.

Hon. J. W. POWELL,
Director U. S. Geological Survey, Washington, D. C.

THE TERTIARY INSECTS OF NORTH AMERICA.

By Samuel H. Scudder.

INTRODUCTION.

That creatures so minute and fragile as insects, creatures which can so feebly withstand the changing seasons as to live, so to speak, but a moment, are to be found fossil, engraved, as it were, upon the rocks or embedded in their hard mass, will never cease to be a surprise to those unfamiliar with the fact. "So fragile," says Quinet[1], "so easy to crush, you would readily believe the insect one of the latest beings produced by nature, one of those which has least resisted the action of time; that its type, its genera, its forms, must have been ground to powder a thousand times, annihilated by the revolutions of the globe, and perpetually thrown into the crucible. For where is its defense? Of what value its antennæ, its shield, its wings of gauze, against the commotions and the tempests which change the surface of the earth? When the mountains themselves are overthrown and the seas uplifted, when the giants of structure, the mighty quadrupeds, change form and habit under the pressure of circumstances, will the insect withstand them? Is it it which will display most character in nature? Yes! The universe flings itself against a gnat. Where will it find refuge? In its very diminutiveness, its nothingness."

The pages and plates of the present volume bear testimony to the fact that our tertiary strata have preserved remnants of an ancient host, so varied in structure, so closely also resembling their brethren of to-day, that nearly or quite every prevalent family-group in the entire range of the insect-world has already been demonstrated to have then existed. While often fragmentary and crushed, sometimes beyond recognition, a not insignificant number are sufficiently preserved for us to repopulate the past;

[1] E. Quinet: La Création, vol. 1, p. 197.

sometimes, too, are they preserved in such a wonderful manner that in tiny creatures with a spread of wings scarcely more than a couple of millimeters one may count under the microscope the hairs fringing the wings.

In attempting thus to restore the past world of our insects, two or three general features have been forced upon my attention, which may well be mentioned here. One of them is the remarkable fact that in hardly a single instance has the same species been found at two distinct localities. These localities, it is true, are in some instances separated by hundreds or even thousands of miles, and analogy with the present distribution of insects would lead us to expect more or less profound changes in passing from one to another. But at other times the distance is not great, or at any rate not great enough to make this a satisfactory reason. It is more probable that the beds in which they occur are not altogether synchronous; and we are led to believe that in the separation of horizons insects will give more precise and definite distinctions than may be gained by the study of the plant remains of the same beds. The data at our disposal are not yet sufficiently varied to enable us to speak with any confidence, but when the other groups of Florissant insects, not considered in the present volume, are worked out, and the new material that is at hand from the other principal localities has been fairly studied, it may be found that we are armed with a new weapon of attack in solving the immediate succession of the Tertiary series of the West in their finer subdivisions.

Another point to which attention may be drawn is the very considerable number and quite extraordinary proportion of species which so far are represented by a single specimen. Leaving out of consideration certain marvelously prevalent forms in the beds of Florissant, such as certain Formicidæ, Alydina, etc., one working these beds, from which many thousands of insects have already been taken, may confidently expect that every third or fourth specimen will prove something new. A quite similar statement can be made of all, or all but one, of the other localities where insects have been found in our Tertiary deposits: it surely indicates that with all the rich results of the explorations so far undertaken we are only upon the threshold of our possible knowledge. We find a richness of fauna far exceeding anything before supposed possible.

The interest of the Tertiary fauna is further enhanced by the discovery that no inconsiderable proportion of the species in this fauna must be re-

ferred to genera not now extant. Granted that our knowledge of the subtropical forms of this continent (with which as a whole at least our Florissant fauna seems to be akin) is much too meager to be of great service; granted also that in many cases we are forced to establish new genera upon what would be regarded among recent animals as too slender grounds: it is nevertheless true that an unexpectedly large number of forms can not be forced into modern genera already established; in many cases, throughout whole groups, kindred differences from modern types are found which indicate considerable changes of structure in the intervening epochs along parallel lines. In illustration of this we would call special attention to the differences observed in the genera of plant-lice, and, in several places among other Hemiptera as well as among the Coleoptera, to the decided differences in the relative length of various members of the body. My own belief, which springs from the comparisons instituted in the study of this fauna, is that a much larger proportion of genera should really have been founded, and that, for every type which may turn up in Central American explorations of the near future identical with those now established upon the fossils alone, it will be necessary to separate from the familiar surroundings in which I have placed it some other of the insects from the same beds.

It should be stated that the larger part of the plates in this volume were engraved before the insects were studied, except in a cursory manner to separate the species; the insects are therefore not always properly grouped, and the legends upon the plates are in part inaccurate.

In the enumeration of the specimens at the end of the specific descriptions the numbers of the obverse and reverse of the same specimen are always connected by "and" without any intervening comma, and this typographical method is employed only for expressing this relation.

In the study of these extinct insects much assistance has been received from friends, to whom my cordial thanks are due; for valuable suggestions from the late Dr. J. L. LeConte, from Baron R. von Osten Sacken, Edward Burgess, Esq., and Drs. G. H. Horn and H. A. Hagen; for the open collections of the late G. D. Smith, Esq., and of Messrs. E. P. Austin and Samuel Henshaw; and for important aid in obtaining typical series of modern insects in various groups by Messrs. E. P. Austin, P. R. Uhler, E. P. Van Duzee, Edward Burgess, Dr. A. Forel, and most especially Mr. Samuel Henshaw.

LOCALITIES WHERE TERTIARY INSECTS HAVE BEEN FOUND IN AMERICA.

Florissant, Colorado.—The Tertiary lake basin at Florissant,[1] already famous for its prolific beds of plants and insects, is situated in a narrow valley high up in the mountains at the southern extremity of the Front Range of Colorado, at no great distance from Pike's Peak.

The basin is shown on Sheet 13 of the geological atlas of Colorado, published by Dr. Hayden's survey, and its outlines are marked with considerable accuracy, although upon a comparatively small scale. The ancient lake lies in the valley of the present South Fork of Twin Creek, and of the upper half of the main stream of the same after the South Fork has joined it. Following the old stage road from South Park to Colorado Springs, and leaving it just above the railway station at Florissant, and then taking the road which leads over the divide toward Cañon City, we pass between the Platte River and the Arkansas divide, through the entire length of the basin. This road crosses the South Platte a short distance, say a kilometer and a half, below the mouth of Twin Creek, climbs a long gradual slope on the east bank of the river to an open grassy glade about 2,500 meters above the sea, and then descends a little more than three kilometers from the river to join the valley of Twin Creek. One scarcely begins the descent before his attention is attracted by the outcropping of drab-colored shales, which continue until almost the very summit of the divide is reached and the descent toward the Arkansas begun, a traveling distance of not far from 13 kilometers. The shales may indeed be seen for several kilometers on the farther side of this divide, but no organic remains have yet been found in them.

By climbing a neighboring peak, thrice baptized as Crystal Mountain, Topaz Butte, and Cheops Pyramid, and known to the old miners as Slim Jim, we obtained an admirable bird's-eye view of the ancient lake and the

[1] This account of Florissant is taken almost bodily from a paper by Prof. Arthur Lakes and myself (Bull. U. S. Geol. Surv. Terr., vol. 6, 1881, pp. 279, seq.).

surrounding region. To the southeast is Pike's Peak; to the west South Park and the cañon of the South Platte, shown by a depression; to the extreme south the grand cañon of the Arkansas; while to the north a few sharp, ragged, granite peaks surmount the low wooded hills and ravines characteristic of the nearer region. Among these hills and ravines, and only a little broader than the rest of the latter, lies, to the south, the ancient Florissant Lake basin, marked by an irregular L-shaped grassy meadow, the southern half broader and more rolling than the northwestern, the latter more broken and with deeper inlets.

Recalling its ancient condition it will appear that this elevated lake must have been a beautiful, though shallow,[1] sheet of water. Topaz Butte, and a nameless lower elevation lying eight kilometers to its southwest, which we may call Castello's Mountain, guarded the head of the lake upon one side and the other, rising 300 or 400 meters above its level. It was hemmed in on all sides by nearer granitic hills, whose wooded slopes came to the water's edge; sometimes, especially on the northern and eastern sides, rising abruptly, at others gradually sloping, so that reeds and flags grew in the shallow waters by the shore. The waters of the lake penetrated in deep inlets between the hills, giving it a varied and tortuous outline; although only about 16½ kilometers long and very narrow, its margin must have measured over 70 kilometers in extent. Still greater variety was gained by steep promontories, 20 meters or more in height, which projected abruptly into the lake from either side, nearly dividing it into a chain of three or four unequal and very irregular open ponds, running in a northwest-southeast direction, and a larger and less indented sheet, as large as the others combined, connected with the southwesternmost of the three by a narrow channel, and dotted with numerous long and narrow wooded islets just rising above the surface.

The ancient outlet of the whole system was probably at the southern extremity; at least the marks of the lake deposits reach within a few meters of the ridge which now separates the waters of the Platte and Arkansas; the nature of the basin itself, and the much more rapid descent of the present surface on the southern side of this divide lead to this conclusion. At the last elevation of the Rocky Mountain chain the drainage flow of this immediate region was reversed; the elevation coming from a southerly or south-

[1] The shallowness of the lake is indicated by the character of the fish, the sun cracking of some of the shales, and the erect sequoia stumps.

easterly direction (perhaps from Pike's Peak), the lake, or series of lakes, was drained dry by emptying at the northwestern extremity. The drainage of the valley now flowed into a brook which followed the deeper part of its former floor, and the waters of the region have since emptied into the Platte and not the Arkansas, passing in their course between Topaz Butte and Castello's Mountain.

The promontories projecting into the lake on either side are formed of trachyte or other volcanic lavas, apparently occurring in fissures directly athwart the general course of the northwestern or upper series of lakes, and masses of the same occur at many different points along the ancient shore, such as the western corner where the waters of the lake were finally discharged; in the neighborhood of the village; along the eastern wall of the lowermost of the chain of upper lakes, near where the present road divides; and at points along both eastern and western walls of the lower southern lake. In general the trachytic flows seem to be confined to the edges of the lacustrine basin, but some, if not all, of the mesas or ancient islands of the southern lake have trachytic flows over them; and toward the southern extremity of the lake what was once a larger island now forms a rounded hill with steep northern walls, crowned by heavy beds of dark trachyte, and its slopes covered with quantities of vesicular scoriæ. The rough and craggy knoll immediately overlooking the present village of Florissant, the reputed scene of Indian combats,[1] is witness of hotter times than those; vertical cylindrical holes, with smooth walls, in which a man could hide from sight, funnels scored by heat, mark, perhaps, the presence of former geysers; the basaltic rocks themselves are deeply fissured by the breaking up of the planes of divisions between the columns, affording the best protection to the Ute and Arapahoe warriors. But the very shales of the lake itself, in which the myriad plants and insects are entombed, are wholly composed of volcanic sand and ash; 15 meters or more thick they lie, in alternating layers of coarser and finer material. About half of this, now lying beneath the general surface of the ground, consists of heavily-bedded drab shales, with a conchoidal fracture, and is totally destitute of fossils. The upper half has been eroded and carried away, leaving, however, the fragmentary remains of this great ash deposit clinging to the borders of the basin and surrounding the islands; a more convenient arrange-

[1] Their rude fortifications still crown the summit.

ment for the present explorer could not have been devised. That the source of the volcanic ashes must have been close at hand seems abundantly proved by the difference in the deposits at the extreme ends of the lake as will be shown in the sections to be given. Not only does the thickness of the beds differ at the two points, but it is difficult to bring them into anything beyond the most general concordance.

There are still other proofs of disturbance. Around one of the granitic islands in the southern lake basin the shales mentioned were capped by from one and a half to two and a half meters of sedimentary material, reaching nearly to the crown of the hill, the lowest bed of which, a little more than three decimeters thick, formed a regular horizontal stratum of small volcanic pebbles and sand (A and B of Dr. Wadsworth's note, further on), while the part above is much coarser, resembling a breccia, and is very unevenly bedded, pitching at every possible angle, seamed, jointed, and weather-worn, curved and twisted, and inclosing pockets of fine laminated shales, also of volcanic ash, in which a few fossils are found (C of Dr. Wadsworth's note). These beds cap the series of regular and evenly stratified shales (D of the same note), and are perhaps synchronous with the disturbance which tilted and emptied the basin. The uppermost evenly bedded shales then formed the hard floor of the lake, and these contorted beds the softer, but hardening, and therefore more or less tenacious, deposits on that floor.

The excavation of the filled-up basin we must presume to be due to the ordinary agencies of atmospheric erosion. The islands in the lower lake take now as then the form of the granitic nucleus; nearly all are long and narrow, but their trend is in every direction both across and along the valley in which they rest. Great masses of the shales still adhere equally on every side to the rocks against which they were deposited, proving that time alone and no rude agency has degraded the ancient floor of the lake.

The shales in the southern basin dip to the north or northwest at an angle of about two degrees, and according to the contours of the Hayden Survey, the southern end of the ancient lake is now elevated nearly two hundred and fifty meters above the extreme northwestern point. The greater part of this present slope of the lake border will be found in the southern half, where it can not fail to at once strike the observant eye, the southernmost margin close to the summit of the divide being nearly two hundred meters higher than the margin next the hill by the forks of the road.

Our examination of the deposits of this lacustrine basin was principally made in a small hill, from which perhaps the largest number of fossils have been taken, lying just south of the house of Mr. Adam Hill, now owned by Mr. Thompson, and upon his ranch. Like the other ancient islets of this upland lake, it now forms a mesa or flat-topped hill about ten or a dozen meters high, perhaps a hundred meters long and twenty-five broad. Around its eastern base are some of the famous petrified trees—huge, upright trunks, standing as they grew, which are reported to have been five or six meters high at the advent of the present residents of the region. Piecemeal they have been destroyed by vandal tourists, until now not one of them rises more than a meter above the surface of the ground, and many of them are entirely leveled; but their huge size is attested by the relics, the largest of which can be seen to have been three or four meters in diameter. These gigantic trees appear to be Sequoias, as far as can be told from thin sections of the wood submitted to Dr. George L. Goodale. As is well known, remains of more than one species of Sequoia have been found in the shales at their base.

At the opposite sloping end of this mesa a trench was dug from top to bottom to determine the character of the different layers, and the section exposed was carefully measured and studied. In the work of digging this trench we received the very ready and welcome assistance of our companion, Mr. F. C. Bowditch, and of Mr. Hill.

From what information we could gain about the wells in this neighborhood and from a shaft sunk obliquely in the side of a hill near the northwestern extremity, it would appear that the present bed of the ancient Florissant lake is entirely similar in composition for at least ten meters below the surface, consisting of heavily bedded non-fossiliferous shales, having a conchoidal fracture. Above these basal deposits, on the slope of the hill, we found the following series, from above downward, commencing with the evenly bedded strata:

SECTION IN SOUTHERN LAKE.

(*By S. H. Scudder and A. Lakes.*)

	Centimeters.
1. Finely laminated, evenly bedded, light-gray shale; plants and insects scarce and poorly preserved	3.2
2. Light-brown, soft and pliable, fine-grained sandstone; unfossiliferous	5
3. Coarser, ferruginous sandstone; unfossiliferous	3.8
4. Resembling No. 1; leaves and insect remains	21
5. Hard, compact, grayish-black shale, breaking with a conchoidal fracture, seamed in the middle with a narrow strip of drab shale; fragments of plants	28

6. Ferruginous shale; unfossiliferous	1.5
7. Resembling No. 5, but having no conchoidal fracture; stems of plants, insects, and a small bivalve mollusk	9
8. Very fine gray ochreous shale; non-fossiliferous	0.5
9. Drab shales, interlaminated with finely divided paper shales of light-gray color; stems of plants, reeds, and insects	46
10. Crumbling ochreous shale; leaves abundant, insects rare	7.5
11. Drab shales; no fossils	7.5
12. Coarse, ferruginous sandstone; no fossils	3.8
13. Very hard drab shales, having a conchoidal fracture and filled with nodules; unfossiliferous	63
14. Finely laminated yellowish or drab shales; leaves and fragments of plants, with a few insects	30
15. Alternating layers of darker and lighter gray and brown ferruginous sandstone; no fossils	10
16. Drab shales; leaves, seeds, and other parts of plants, with insects, all in abundance	61
17. Ferruginous, porous, sandy shales; no fossils	5.7
18. Dark gray and yellow shales; leaves and other parts of plants	9
19. Interstratified shales, resembling 17 and 18; leaves and other parts of plants, with insects	17.8
20 Thickly bedded chocolate-colored shales; no fossils	41
21. Porous yellow shale, interstratified with seams of very thin drab-colored shales; plants	7.5
22. Heavily bedded chocolate-colored shales; no fossils	30
23. Thinly bedded drab shales; perfect leaves, with perfect and imperfect fragments of plants, and a few broken insects	20
24. Thinly bedded light-drab shales, weathering very light; without fossils	20
25. Thick bedded drab shales, breaking with a conchoidal fracture; also destitute of fossils	18
26. Coarse arenaceous shale; unfossiliferous	9
27. Gray sandstone, containing decomposing fragments of some white mineral, perhaps calcite; no fossils	178
28. Coarse, ferruginous, friable sandstone, with concretions of a softer material; fragments of stems ..... perhaps	60
29. Thinly bedded drab shales, having a conchoidal fracture, somewhat lignitic, with fragments of roots, etc	25
30. Dark-chocolate shales, containing yellowish concretions; filled with stems and roots of plants	25
Total thickness of evenly bedded shales ("D," of Dr. Wadsworth's note) above floor deposits ..... (Meters)	6.668

The bed which has been most worked for insects and leaves, and in which they are unquestionably the most abundant and best preserved, is the thick bed, No. 16, lying half-way up the hill, and composed of rapidly alternating beds of variously colored drab shales. Below this, insects were plentiful only in No. 19, and above it in Nos. 7 and 9; in other beds they occurred only rarely or in fragments. Plants were always abundant where insects were found, but also occurred in many strata where insects were either not discovered, such as Nos. 18 and 21 in the lower half and No. 6 in the upper half, or were rare, as in Nos. 10 and 14 above the middle and No. 23 below; the coarser lignites occurred only near the base.

The thickest unfossiliferous beds, Nos. 20 and 27, were almost uniform in character throughout, and did not readily split into laminæ, indicating an enormous shower of ashes or a mud flow at the time of their deposition; their character was similar to that of the floor-beds of the basin.

These beds of shale vary in color from yellow to dark brown. Above them all lay, as already stated, from fifteen to twenty-five decimeters of coarser, more granulated sediments, all but the lower bed broken up and greatly contorted. These reached almost to the summit of the mesa, which was strewn with granitic gravel and a few pebbles of lava.

Specimens of these upper irregular beds, and also of the underlying shales, were submitted to Dr. M. E. Wadsworth, of Cambridge, Massachusetts, now of Houghton, Michigan, who caused thin sections to be made from them and has furnished the following account of their microscopical structure:

TUFA FROM FLORISSANT.

The method and scheme of classification employed here is that briefly sketched in the Bulletin of the Museum of Comparative Zoölogy (vol. 5, pp. 275–287). By this system only do we think that the inclosed fragments could be named, for they contain so few crystals that in most cases the base is the principal thing upon which the decision must rest.

A.—THE FINER DEPOSIT JUST ABOVE THE SHALES.

A medium-grained gray tufa, containing crystals and fragments of feldspar, augite, etc., cemented by a fine earthy groundmass.

In the thin section it is seen to be an epitome of the volcanic rocks of the Cordilleras. The groundmass holds fragments of basalt, andesite, trachyte, and rhyolite, with detached minerals derived from them.

The basaltic fragments have in part a dense globulitic base porphyritically holding ledge-formed plagioclase crystals and a few augite granules. Some of the basalt is quite coarsely crystallized, approaching the doleritic type. Olivine was observed in some of the fragments, but it is largely altered to a reddish-brown serpentine. Magnetite is abundant. In many of the fragments the groundmass has decomposed to a reddish-brown mass, which is untransparent and holds clear crystals of plagioclase. The basaltic fragments have suffered more from alteration and decomposition than any others in the tufa.

Of andesite, both varieties pointed out by us (loc. cit., p. 280) occur in this tufa. The first, which is nearest the basalt in composition, has a brown glass as its base, filled with microlites. This base holds minute rectangular and oblong crystals of feldspar. Large microlites of augite and grains of magnetite were seen. Fragments of this are common, and are clear and unaltered. The second variety of andesite was seen to have a dense gray micro-felsitic base, holding ledge-formed feldspars and magnetite grains. Some contained the reddish-brown fibers of the destroyed hornblende. Fragments of this variety of andesite are quite abundant.

The trachyte has a light gray, felty, and glassy base, some fragments showing besides this only faint traces of polarization caused by incipient feldspars. Other fragments show minute, well-formed crystals that appear to be sanidin. Grains of magnetite occur scattered through the base. This is also quite abundant, and it, as well as the basalt and andesite, surpasses the rhyolite in amount.

The rhyolite occurs in the form of a more or less clear glass, often cellular. The cells are often drawn out in the direction of the original flow, forming a fibrous struct

ure, which when of a grayish or reddish brown color resembles woody fiber. Some of the fragments contain ellipitical cells, and a few shards of water-clear glass free from inclusions were seen.

Many crystals, entire or broken, are scattered throughout the groundmass of the tufa. These crystals belong to plagioclase, sanidin, olivine, magnetite, augite, and quartz. But little quartz was observed; one crystal contained trichites and vapor cavities. The trichites are the same as those commonly seen in the quartz of granite, but this appears to have been derived from the lava. The feldspar contains inclusions of base, glass, and microlites, and through these the rock from which the feldspar was derived can often be told. The augites have the characters of andesitic augite. A little palagonite and one crystal of microline were seen.

The groundmass of the tufa is composed of comminuted and decomposed material derived from the lavas before described. In the groundmass trachytic and rhyolitic material appears to predominate.

This specimen was chosen for description, as it best represented the general characters of the tufas.

B.—THE COARSER DEPOSIT JUST ABOVE THE SHALES.

This is more coarsely fragmental than any of the others, and is composed of a yellowish brown earthy groundmass, holding fragments of quartz, feldspar, basalt, etc. Some of the fragments appear to belong to the older rocks, but none of them were seen in the section. Under the microscope the tufa is similar to the first one described, but its fragments are larger and sometimes better marked. Some kaolinized feldspars and a little biotite were seen. The hornblende in the andesite is in the usual broken forms, with blackened edges.

C.—A SPECIMEN FROM FINER PORTION OF THE UPPER CONTORTED BEDS.

A yellowish earthy groundmass holding crystals and fragments of augite and feldspar. On one side is a layer of fine detritus, composed of the same material as the groundmass of the more coarsely fragmental portion. Its microscopic characters are similar to those of A, except that its materials are more decomposed and sanidin is more abundant. One kaolinized feldspar was observed.

D.—THREE SPECIMENS OF THE INSECT-SHALES.

These are brownish and grayish brown shales, being simply the finer material of the tufas laid down in laminæ of varying thickness and coarseness. One is very thinly bedded.

This volcanic material has evidently been worked over by water, but the conditions can of course best be told in the field. So far, however, as we can judge by microscopic examination, when the water commenced its work the material was in loose unconsolidated deposits. That it was thrown out as an ash, or rather deposited as a *moya* near its present location, is the most probable supposition. It seems then to have been taken up by the waves and spread out as it is now found. The reason for this opinion is that the fragments are not worn, as they would naturally be if they had been derived directly from solid rock by water action, and the decomposition is not so great as we should expect. The deposition appears to have been gentle but comparatively rapid, for there is no sign of violence or even of such decomposition as we should expect in slow deposition; and showers of ashes falling on still water or a lake acting on an unconsolidated tufa bank answer best the conditions called for here. It is

probable from the kaolinized feldspars and the macroscopic fragments of apparently older rocks that the latter are present in the tufa to some extent. This can best be explained by the supposition that it was deposited as a *moya* or mudflow within reach of the waters that have worked it over and deposited it in its present position. As we said before, the field evidence must be relied upon mainly in deciding such questions as these.

M. E. WADSWORTH.

CAMBRIDGE, MASSACHUSETTS, *April* 15, 1880.

Another section, less carefully measured and noted with less detail than the other, was taken at the extremity of one of the promontories jutting in a southwesterly direction into the middle of the upper chain of lakes, about three kilometers west of the present post-office. The top of the hill was covered with granitic gravel and loose bowlders of dark scoriaceous trachyte; below this we found, passing, as before, from above downward, the following succession:

SECTION IN THE NORTHWESTERN LAKE.

(*By S. H. Scudder and A. Lakes.*)

	Decimeters (estimated).
1. Finely laminated yellow-drab shales; no fossils	12
2. Coarse decomposing yellowish shales; no fossils	12
3. Fine compact drab shales; perfect remains of plants and insects	15
4. Arenaceous shales; very lignitic	6
5. Heavily bedded, coarse-grained, crumbling sandstone, of a grayish-yellow and whitish color, becoming ferruginous in places; partially lignitic	60
6. Chocolate and drab colored shales having a conchoidal fracture, passing below into whitish paper-like shales inclosed between coarse arenaceous laminæ; plants and insects	45
Total thickness of shales above floor deposits. (Meters, estimated)	15

These measurements, being estimated, are undoubtedly too great. The composition of this bluff is coarser in character than that of the section in the southern extension of the lake. The lignitic beds, which have been used for quarrying purposes, contain numerous fragments of reeds and roots not well preserved. The lower portions of the section correspond better with the other than do the upper beds, where it is difficult to trace any correspondence; No. 3 of the northwestern seems, however, to correspond to No. 16 of the southern series. The whitish paper shales lying at the base of this appear to be entirely absent from the southern section, and the distorted beds which crown the mesa are not apparent in the bluff, or, if present, are wholly regular. A more careful and detailed section of the bluff (for which we had not time), and particularly the tracing of the beds along the wall of the lake, would probably bring to light better correspondences.

Judging from the present physical condition of the basin, its age is marked as later than the movements which closed the Cretaceous epoch and earlier than the last upheaval in the Tertiary, which seems to have taken place during or after Miocene times, but there are no physical data yet at hand to warrant definite conclusions on this head.

The insects preserved in the Florissant basin are wonderfully numerous, this one locality having yielded in a single summer more than double the number of specimens which the famous localities at Oeningen, in Bavaria, furnished Heer in thirty years. Having visited both places I can testify to the greater prolificness of the Florissant beds. As a rule the Oeningen specimens are better preserved, but in the same amount of shale we still find at Florissant a much larger number of satisfactory specimens than at Oeningen, and the quarries are fifty times as extensive and far more easily worked.

The examination of the immense series of specimens found at Florissant has not yet critically covered the whole field. It may, nevertheless, be interesting to make the single comparison with the Oeningen insect fauna which the number of individuals will furnish. This is indicated by the following table:

Percentage of representation by—	At Florissant.	At Oeningen.
Hymenoptera	40	14
Lepidoptera	0.04	0.1
Diptera	30	7
Coleoptera	13	48
Hemiptera	11	12
Neuroptera	5	17
Orthoptera	0.25	3
Arachnida	0.25	0.5
	99.54	101.6

It will be seen that in all the orders that are well represented the proportion of specimens of each is very different, with the sole exception of the Hemiptera, while the same groups (Orthoptera, Arachnida, and Lepidoptera) are feebly represented in both. The greatest difference occurs in the Diptera, which are less than 7 per cent. of the whole at Oeningen and about 30 per cent. at Florissant; in the Hymenoptera, which have less than 14 per cent. at Oeningen and 40 per cent. at Florissant, due largely to the

prodigious number of ants; while the case is reversed in Coleoptera, which form nearly one-half the specimens found at Oeningen and only 13 per cent. at Florissant. We possess no count of the specimens found at Radoboj, in Croatia, which is regrettable, since the fauna of Florissant appears to agree much better with it than with any other in one or two points, such as the comparatively minor part played by the Coleoptera and the great number of ants; these latter number fifty-seven species in Radoboj, and five hundred specimens have been found of one of them. Still the comparison can not be carried very closely into other departments; for instance, only one rhynchophorous coleopteron has been reported from Radoboj, while they are very numerous and rich in species at Florissant, and local causes must have had much to do with the fauna of each of these localities. It is hardly worth while to institute any inquiries into the proportion of the groups represented at Florissant and in amber, since the nature of the entombment is entirely different.

Since so far as the Florissant insects are concerned only the lower orders are reported upon in the present volume, it may be worth while to present a rapid sketch of the higher orders, to complete in however imperfect a way the partial view of the Florissant insect fauna which the volume affords.

About three-fifths of the Coleoptera belong to the normal series and two-fifths to the rhynchophorous division. There are eighty to ninety specimens of Carabidæ, including, perhaps, twenty-five species; many of them are very fine and perfect, especially in the sculpturing of the elytra. Water-beetles are not so numerous as would be anticipated; indeed, there are very few specimens, with perhaps half a dozen species; there are no large species such as occur abundantly at Oeningen; the largest of our species, perhaps an Hydrophilus, not exceeding twelve millimeters in length. The Staphylinidæ are rather more numerous than the ground-beetles, with over thirty species, some of them tolerably large. There are half a dozen species of Nitidulidæ. Some sixty or more Scarabæidæ show considerable variety, there being nearly thirty species among them. Nearly as many Buprestidæ have quite as great variety of form; a considerable number of them are large and nearly all fairly preserved, some remarkably perfect; one species, Chrysobothris haydeni, has been described. Elateridæ are more abundant, numbering more than one hundred species, many of them in beautiful condi-

tion; they are abundant in species, over forty having been separated, and are mostly of a medium, none of a large, size. Considerably over one hundred specimens are to be referred to the Meloidæ, Mordellidæ, and Malacodermata, but the specimens do not appear to be very well preserved, although about forty species may be distinguished. The Cerambycidæ are very beautiful, furnishing thirty or more specimens, representing more than half as many species; one fine species of a new extinct genus, Parolamia rudis, has already been described, and there are others equally fine. There are a dozen or more species of Bruchidæ, one of which, Spermophagus vivificatus, has been published. Chrysomelidæ are not uncommon; thus far I have recognized about two dozen species among the sixty or eighty specimens; one, Oryctoscirtetes protogæus, belonging to a new genus, has already been published. Nearly twenty species of Tenebrionidæ have been separated, rarely represented by more than a single specimen each, and there are also a few (from two to ten species each) of Silphidæ, Histeridæ, Dermestidæ, Ptinidæ, and Coccinellidæ, and a single species each of Cleridæ and Telephoridæ, the latter already described under the name of Chauliognathus pristinus. Two specimens of Rhynchophora, Anthonomus defossus and Eurhinus occultus, have been described; I have already mentioned the predominance of this type in opposition to the European Tertiaries; the species are very numerous, nearly one hundred and twenty having been separated, with over five hundred specimens, and among them are a goodly number of large and fine species; but some of the minutest are most admirably preserved; especially is this true of the sculpturing of the thorax and elytra; no attempt, however, has yet been made to do more than rudely separate the species, so that no details can now be given.

Nearly a third of all the specimens I have seen from Florissant belong to the Diptera. Culicidæ and Chironomidæ are abundant, but not generally very perfect. Tipulidæ are abundant and admirably preserved; of the larger forms alone there appear to be several hundred specimens, and apparently a considerable number of species; the smaller Tipulidæ, including the Limnobina, are also abundant and well preserved. Many beautiful Mycetophilidæ occur, probably twenty or thirty species. Bibionidæ are the prevailing type among the Diptera; there must be a thousand specimens belonging to this family, and on a cursory view there appears to be no great variety; probably both here and in the ants, as in some gen-

era of plants, it will appear that there are vast numbers of a single species; a great many specimens are represented by bodies only, or these accompanied by insignificant fragments of wings, but even putting all these aside there remain a goodly number with tolerably perfect wings, and some in which almost every part of the body is preserved; taken as a whole, however, they are perhaps less perfect than specimens of almost any other family. There are a dozen or more Stratiomyidæ, of two or three species, and several species of Midasidæ or Hirmoneuridæ, one admirable specimen of the latter family having been described as belonging to a new genus under the name of Palembolus florigerus. There are nearly half a hundred Asilidæ and Therevidæ, many of them exquisitely preserved, some of great size, and among them a fair variety of forms. Bombylidæ are somewhat less abundant, but show some superb specimens of great size and in wonderful preservation; there are certainly six or eight species. Syrphidæ are more abundant than the last, nearly fifty specimens having been found in which the patterns of the abdominal colors are generally well marked, and among which we find a considerable variety; they have been studied by one very familiar with that group, Dr. S. W. Williston, and the results of his examinations are given in his Synopsis of the North American Syrphidæ (pp. 281-283), published by the U. S. National Museum. There is a vast host of Muscidæ and allied groups, of which no account has yet been taken, and with which no doubt many other forms are still commingled, but three or four species of very pretty Ortalidæ may be mentioned with ten or a dozen specimens, and there are a large number of Empidæ.

A few Lepidoptera occur. The butterflies, seven in number, have been described in the Eighth Annual Report of the present Geological Survey. They all represent distinct and extinct genera. Six of the seven belong to the Nymphalidæ, the seventh to the Pierinæ. Of the Nymphalidæ all but one are Vanessidi. The exception is of special interest, since it belongs to the Libytheinæ, the family of living butterflies the most meager in numbers, though found in every quarter of the globe. To be able to add that still an eighth butterfly, found since the others were described, belongs to a second extinct genus of Libytheinæ (which I have called Barbarothea) is certainly marvelous. Besides these I have set aside about a dozen specimens of perhaps eight species of moths, but they are obscure, mostly of small size, perhaps Pyralidæ or Tortricidæ, and, excepting one described in

this work, have not been critically studied. A single caterpillar has been found, and the structure of its skin has been studied by Dr. C. S. Minot,[1] but without any very satisfactory results.

No Hymenoptera have yet been described. About a dozen specimens are referred to Apidæ and Andrenidæ; several species are represented, but most of them are badly preserved; the largest appears to be a Bombus. Of Vespidæ and other large wasp-like Hymenoptera about seventy or eighty specimens have been found, referable to about thirty species, one of which is a large Scolia or allied genus; several are Sphegidæ, including an Ammophila; one, which seems to be a Polistes, shows traces of a blue-green metallic tint; another, apparently one of the Pompilidæ, represents a species with a large subapical fuliginous spot on the wing; another, perhaps of the same family, has a circular clear spot in the center of the wing, surrounded with fuliginous. The ants are the most numerous of all insects at Florissant, comprising, perhaps, a fourth of all the specimens; they form more than three-fourths, perhaps four-fifths, of all the Hymenoptera; I have already about four thousand specimens of perhaps fifty species (very likely many more); they are mostly Formicidæ, but there are not a few Myrmicidæ and some Poneridæ. I have noticed no Mutillidæ. Ichneumonidæ are very numerous; of minuter forms, having an expanse of wing of less than a centimeter, there are nearly two hundred specimens, unusually well preserved; judging from a cursory examination they are exceedingly numerous in species, perhaps eighty all told, and many genera are represented; the larger forms, whose wings expand more than a centimeter, are even more numerous both in species and individuals, and most of them are very fine, including a great variety, among which are especially noticeable a good assortment of species of Pimpla and allied genera; I have looked in vain for Pelecinus, or any long-tailed Rhyssæ or Thalessæ. The Braconidæ, Chalcididæ, Cynipidæ, and Chrysidæ, exceedingly few fossil species of which have ever been described, are very abundant, but have not been fairly separated from each other and from other small species; together they number nearly two hundred and fifty specimens and probably fifty species; among others there is a Chrysis, showing metallic green reflections on the abdomen, and also more than half a dozen species of Chalcididæ, with expanded femora, represented by over twenty specimens.

[1] Arch. f. mikr. Anat., vol. 28, pp. 46–47, 1886.

Finally, there are about sixty Tenthredinidæ of fourteen or fifteen species and several genera, besides a single species of Uroceridæ.

Animal remains besides those of insects are rare at Florissant. The most abundant is a species of thin-shelled Planorbis, which is not uncommon, and always occurs in a more or less crushed condition; it is the only mollusk yet found there (excepting a Physa or allied form and a single small specimen of a bivalve, referred to above in the section from the southern lake), and according to Dr. C. A. White is probably undescribed, although very similar to a species found in the Green River shales, differing from it principally in its smaller size.

Fishes rank next in numbers. Eight species have been found, belonging to four genera. Of Amiidæ we have Amia scutata and A. dictyocephala; of Cyprinodonts, Trichophanes foliarum and T. copei; of Catostomidæ, Amyzon pandatum, A. commune, and A. fusiforme; and of Siluridæ, Rhineastes pectinatus. All the species have been described by Cope, excepting T. copei, which was published by Osborn, Scott, and Speir.

Several bird's feathers have been found in these beds, and a single tolerably perfect passerine bird, with bones and feathers, has been described by Mr. J. A. Allen under the name of Palæospiza bella, and admirably illustrated by Blake. No other figure of a Florissant animal has yet been published. Besides these, Cope has described a plover, Charedinus sheppardianus, and writes that a finch is also found in these beds.

The plants, though less abundant than the insects, are exceedingly numerous, several thousand specimens having been studied by the late Mr. Leo Lesquereux. About one hundred and sixty species have been described or indicated, of which the apetalous plants show the larger number, sixty-eight species; the next most abundant group is the polypetalous division, forty species, the gamopetalous having twenty-five, the Coniferæ eight, and the lower plants nineteen species.

Among the exogenous plants the following polypetalous families are represented: the Malvaceæ by a rare species of Sterculia, besides some flowers with long stamens, which are referred, doubtfully, to the genus Bombax. Of Tiliaceæ, a species of Tilia has been found. Of Rutaceæ, one species of Ailanthus and one of Xanthoxylon. No less than ten species of Rhus represent the Anacardiaceæ, and two species each of Paliurus and Rhamnus the Rhamnaceæ. The Celastraceæ show three species of Celastrus and one

of Celastrites, known only by a few leaves. The Sapindaceæ are very numerous in individuals; a species of Acer is represented by leaves, flowers, and fruits, but not yet described; leaves of a Staphylea occur with five species of Sapindus and one of Dodonæa. The flora has a large number of Leguminosæ, eleven species occurring, of eight genera, Cytisus, Dalbergia, Cercis, Podogonium, Cassia, Leguminosites, Acacia and Mimosites; Lesquereux formerly referred some of them to Robinia and Colutea. The Rosaceæ show an Amygdalus, leaves of Rosa, and a species of Spiræa, with very finely preserved leaves of an Amelanchier, scarcely distinguishable from some of the varieties of the living species. Numerous leaves of Weinmannia of three species represent the Saxifragaceæ, and, finally, a species of Aralia and another of Hedera, the Araliaceæ.

Among the gamopetalous plants the Ericaceæ are represented by what is probably Vaccinium reticulatum Al. Br., together with a species of Andromeda; no less than six species of Ilex represent the Aquifoliaceæ; two of Diospyros, and one each of Bumelia and Macreightia, the Sapotaceæ; a species of Myrsine, so common in the European Tertiaries, but in our country represented only by this single leaf, the Myrsineæ. Convolvulaceæ show two species of Porana, and the Apocynaceæ a single species of Apocynophyllum.[1] Oleaceæ have a flowering branch of Olea and eight species of Fraxinus, one regarded as identical with a European Tertiary plant.

The apetalous angiosperms show a great variety of forms at Florissant, and among them many are referred to species from foreign Tertiaries. A species of Banksia and seven of Lomatia represent the Proteaceæ; a species of Pimelia the Thymelaceæ; one of Santalum the Santalaceæ. Urticaceæ are the most numerous of all plants; four species of Ulmus occur, one found also in the European Tertiaries; another formerly thought to be identical with a second European species but now regarded as distinct, and two others, one of them found also in western Colorado; of Celtis there is one species, whose leaves have a close affinity to the existing C. occidentalis and its Texan variety; two species of Ficus are identical with European species; but the mass of specimens—nearly or quite one-half of all that have been brought from this locality—represent species of Planera; two species only occur, one identical with a European form; the other known only from Florissant and the White River, and in the former very variable; Lesquereux

[1] In the text of his last report Lesquereux refers this to Alkali, Wyoming, but in his table to Florissant.

has seen at least two thousand specimens. The Juglandaceæ are represented by single specimens of Pterocarya americana and Juglans thermalis, besides two other species of Juglans, one of them European, three of Carya, all European, and one Engelhardtia, also European. The Cupuliferæ show one species each of Ostrya and Castanea, three of Carpinus, one of them European, and seven of Quercus, of which five are European species. The Myricaceæ are the next most abundant type after Planera, being represented by no less than fifteen species of Myrica, of which six are European. Of Betulaceæ two species of Betula occur and two of Alnus, one of the latter European. Salicaceæ are tolerably abundant; there are four species of Populus, all now regarded as European, though Lesquereux first looked on them as new; and two peculiar species of Salix, besides four identical with European species. Finally, there are one or two undetermined plants in this group represented by parts of flowers or seeds.

Among the Coniferæ there is considerable variety, eight species occurring, of six genera, most of them represented in the European flora. There are, first, two species of Pinus, one European; a species of Widdringtonia; well preserved branches of a European Taxodium; abundant remains of a European Glyptostrobus; a couple of leaves of a European Podocarpus; as well as two species of Sequoia, one European, the other indigenous. The presence of the last-named genus is also well attested by their cones and by the remains of gigantic silicified trunks in an erect position.

Finally, in the lower orders of plants the following have been found: Of the Palmæ, a large specimen of a Sabal and a fruit referred to Palmocarpon; of the Araceæ, a species of Acorus, first described from Spitzenberg; of the Typhaceæ, finely preserved leaves of a Typha; of the Naiadaceæ, two species of Potamogeton and one of Najadopsis; of the Lemnaceæ, a species of Lemna; of the Gramineæ, fragments of leaves of Phragmites; of Filices, numerous specimens of five genera, Sphenopteris, Adiantites, Lastræa, Pteris, and Diplazium, the last a European species; of Rhizocarpæ, many specimens of two species of Salvinia; of Musci, one species each of Fontinalis and Hypnum, and of Characeæ, two specimens of a Chara.

According to Mr. Lesquereaux, such an assemblage of plants indicates a climate like that of the northern shores of the Gulf of Mexico at our epoch. "The preponderance of conifers, of shrubs, . . . of trees of small

size, . . . gives to the flora a general aspect which recalls that of the vegetation of uplands or valleys of mountains." Palms are almost entirely absent, only a single specimen of one species of Sabal having occurred, with a fruit of Palmocarpon. "The leaves of some species are extremely numerous, none of them crumpled, folded, or rolled, as if driven by currents, but flat, as if they had been embedded in the muddy surface of the bottom when falling from the trees or shrubs along the borders of a lake."

It is remarkable for the almost complete absence of hard fruits, and this, with the presence of flowers, of unripe carpels of elm and maple, and of well-preserved branches of Taxodium, which in the living species "are mostly detached and thrown upon the ground in winter time or early spring," led Mr Lesquereaux to believe that the deposition of the vegetable materials took place in the spring time, and that the lake gradually dried during summer.

To this we may add that the occurrence of Acorus, of Typha, and especially of Potamogeton, leads to the conclusion that the water of the lake was fresh, and not saline or brackish, equally proved by the fish, according to Cope, and by the presence of larvæ of Odonata and other insects whose earlier stages are passed only in fresh water.

Neither the groups of fishes which have been found, nor the water-plants, nor the water-insects, nor the mollusks exclude Mr. Lesquereux's suggestion of the annual drying of the body of the lake; moreover, certain thin layers are found overlying coarser deposits, which are sun-cracked through and through. But, on the other hand, the thickness of the paper shales, upon which most of the fossil remains are found, and which are composed of uniform layers of triturated flakes of volcanic products, being necessarily the result of the long-continued action of water, excludes this idea. The structure of the rocks rather indicates a quiet deposition of the materials in an unruffled lake through long periods, interrupted at intervals by the influx of new lava-flows or the burying of the bottom sediments beneath heavy showers of volcanic ashes.

The testimony of the few fishes to the climate of the time is not unlike that of the plants, suggesting a climate, Prof. E. D. Cope informs me, like that at present found in latitude 35° in the United States; while the insects, from which, when they are completely studied, we may certainly draw more definite conclusions, appear from their general ensemble to prove the same

or a somewhat warmer climate. If we inquire what testimony the lower orders of Florissant insects bear to the climate of that district in Tertiary times, there is only one answer to be given: the present distribution of their allies certainly points to a considerably warmer climate than now—a climate which may, perhaps, best be compared to the middle zone of our Southern States. The known living species of the genera to which they belong are in general credited to regions like Georgia in this country and the two shores of the Mediterranean in Europe, or even more southern districts. Further remarks on this point will be found in the body of the volume.

As noted above, the superabundance of specimens of single species of plants (Planera and Myrica) is repeated in the insects, where certain species of Formicidæ among Hymenoptera, of Bibionidæ among Diptera, of Cercopida and of Alydina among Hemiptera, are to be counted by fifties and hundreds.

The only other general feature which may already be noted among the insects is an unexpected paucity of aquatic larvæ or the imagos of water-insects. Hardly a dozen neuropterous larvæ have come to hand, very few aquatic Hemiptera in any stage, and of Hydrophilidæ and other water beetles no great number. The paucity of neuropterous larvæ is the more remarkable from the abundance of Phryganidæ, while not a single larva-case has been found.

As to the age of these deposits, the opinions of Lesquereux, based on the study of Tertiary plants, and of Cope, drawn from his knowledge of Tertiary fishes, are far more harmonious than one would expect from their known divergence of view concerning the testimony of the fossils to the age of other Tertiary beds in the West. Such disparity of ideas did hold at first, Mr. Lesquereux maintaining in his earlier notices of the flora the probability of its later Miocene age; in the Tertiary Flora he placed it in the "Upper Green River" division of his "fourth group," together with the flora of Elko, Nevada, the Green River beds being placed directly beneath them. In Hayden's report for 1876 he refers the Florissant deposits to the upper Miocene. In his review of Saporta's Monde des Plantes,[1] while still considering this flora as Miocene, he points out certain important relations which it bears to the flora of Aix, in Provence, then considered as Eocene.

[1] Amer. Jour. Sci., ser. 3, vol. 17, 1879, p. 279.

But later, after a more careful revision, drawn from more extended sources, he writes that while, by the presence of many genera, "there is an evident relation of the Florissant flora with that of the European Miocene, yet by the affinities and even identity of some of the species with those of the flora of the gypsum of Aix, which, according to Saporta, includes types related to those of the whole extent of the Tertiaries from the upper Cretaceous to the Oligocene and above, I should rather refer this group to the lower Miocene or Oligocene."

Both Lesquereux and Cope agree in placing the Florissant beds at the same horizon as those of Elko, Nevada, and also those directly above the Fish-cut beds at Green River, Wyoming. Lesquereux has identical species also from White River, Colorado, among specimens communicated by Mr. Denton. Cope calls the Florissant and Elko deposits the Amyzon beds, from the prevalence of that type of fish, and refers them to the "later Eocene or early Miocene." Mr. Clarence King places the Green River deposits in the middle Eocene, but considers the Elko deposits of the same age. We may therefore provisionally conclude, from the evidence afforded by the plants and vertebrates, that the Florissant beds belong in or near the Oligocene.

At present no geological conclusions can be drawn from what is known of the insects. So far as specific and generic determinations has proceeded, scarcely anything identical has been found in the Green River and Florissant beds, but some remarkable affinities have been noticed. To attempt, however, to draw any conclusion as to the age of either of these deposits, and especially of that of Florissant, before a closer examination is made would be folly. Almost the entire series of fossil insects from the beds of Aix, Oeningen, and Radoboj requires a careful generic revision, and until this is done it will be difficult to make much use of the information given us in the works of European authors. This should not be considered as reflecting upon the character of these works, for it must be remembered that they were nearly all completed thirty years ago and could not be expected to meet present demands. It is, indeed, probable that the richer American fields, the exploitation of which has only just begun, may yet be found the best basis for the study of the relationship of the Tertiary insect faunas of Europe.

White River.—Fossil insects were first discovered on the lower White River in western Colorado and eastern Utah by Mr. William Denton during

his passage down the river on horseback in 1865, and his brief and cursory account of the geological structure of the region is, I believe, the first and only one until the parties of the Hayden Survey entered the region ten or more years later. Brief reports of the geological and topographical character of the country were made by Drs. C. A. White and F. M. Endlich, and Messrs. G. B. Chittenden and G. R. Bechler. None of these, however, obtained any insects, excepting Dr. White, who in a single locality found a few poor specimens. On a visit to the place in the summer of 1889, however, I was able to rediscover the beds in which they were found by Mr. Denton east of the Colorado-Utah line, and to greatly extend the stations at which they could be found. In the two localities on the lower White River where Denton found fossil insects, "Chagrin Valley" and "Fossil Cañon," as he called them, the general topographical features were the same, bluffs or buttes of a thousand or more feet in thickness being composed of evenly bedded-stratified deposits. "Chagrin Valley" must be identified with the valley of Douglas Creek, though it was not here but five or six miles lower down the White River that Denton really obtained his fossils, at a point where, to one traveling westward, Green River beds first appear in mass and are readily accessible, probably in the immediate vicinity of Cañon Butte, where the old Indian trail on the south side of the river cuts off a sharp bend and passes directly over many favorable outcrops. It was in fact at precisely this place that I obtained from the rocks collections agreeing most closely in general appearance and character with those secured by Denton. This locality is in Colorado a few miles east of the Utah boundary. His other locality is represented by him to be fifty or sixty miles farther down the river, but still at some distance from its mouth. The distance is no doubt exaggerated, and the locality on the north side of the river, certainly in Utah, not improbably near the mouth of Red Bluff Wash. I made no search for this place.

It may in brief be said that the Green River beds in the bluffs on each side of the White River Cañon near the boundary line between Utah and Colorado, but especially on the northern side, are filled for over a thousand feet with insect remains; the highest and the lowest beds respectively yielded me the best results, but hardly a level could be found where patient search did not reveal some relics, though perhaps of no value; the more prolific beds were oftentimes simply crammed with remains, frequently in

an exquisite state of preservation. Vegetable remains, excepting of a very fragmentary nature, were rare, and most of the insects, like those obtained by Denton, of a small size; excepting, indeed, dipterous larvæ, which were found in quite incredible numbers, square rods of stone near the higher levels being absolutely covered with them in multitudes of places.

The insects obtained by Mr. Denton and Dr. White at these localities are all included in the present volume, but no reference is made to those found by myself in 1889. The age of the deposit can hardly be said to be as yet determined, but the leaves found by Mr. Denton (presumably at "Fossil Cañon") were regarded by Mr. Lesquereux as more certainly synchronous with those of Florissant than with those of the Green River beds, and in any event all three are of very nearly the same age.

Green River, Wyoming.—All the insects described in this volume from Green River were obtained at a single spot, next what is known as the Fish-Cut, where the railway cuts through the rocks, about three or four kilometers west of the crossing of Green River. Even here they have been found only within the compass of one or two square meters of ground, and by repeated visits this "pocket" has now been entirely chipped away. There is no doubt that other equally prolific pockets will be found in the same immediate vicinity, especially in the more favorable exposures east of the river, as one such was found during the summer of 1889. It is by no means improbable that the beds at this locality and those at White River may prove to belong to the floor of one and the same Tertiary lake to which King gave the name of Gosiute Lake. About one hundred and fifty different insects have been found here, besides many others not yet described. They are most commonly Coleoptera, this order being represented by fully one-third of the species. Hemiptera and Diptera come next with almost equal representation, or about twenty-three per cent each. Next come the Hymnoptera with eight per cent. The other orders are about equally and meagerly represented, the Lepidoptera not at all.

Fossil, Wyoming.—A few species of insects have been found in the bluffs facing the town of Fossil at the head of Twin Creek, a tributary of Bear River, bluffs which are famous for the immense number of fossil fish they have furnished. As a rule the insects are scarce, and, like the fish, belong to a very limited number of species, in this case mostly Coleoptera and Diptera. In the present work only two or three are mentioned.

Horse Creek, Wyoming.—At a point three miles south of this creek, which empties into the Green River from the west near its source, and about two miles west of Green River, a thin, hard layer of white limestone was found by Dr. A. C. Peale covered with petrified larval cases of caddis-flies, which are described below under the name of Indusia calculosa.

Quesnel, British Columbia.—The discovery of the different localities for fossil insects in British Columbia by the Geological Survey of Canada has been due entirely to the investigations of Dr. George M. Dawson. On the left bank of the Fraser River, at the town of Quesnel, he discovered a series of clays, sands, and gravels, their upturned edges covered by the valley deposits, in one of which series (a stratum of fire-clay eight or nine inches thick) insects and plants were found, the beds being exposed on the river bank at a low stage of the water. Nearly twenty species of plants were met with, mostly of apetalous families in the neighborhood of the Cupuliferæ, such as the beech, walnut, oak, birch, and poplar, and a considerable number of insects. Such of these as are included in the present report consist of twenty-five species, nearly all Hymenoptera and Diptera, and especially the latter, and, what is very unusual, only a single beetle. Sir William Dawson, who determined the plants, regarded them as to a great extent identical with those from the Miocene of Alaska, but adds: "Whether the age of these beds is Miocene or somewhat older may, however, admit of doubt." Apart from an uncharacteristic egg-cocoon of a spider, none of the insect remains can be regarded as identical with any found elsewhere.

Nicola, North Similkameen, and Nine Mile Creek, British Columbia.—The other localities at which remains of insects have been found, though in smaller numbers, lie at no great distance apart to the south of Quesnel and south of the Canadian Pacific Railway, near our own border. One of these localities is upon the Nicola River, two miles above its junction with the Coldwater, at the base of a series of beds containing coal. Another is on the North Fork of the Similkameen River, three miles from its mouth; the beds here, on the bank of the river, "include a layer of lignite about a foot thick, which rests in black, rather earthy, carbonaceous clays, and is overlain by fifteen feet or more of very thinly bedded almost paper-like yellow gray siliceous shales," which contain plants and insects. The third is on Nine Mile Creek, flowing into Whipsaw Creek, a tributary of the Similka-

meen, where a small section of hard laminated clays occurs with layers of softer arenaceous clay. Seven species were obtained from the first-named locality, five from the second, and four from the third. The Nicola locality is remarkable for yielding only Coleoptera; from Nine Mile Creek come three species of Coleoptera and one of Hemiptera; while the Similkameen locality, like Quesnel, affords us Hymenoptera, Diptera, and Hemiptera—three species of the last—but no Coleoptera. There can be no doubt, Dr. Dawson informs me, "that the specimens from the North Similkameen and Nine Mile Creek represent deposits in different portions of a single lake. A silicifying spring, probably thermal, must, however, have entered the lake near the first-named place, as evidenced by the character of some of the beds, in which fragments of plants, with a few fresh-water shells, have been preserved." The insects of each locality are specifically distinct from those of any of the others. As to their age, Dr. Dawson, the only geologist who has studied them, remarks that we shall "probably err little in continuing to call the Tertiary deposits of the interior as a whole Miocene, and in correllating them with the beds attributed to the same period to the southward in the basin lying east of the Sierra Nevada."

Scarboro, Ontario.—In the vicinity of Toronto, on the north shore of Lake Ontario, Mr. George J. Hinde has discovered vegetable and animal remains in thin seams in clay beds which he regards as interglacial, lying as they do upon a morainal till of a special character and overlain by till of another and quite distinct kind. His account of the locality and the reasons for his conclusions have been given by him in full.[1] Among the material found by him was a considerable number of the elytra and other parts of beetles, an assemblage indeed larger than has ever before been found in such a deposit in any part of the world, and they are mostly in excellent condition. Twenty-nine species have been obtained, some of them in considerable numbers. Five families and fifteen genera are represented; they are largely Carabidæ, there being six or seven species each of Platynus and Pterostichus and species also of Patrobus, Bembidium, Loricera, and Elaphrus. The next family in importance is the Staphylinidæ, of which there are five genera, Geodromicus, Arpedium, Bledius, Oxyporus, and Lathrobium, each with a single species. The Hydrophilidæ are represented by Hydrochus and Helophorus, each with one species; and the Chrysomelidæ

[1] Canadian Jour. Sci., new series, vol. 15, 1887, pp. 388–413.

by two species of Donacia. Finally, a species of Scolytidæ must have made certain borings under the bark of juniper.

Most of these are described and figured in the present volume. Looking at them as a whole and noting the distribution of the species to which they seem to be most nearly related, they are plainly indigenous to the soil, but would perhaps be thought to have come from a somewhat more northern locality than that in which they were found; not one of them can be referred to existing species, but the nearest allies of not a few of them are to be sought in the Lake Superior and Hudson Bay region, while the larger part are inhabitants of Canada and the northern United States, or the general district in which the deposit occurs. In no single instance were any special affinities found with any characteristically southern forms, though several are most nearly allied to species found there as well as in the north. A few seem to be most nearly related to Pacific forms, such as the Elaphrus and one each of the species of Platynus and Pterostichus. On the whole, the fauna has a boreal aspect, though by no means so decidedly boreal as one would anticipate under the circumstances.

Port Kennedy, Pennsylvania.—The only locality remaining to be noticed is Port Kennedy, in southeastern Pennsylvania, where the clays in the bone caves have furnished about a dozen species of Coleoptera; described by Dr. G. H. Horn, in 1876, but now first figured. His descriptions are reprinted in the present work, with the results of my own study of the same material.

DESCRIPTIONS OF GENERA AND SPECIES.

MYRIAPODA Linné.

Myriapoda from the Tertiary rocks are almost unknown, a single species a little larger than ours having been figured by Bertkau from Rott under the name of Iulus antiquus Heyden. Other species have been indicated. Serres, for instance, speaks of one found near Montpellier, allied to the living I. sabulosus, and this mention has been quoted by Meyer, Keferstein, and Geinitz. Hope also catalogues one from Aix, and Cotta mentions one, perhaps I. terrestris, from Tharand, Saxony, which is probably a recent inclosure, and is quoted by Brullé and Berendt. Besides these diplopods Hope catalogues a Scolopendra from Aix, and Keferstein, on the authority of Aldrovandi, mentions a Scolopendra from Glarus, in Switzerland.

The Baltic amber, however, contains a considerable number of species, twenty diplopods having been recorded and most of them described, belonging to the genera Craspedosoma (seven species), Polyxenus (five species), Iulus (four species), and Euzonus, Lophonotus, Blaniulus, and Polydesmus (one species each). The chilopods have a less number of species, fifteen, representing the genera Lithobius (eight species), Geophilus (three species), and Cermatia and Scolopendra (two species each). All these genera excepting Euzonus are represented among living forms.

The single species found in America belongs to the diplopods. (November, 1881.)

Order DIPLOPODA Gervais.

Family IULIDÆ Leach.

As in the case of the Rott species described by Bertkau, the form described below is only referred to the genus Iulus in a broad sense, its preservation being very defective. It is smaller than the European species.

IULUS Linné.

IULUS TELLUSTER.

Pl. 6, Fig. 15.

Iulus telluster Scudder, Bull. U. S. Geol. Surv. Terr., vol. 4, 1878, p. 776.

The single specimen is so fragmentary that it can only be referred to Iulus in a broad generic sense. The piece is composed of ten or twelve segments, probably from near the middle of the body, lying in a straight line and crushed, with no trace of any appendages. The segments appear to be composed of a short anterior and a larger posterior division, each independently and very slightly arched; the posterior division is about twice as long as the anterior, and each is transversely, regularly, and very finely striate, parallel to the anterior and posterior margins of the segments. The foramina can be detected on some of the segments, and by their aid the width of the body can be more accurately determined.

As crushed, the body is 2.3^{mm} broad, but its probable true width is 1.5^{mm}, while the segments are each about 0.8^{mm} long; the fragment preserved measures 8.5^{mm} long.

Green River, Wyoming, one specimen, No. 154, F. C. A. Richardson.

The object represented on Pl. 12, Fig. 1, was at one time thought to be a myriapod and accordingly figured, but examination proved it to be the broken section of the cone of Sequoia, not uncommonly found at Florissant.

ARACHNIDES Latreille.

Up to the present writing a little more than two hundred and fifty species of Arachnides have been described as found in Tertiary deposits. Of these about one hundred and ninety are true spiders, while the remainder are mostly Acarina (thirty-seven species), Opiliones (eleven species), or Chernetidæ (nine species). All but a single species, Aranea columbiæ, described below, are from European beds, and nine-tenths of them are preserved to us in the Eocene amber. Were this means of restoring the ancient Tertiary fauna unknown to us, our information at the present day would be based upon twenty-four species, although in addition to these half a dozen more are indicated by simple reference to genera or families. This number is already exceeded by those described below from a single locality, Florissant alone having yielded more than thirty species. Whether we examine the American or European species preserved in stratified deposits we find an almost total absence of any but true spiders or Araneides; in each (including the one herewith figured) a single species of Acarina has been described, though a number of others are credited without description to European strata. In Prussian amber, on the contrary, though Araneides are vastly in the majority, the other groups of Arachnides form 27 per cent of the entire number of species, distributed mainly in the three groups mentioned above.

This greater proportion of true Araneides in Tertiary deposits, a proportion exaggerated at the present day, can scarcely be well compared to what we find in the older deposits, from the extreme paucity of their remains in the latter. Brodie has found only a single species (which he considers a true araneid) in the secondary strata of England, and the European Jura has furnished merely half a dozen arachnids (nominal species, perhaps reducible to four), of which only a single one is referable to the Araneides, Hasseltides, considered one of the Agalenides by Weyenbergh. In the paleozoic formations, again, a dozen species are known, all but three of which have been considered scorpions, Phrynidæ or Chernetidæ, or else placed in their vicinity, while one of the other three has not been placed

by its describer among the true spiders, but named Arthrolycosa only from its somewhat marked araneid features. The remaining two are considered by their describers as true araneides and seem to be the only true precursors of this group known to us from the paleozoic rocks; the proportion therefore of the Araneides to other Arachnides is reversed between Paleozoic and Cenozoic times.

In the present volume we are able to more than double the number of Arachnides (apart from the amber inclosures) which are hitherto known from Tertiary strata, and, as we shall see further on, find some interesting points of comparison between the European and American spider fauna of Tertiary times. (February, 1881.)

Since the above was written the number of known Paleozoic Arachnides has greatly increased and a large proportion of them have been placed in a distinct order, Anthracomarti Karsch, with eight or ten genera. (October, 1889.)

In the classification of the remains of these animals, from the almost complete absence of such characteristic parts as the details of the structure of the ocelli and palpi, it has been impossible to do much more than to indicate the probable affinities of the species to living types by means of the general resemblances which the form of the cephalothorax and abdomen and the relative length of the legs furnish. In a few instances these can hardly fail to furnish us with sufficiently clear evidence, while in others the reference is plainly open to a greater or less degree of doubt, which it is hoped future material will eventually extinguish.

Order ACARINA Nitzsch.

Acarina are by no means rare in Tertiary deposits, the group being better represented than any other Arachnides excepting the true spiders, and it is quite in keeping with this fact that the only arachnid yet discovered in the American strata not belonging to the Araneides should fall in this group. Yet the group is unrepresented even in Mesozoic strata, while the scorpions and their allies, nearly unknown in Tertiary beds, are proportionally abundant in earlier times. The amber of the Baltic is particularly rich in Acarina, thirty-five species being recorded therefrom, while apart from the Araneides this group is almost if not quite the only one represented in the stratified deposits of Europe; feebly represented, indeed,

for we have only one species (referred to Limnochares) described by Heyden from Rott; another from the same locality based upon leaf-galls and called Phytoptus antiquus, and a third indicated merely (Acarus) by Heer, as found at Oeningen. (November, 1881.)

Gourret has latterly described among the arachnids of Tertiary Aix a couple of genera of Acarina with one species each which he regards as belonging to the Trombididæ. (October, 1889.)

IXODES Latreille.

No fossil species have before been referred to this genus or anywhere near it. The nearest is Acarus, which is only distantly related, belonging indeed to a distinct subfamily. The species of Ixodes, like other ticks, bury themselves in the flesh of animals to suck their blood. (November, 1881.)

IXODES TERTIARIUS.

Pl. 6, Fig. 12.

Ixodes tertiarius Scudder, Zittel, Handb. d. Palæont., I, ii, 733, Fig. 906 (1885).

Although there are few definite salient points in the structure of the single specimen known, its general appearance and its size make it tolerably evident that it belongs to the Ixodidæ or Ricini and probably to Ixodes proper. The body is of a very regular obovate form, twice as long as broad, with a slight indication of a frontal shield of a triangular shape (not represented in the plate and perhaps illusory), formed by two sulcations meeting at right angles and terminating just within the front pair of legs on either side. The rostrum is not preserved, but the right palpus (poorly given on the plate) is slender and 0.2^{mm} long, or rather projects beyond the body to that amount. Nearly all the legs are present, but the hinder legs of the left side have been crowded out of place and appear on the right side below those which properly belong there, and which apparently are the upper four there seen. The legs are apparently complete, except the terminal appendages, as they all taper rather rapidly at the end, after the manner of ticks; they are stout, short, and of similar length, extending beyond the body by about the width of the latter.

Length of body, 3.5^{mm}; breadth of same, 1.75^{mm}.

Fish-Cut, Green River, Wyoming. Dr. A. S. Packard, No. 258.

Order ARANEIDES Latreille.

As stated above, by far the larger part of the fossil Arachnides known are true spiders, about one hundred and ninety species having been described from the Tertiary deposits of Europe, and more than thirty being added to the total list in this volume. These last are distributed among the larger groups as follows: Saltigradæ (all Attides), three; Citigradæ, none; Laterigradæ (all true Thomisides), three; Territelariæ, none; Tubitelariæ (Agalenides, one; Drassides, five; Dysderides, two) = eight; Retitelariæ (all Theridides), four; Orbitelariæ (all Epeirides), fourteen = thirty-two. By this it appears that nearly half are Epeirides, and that after these the Drassides are best represented. A comparison of this result with the fossil spiders of Europe is shown by the following table, in which the percentages of the groups represented are compared in each country with the total representation in each:

Percentages of groups of Tertiary spiders in Europe and in America.

Suborders.	Percentage.	
	Europe.	America.
Saltigradæ	8	9
Laterigradæ	16	9
Tubitelariæ	36	24
Retitelariæ	29	12
Orbitelariæ	8	44
	97	98

This shows that America is far the richer in Orbitelariæ, and Europe much better represented in Retitelariæ, less but still considerably better in Laterigradæ and Tubitelariæ, while the Saltigradæ have an almost equivalent representation in the two countries.

If, however, we eliminate from the inquiry the species entombed in amber, and compare only those recovered from the rocks in which they have been preserved, we shall reach perhaps a more just comparison, although the data will be far more meager, America with its thirty-two species being actually better represented than Europe with its twenty-two species, all belonging to the same five larger groups which are represented in America.

Percentages of groups of Tertiary spiders in Europe and America, excluding those found in amber.

Suborders.	Percentage.	
	Europe.	America.
Saltigradæ	0.5	9
Laterigradæ	20	9
Tubitelariæ	23	24
Retitelariæ	41	12
Orbitelariæ	14	44
	98.5	98

The excess of proportion in America of Orbitelariæ is here nearly as great as is shown in the former table, but is not so great as the now heightened proportion in Europe of Retitelariæ, while the Tubitelariæ are now the ones in which the proportion is similar in each, the Laterigradæ the only one where the proportion remains nearly the same as before, and the Saltigradæ are nearly lost sight of in Europe, a single species being known.

If now we carry the analysis a little further we shall find more interesting relations, as will appear from the following table, in which all the groups represented in Europe are introduced, and both the total fauna and the species from the strata tabulated:

Number of species of Tertiary spiders found in Europe and in America, by families.

Suborders.	Families.	In Europe, including those in amber.	In Europe, excluding those in amber.	In America.
Saltigradæ	Attides	14	1	3
	Eresoidæ	2	0	0
Citigradæ	Lycosoidæ	2	0	0
Laterigradæ	Philodrominæ	4	0	0
	Thomisides	21	4	3
	Uncertain	6	0	0
Territelariæ	Theraphosoidæ	1	0	0
Tubitelariæ	Dysderides	14	0	1
	Drassides	38	2	5
	Agalenides	12	3	2
	Hersilioidæ	3	0	0
	Uncertain	2	0	0
Retitelariæ	Scytodoidæ	1	0	0
	Theridides	54	9	4
Orbitelariæ	Epeirides	16	3	14

Here it appears at a glance that exactly the same groups are represented in the stratified deposits of Europe and America in every instance, excepting the Dysderides, which is unrepresented in Europe and has a single member in America. It also appears that only those groups which are represented abundantly in amber (and all of them) are also represented to some extent in the American fauna and (excepting, as before, the Dysderides) in the European rocks. Exception should perhaps be made for the European amber genus Archæa, the position of which in the Laterigradæ is uncertain, and of which Thorell says: "This genus may perhaps for the present best be taken as the type of a separate family" of Laterigradæ (European spiders, p. 232). Six species are known, and they are classed above as uncertain. The relation brought out in this table is certainly striking, but it should be noticed at the same time that the Drassides and Theridides, and especially the latter, are enormously represented in the Baltic amber, and in comparison with them (though not by any means to the same extent in comparison with the other groups) feebly represented in the stratified deposits of Europe and America.

We may venture one further investigation, although little weight can be given to it from the meagerness of the data, viz, a comparison of the percentage of representation of the different larger groups in the different horizons of Tertiary times in Europe with that of Florissant, where all the American species so far known have been found.

Percentage of groups of Tertiary spiders of Florissant, Colorado, compared with those of Europe.

Suborders.	Florissant.	Amber and Aix; Ligurian (Oligocene).	Rott; Aquitanian (Lower Miocene).	Oeningen; Tortonian (Upper Miocene).
Saltigradæ	9	9	0	0
Laterigradæ	9	16	13	30
Tubitelariæ	24	37	25	30
Retitelariæ	12	28	37	30
Orbitelariæ	44	8	25	10
	98	98	100	100

As this table shows so great a difference between the percentage of representation in the Oligocene and Lower Miocene of Europe that it can scarcely prove very instructive, it still seems to indicate a greater difference between the Florissant deposits and those of Oeningen than between the

former and either of the others; and although the proportionate numbers of Tubitelariæ and Orbitelariæ of Florissant and especially of the former group are more nearly like those of Rott, the representation of the groups in general allies Florissant on the whole with the Oligocene rather than with the Lower Miocene of Europe.

Of extinct genera there have certainly been proposed a very large number for the European Araneidæ, more than half the genera to which the species have been referred having been described as new and peculiar to Tertiary times; these genera include about two-fifths of the species. Among the genera are some remarkable forms, such as Archæa and Mizalia, each of which is considered by Thorell and others as representing a distinct family.[1] Two only of the thirteen genera to which the American species are referred are described as new, and to them are referred seven of the thirty-two species. Other genera, not before recognized in a fossil state, but here recorded from American strata, are Titanœca, Tetragnatha, and Nephila. To enter into details, seventy-one genera of Araneidæ have been described from the Tertiaries, sixty-six from Europe, and thirteen (below) from America, eight being common to both. Of these seventy-one genera thirty-seven are accounted extinct, thirty-five from Europe, and two from America, none of these being found in both countries. The European genera are, as may be supposed, largely composed of amber species, no less than fifty-two, including thirty-two extinct genera, being confined to amber deposits, besides others which they possess in common with the stratified beds.

If it be asked what indications the fossil spiders of Florissant give as to the climate of that district in Tertiary times, there is but one answer which can be given: that the present distribution of their allies certainly points to a considerably warmer climate than now, a climate which may perhaps best be compared to the middle zone of our Southern States. The known living species of the genera to which they belong are in general credited to regions like Georgia in this country and the two shores of the Mediterranean in Europe; but our own species are so little known that nothing can be said very definitely upon their immediate relationship with exotic or indigenous forms. The presence of species of Theridium, Linyphia, Tethneus, and Epeira, including two-fifths of the species, has no special significance, but Thomisus, Segestria, Clubiona, Anyphæna, and Titanœca, and especially

[1] A good critical review of the described fossil species of Araneides will be found in Thorell's European Spiders, pp. 223–233.

Parattus, Tetragnatha, and Nephila certainly present an ensemble the indications of which can not be overlooked. (November, 1881.)

Since the above was written a notable addition to our knowledge of the Arachnides of Tertiary Europe has been made by Gourret in a paper on those of Aix, in which among others eighteen species of Araneides are described, including Eresoidæ (two species), Lycosoidæ (two species), Theraphosoidæ (one species), Dysderides (one species), Hersilioidæ (two species), Urocteoidæ (two species), Enyoidæ (one species), none of which families had before been found in European rocks, and the last two not even in amber. (October, 1889.)

In the measurements of legs in the Araneides the length of the femur is the distance of the apex of the femur beyond the margin of the cephalothorax, no account being taken of the coxa, unless it is specially mentioned; so too the first joint of the tarsus, which according to arachnologists is consolidated with the tibia, is here regarded (in the measurements) as a part of the tibia, and the second and third joints of the tarsi are alone measured as tarsi, except when, as in Tethneus hentzii and Thomisus defossus, separate account is taken of them.

Suborder SALTIGRADÆ Latreille.

As in the north temperate zone to-day, so in Tertiary times, the two families of Saltigradæ, Attides and Eresoidæ, are very unequally represented in species, only two fossil species of the latter family being known against seventeen of the former. The two Eresoidæ are amber species; of the Attides, thirteen are known from amber, one from Aix in Provence, and three from Florissant, Colorado, described below. (November, 1881.)

Since this was written Gourret has described one species of each of these two families from Aix.

Family ATTIDES Koch.

The fossil species of this family of jumping spiders hitherto recorded are all confined to the Prussian amber excepting one, a species referred to a new genus, Attoides, described by Brongniart from Aix. The amber species are referred to four genera, Euophrys (one), Gorgopis (five), Propetes (five), and Steneattus (one), besides an undescribed species referred by Menge to Salticus. The species of Gorgopis were formerly referred to Phidippus, a genus richly represented to-day in North America, and it

is therefore interesting to notice that the three species described below and referred to a new and aberrant genus of the family, Parattus, are more nearly related to Gorgopis than apparently to any other known, and that the amber genus contains nearly one-half of the species of this family preserved in Europe from Oligocene times. The species of this family are spread all over the world, both in tropical and temperate regions, but seem to be comparatively rare in Africa south of the desert. (November, 1881.)

Gourret has added another species from Aix, referred to an extinct genus, Attopsis.

PARATTUS, gen. nov. (*πάρος*, *ἄττω*).

The three species here referred to the Attoidæ seem to belong to a distinct genus allied to Gorgopis of the Prussian amber, in that the posterior eyes are placed far behind the others, but differing markedly from that, as from all members of the family, so far as I know, in two points: (1) The exterior eyes of the first row are placed a little in advance of the median pair of the same row, and (2), more particularly, they are as large as or scarcely smaller than these median eyes. The anterior row, therefore, is formed of four very large, nearly equal and nearly equidistant eyes, arranged in a gentle curve opening forward; the eyes of the second row, so far as known, are minute and situated within and behind and in close proximity to the median eyes of the anterior row, while those of the third row, so far as known, are of medium size, placed at a greater or less distance apart in the middle of the cephalothorax, as in the American genus Phidippus and the amber Gorgopis. The American genus Phidippus is confined to the warmer parts of the continent and to a large extent to the tropics, so that the presence of this somewhat allied genus indicates, so far as such analogy indicates anything, a warmer climate in early times for Florissant.

Table of the species of Parattus.

Cephalothorax and abdomen well rounded, with convex sides .....1. *P. resurrectus.*
Cephalothorax quadrate, with nearly straight sides.
Small species; cephalothorax less than twice as long as broad; abdomen quadrate..2. *P. evocatus.*
Large species; cephalothorax more than twice as long as broad; abdomen round ...3. *P. latitatus.*

1. PARATTUS RESURRECTUS.

Pl. 11, Fig. 26 (♀?).

Cephalothorax broad oval, subquadrate, the sides gently convex, the two ends broadly rounded; front regularly semicircular; the two middle eyes of the anterior row very large, circular, situated just behind the front edge; the lateral eyes of the same row nearly or quite as large, circular,

forming with these a very slightly curved row, opening forwards, of equidistant eyes. Eyes of second row from one-eighth to one-tenth the size of those of the first row, situated behind and within the middle anterior pair, so that lines drawn through the middle of the large and small ones would meet in a right angle behind the small ones and leave them distant from each other by about their own diameter; the outer edge of either of the small ones is behind the inner edge of one of the large ones; the eyes of the third row are not discernible on either of the specimens, and on one the lateral eyes, on the other the eyes of the second row, can not be seen.

Palpi of the male with the tip very large, conchiform, as if made of three whorls, the middle twice as large as the other two together and subglobose, the terminal small and globular. Only one palpus is exposed, but the other may partially be seen through the cephalothorax. Abdomen short ovate, somewhat larger than the cephalothorax, being somewhat longer and slightly broader, subacuminate at tip, with a pair of short styles darkest in a broad mediodorsal band. Legs moderately long and slender, subequal, not greatly tapering, furnished throughout and rather abundantly with generally alternate, divergent, long, and tapering spines, fully as long as the width of the joint from which they rise.

Length of body, 4.85^{mm}; cephalothorax, 2^{mm}; abdomen, 2.85^{mm}; width of cephalothorax, 1.6^{mm}; abdomen, 1.7^{mm}; longer axis of middle section of palpal swelling, 0.8^{mm}; length of whole swelling, 1.45^{mm}; length of first pair of legs, 5.5^{mm}; second pair, 5.5^{mm}; third pair, 4^{mm} (?); fourth pair, 4.75^{mm}. Excepting in the palp the measurements are those of the female.

One of the specimens is a male; the other, the palpi of which are not preserved, is judged to be a female merely from its variation from the other in its larger abdomen. The species is readily distinguished from the others by the rounded outline of the cephalothorax both on the sides and on the strongly convex front.

Florissant. One ♂, No. 1081; one ♀, Nos. 8282 and 8459.

2. Parattus evocatus.

Cephalothorax subquadrate, somewhat less than twice as long as broad, slightly broadest posteriorly, with straight, scarcely divergent sides; anterior and posterior margins broadly convex, the lateral angles well rounded off; eyes of anterior row large, round, equal, equidistant, the middle ones at less than their own diameter from the front edge and from

each other, the whole arranged in a slightly curving row opening forward; eyes of second row indistinguishable; those of third row rounded oval, obliquely placed, situated each in the center of either lateral half of the cephalothorax. Abdomen slightly longer than the cephalothorax, of the same width, with nearly straight sides, rounded off anteriorly and tapering to a subangulate apex on the posterior third or fourth. The cephalothorax is blackish in the middle posteriorly, and all the abdomen but the terminal tapering part is nearly black. Legs very poorly and imperfectly preserved, but evidently tolerably stout and furnished with abundant, divergent, tapering, slender spines.

Length of body, 6.65^{mm}; cephalothorax, 3^{mm}; abdomen, 3.65^{mm}; breadth of cephalothorax anteriorly, 1.8^{mm}; posteriorly, 2^{mm}; abdomen, 1.5^{mm}; length of first pair of legs, 7.5^{mm}.

The specimen is presumed to be a female from some faint traces of a slender palpus. The squareness of the form distinguishes this from the preceding species; from P. latitatus it differs by its smaller size and proportionally shorter cephalothorax as well as by the more rounded front of the latter.

Florissant. One ♀, No. 12005.

3. Parattus latitatus.

Cephalothorax quadrate, nearly three times as long as broad, equal, with straight and parallel sides, the extreme anterior and posterior angles rounded off; front nearly straight between the rounded angles. Eyes of anterior row large, equal, circular, subequidistant, the middle pair situated their own diameter behind the front, the lateral ones at the front, forming thus a curving series opening forward; eyes of second row not discernible in the single specimen; those of third row also doubtful, but apparently represented by a pair of spots considerably smaller than the anterior eyes, slightly nearer together than the middle pair and situated a little in front of the middle. Across the middle of the cephalothorax, or rather a little behind it, is a straight, raised, black line, in front of which the cephalothorax is black in a very large round patch. Abdomen almost globular, shorter than the cephalothorax but much broader, covered profusely with dusky and blackish hairs. Legs moderately slender and long, armed sparsely with very long and slender tapering spines longer than the breadth of the femora.

Length of body, 7.65^{mm}; cephalothorax, 4.2^{mm}; abdomen, 3.5^{mm}; breadth of cephalothorax, 1.7^{mm}; abdomen, 3.2^{mm}.

The legs are imperfect in the single specimen known, and as no palpi are preserved the sex is uncertain. The species differs from both the preceding in its much larger size; from P. resurrectus also in its very quadrate cephalothorax, and from P. evocatus in its globular abdomen.

Florissant, No. 9823.

Suborder LATERIGRADÆ Thorell.

The two families of crevice-inhabiting crab-spiders which have been found fossil in Tertiary deposits, Thomisides and Philodrominæ, are both (the former particularly) common at the present day in Europe and North America. The fossil species belong mostly to the former, only four species of Philodrominæ having been recorded, all from amber, while twenty-one Thomisides are known, not including those described below, all of which also fall here. In this statement the strange amber genus Archæa is not included, since, though placed by both Menge and Thorell in this group, it differs strikingly from the other members and should form a family group apart from them, having no known affinities with any of the species from the stratified deposits of Europe or America. (November, 1881.)

Two additional species of Thomisides have lately been described from Aix by Gourret. (October, 1889.)

Family THOMISIDES Sundevall.

All but four of the fossil Thomisides described up to the present time come from amber and represent the genera Athera (one species), Clythia (five species), Ocypete (four species), Opisthophylax (one species), Syphax (five species), and Thomisus (one species). Thomisus is also represented, with Xysticus, by two species each in the stratified deposits of Oeningen and Rott, the latter locality furnishing one Xysticus, the former the remaining species. The species described below appear pretty certainly to fall in the Thomisides proper and probably also in the vicinity of Thomisus or Xysticus. The family is widely distributed in all parts of the world. (November, 1881.)

The two species recently described by Gourret from Aix are regarded as types of extinct genera which he terms Amphithomisus and Pseudothomisus. (October, 1889.)

THOMISUS Walckenaer.

Three species of Thomisides occur in the Tertiaries of Colorado, and apparently all of them (one is mutilated) belong to the true Thomisinæ, in which the hinder two pairs of legs are much weaker than the others. As the cephalothorax is in all cases poorly preserved or lost, it is impossible to speak at all definitely of their generic relations, and therefore I have placed all of them in the typical genus Thomisus, from which the family derives its name, and which, or Xysticus, its near ally, they closely resemble in general appearance. In all the abdomen is nearly round. It is interesting to find, as observed above, that the species of this family from the stratified deposits of the European Tertiaries have also been placed in Thomisus and Xysticus, though none of them appear to be very closely allied to our species.

This genus is widely spread, but nearly all the species belong to the warm temperate regions of Europe and North America. (November, 1881.)

Table of the species of Thomisus.

Tibiæ of hinder pairs of legs broader at tip than at base, and much broader than the tarsi...1. *T. resutus.*
Tibiæ of hinder pairs of legs of equal width throughout.
Small species; femora of first pair of legs half as long again as those of second pair; tarsi as broad as the tibiæ ..... 2. *T. disjunctus.*
Large species; femora of first and second pairs of legs of about equal length; last tarsal joint slenderer than the tibiæ ..... 3. *T. defossus.*

1. THOMISUS RESUTUS.

Pl. 11, Fig. 13.

Abdomen plump, short ovate, about a fourth longer again than broad, the base broad, the sides well rounded, the hinder extremity full, with the extreme apex squarely truncate. Only a fragment of the cephalothorax remains, showing the broad attachment of the abdomen. The two hinder pairs of legs only are preserved, showing limbs of considerable length, bent forward, the femora nearly as long as the abdomen, longer than the tibiæ and flattened, largest in the middle; the tibiæ are straight, completely consolidated with the first tarsal joint as in spiders generally, also flattened, slender at base and gradually though slightly increasing in size apically, a peculiarity which is not shown in the plate; the tarsi are much slenderer, not flattened, and longer than the tibiæ, the first joint alone being nearly as

long as they; the whole leg is devoid of armature or clothing and none is perceptible on the abdomen.

Length of abdomen, 3^{mm}; breadth, 2.5^{mm}; length of third pair of legs, 5.3^{mm}; its femora, 1.85^{mm}; tibiæ, 1.65^{mm}; tarsi, 1.8^{mm}; first joint of same, 1.2^{mm}; second joint, 0.6^{mm}; fourth pair of legs, 7.45^{mm}; its femora, 2.75^{mm}; width of same, 0.5^{mm}; its tibiæ, 1.5^{mm}; width of same at base, 0.25^{mm}; at tip, 0.4^{mm}; its tarsi, 3.2^{mm}; width of same, 0.1^{mm}; length of first joint, 2^{mm}; second joint, 1.2^{mm}.

A single specimen is preserved, in which all anterior to the two hinder pairs of legs is lost. The species is readily distinguished from either of those here described by the unequal width of the tibiæ, as well as for the disparity in width between the tibiæ and tarsi. As the front legs are wanting, this may not so properly be referable as the others to the Thomisides rather than the Philodrominæ.

Florissant. Nos. 5502 and 7521.

2. Thomisus disjunctus.

Pl. 11, Fig. 9.

Cephalothorax obscure in both specimens, and apparently preceded by a slender beak, more than half as long as the abdomen and divided into two lateral halves closely united; they seem to be a pair of elongated cheliceres, but are poorly preserved in both cases. Abdomen rounded, short oval, about a fourth longer than broad, with both ends equally rounded. Legs long and slender, the two front pairs longer than the hinder two, the first also considerably longer than the second; the femora are long and slender (the front pair about as long as the abdomen), flattened and tapering at either end; the tibiæ and first tarsal joint are completely consolidated into a single piece, so that the line of demarkation can not be seen, and are very slender, equal, as long as the femora; the other tarsal joints are together less than half as long as the previous member and scarcely slenderer than it, terminating in a slightly curved delicately pointed claw as long as the width of the tarsus.

Length of abdomen, 1.75^{mm}; breadth, 1.45^{mm}; length of first pair of legs, 4.2^{mm}; its femur, 1.8^{mm}; tibia, 1.7^{mm}; tarsus, 0.7^{mm}; second pair, 2.85^{mm}; femur, 1.2^{mm}; tibia, 1.15^{mm}; tarsus, 0.5^{mm}; tibia of third pair, 1.05^{mm}; tarsus, 0.4^{mm}; fourth pair, 2.2^{mm}; femur, 1^{mm}; tibia, 0.8^{mm}; tarsus,0.4^{mm}.

The sex of both specimens is uncertain. The species is readily distinguished from the others by its small size, slender and long legs, and the complete consolidation of the tibia and first tarsal joint.

Florissant. Nos. 9677, 10377.

3. Thomisus defossus.

Pl. 11, Fig. 23, ♂.

Cephalothorax bent at a strong angle with the abdomen and perhaps distorted in the single specimen known, but as preserved it is of an oval shape, slenderer than the abdomen, but not much smaller, half as long again as broad, similarly and fully rounded at either end, the sides not strongly convex; it appears to have a median transverse constriction and incision. Nothing can be made out of the eyes, but a single large, black, subcircular, palpal swelling (represented of the same tint with the rest and merged with the cephalothorax on the plate) lies bordering the middle of the front, a little broader than long. Abdomen very broad ovate, not more than a third to a fourth longer than broad, the base slightly broadest and broadly rounded, the apex similarly rounded and the sides between the well-rounded corners nearly straight; a faint separation into three or four segments can also be seen, and the surface is sparsely covered with minute short black hairs. Front pairs of legs much larger than the hinder, showing that the species is one of the true Thomisinæ, the femora large, swollen in the middle and depressed, the front pairs much longer than, the hinder pairs nearly as long as, the abdomen; the tibiæ proper are very distinctly separated from the first joint of tarsi (in the other species it is reckoned with them in the measurements), excepting on the hindmost legs having a distinct oval form of their own, about half as long again as broad; the first joint of the tarsi is only a little shorter than the femora (on these same legs) and with the tibia longer than the femora; it is armed sparingly with long and slender recumbent spines; the second and third joints of the tarsi are subequal, together shorter than the first joint, and besides their sparse clothing of short fine black hairs the tip is armed with a single short blunt claw.

Length of cephalothorax, 3.5^{mm}; breadth, 2.1^{mm}; length of abdomen, 4.2^{mm}; breadth, 2.7^{mm}; length of first pair of legs (as preserved), 7.75^{mm}; its femora, 3.5^{mm}; tibia (proper), 1.1^{mm}; (true) first joint of tarsi, 2.4^{mm}; second joint (as preserved), 1^{mm}; femora of second pair of legs, 3^{mm}; third pair of

legs, 7.15^{mm}; its femora, 2.6^{mm}; its tibia (proper), 0.8^{mm}; (true) first joint of tarsi, 2^{mm}; second joint, 1^{mm}; third joint, 0.75^{mm}; femora of fourth pair of legs, 3^{mm}; its tibia (proper), 1^{mm}; combined tibia and first joint of tarsi (as preserved), 3 5^{mm}.

This species is very readily separated from the others by its size, and undoubtedly belongs to a genus distinct from them; the specialization of the tibia proper is sufficient indication of this.

Florissant. One ♂, No. 4742.

Suborder TUBITELARIÆ Thorell.

This group of spiders, given to the construction of silken tubes above ground, is considered by Thorell as the most lowly organized of the Araneides, and it is interesting to find that it is far better represented in the Tertiary deposits than any other, comprising more than one-third of the species now known and 36 per cent. of the fossil species of Europe. It is equally remarkable for its diversity of form, all the families which are rich in genera in Europe at the present time being well represented in the Tertiaries of that country, and particularly in amber, both in genera and species; especially, as we shall see below, is this true of the Drassides, a group which is only surpassed in the number of its fossil species and the variety of its genera by the Theridides. It is, however, neither of these families, but the Epeirides, which predominates in the American Tertiaries, though next to these the Tubitelariæ stand pre-eminent, and particularly the family of Drassides, already mentioned. The same three families, viz, Dysderides, Drassides, and Agelenides, which are best represented in the European Tertiaries and are most abundant in species at the present day, are also present in the American strata, the first by a single species, the second by five, and the last by two, in all one-fourth of the American Araneides. (November, 1881.)

Family DYSDERIDES Koch.

Three genera of this family, Dysdera (four species), Segestria (eight species), and Therea (two species), have been found in Prussian amber, and comprise all the fossil species known up to the present time. To this list we can add from America one species, belonging to the genus most richly represented in amber. So far as known the living species of this

family, which are not numerous, are almost exclusively confined to the European fauna (especially the Mediterranean district) and to South America. (November, 1881.)

Gourret has recently described a species of this family from Aix, the first known from the European rocks; it is referred to an extinct genus, Prodysdera. (October, 1889.)

SEGESTRIA Latreille.

A single species is referable to this genus, and with little doubt, as it bears a striking resemblance to the living S. senoculata (Linn.) of Europe. Eight species of the genus have been found in the European Tertiaries, all from the amber of the Baltic, and two others are reported as known to Menge from the same source. All the described amber species are smaller than the American species, and have longer legs and more elongated cephalothorax, being evidently more nearly related to one another than to the American form. The living species of the genus are found in southern Europe, northern Africa, and Chili, with a single one in New Zealand. A warm temperate climate is therefore indicated. (November, 1881.)

SEGESTRIA SECESSA.

Pl. 11, Fig. 28 (♀).

Female.—Cephalothorax short, rounded ovate, about one-fourth longer than broad, with no distinction of cephalic and thoracic areas, the front broadly rounded, obscure, with no trace of eyes. Mandibles very stout, tapering, rounded at the tip, half as long again as broad, half as long as the cephalothorax, and together as broad at base as the front of the cephalothorax. Palpi slender, longer than the cephalothorax. Abdomen rather long ovate, about twice as long as the cephalothorax, and a little broader, broadest in the middle, tapering only a little toward the base, considerably toward the acuminate tip. Whole body of an almost uniformly dark color. Legs subequal, moderately long, and pretty slender, tapering a little only, the tibiæ and tarsi furnished above with lateral rows of very long tapering spines which do not diverge, but lie along the sides base to tip.

Length of body, 9.5^{mm}; cephalothorax, 2.75^{mm}; abdomen, 5.25^{mm}; breadth of cephalothorax, 2.25^{mm}; abdomen, 2.65^{mm}; length of cheliceres,

1.5mm; extent of palpi beyond corselet, 3.5mm; length of first pair of legs, 10mm; its femora, 3mm; tibiæ, 1.5mm; tarsi, 5.5mm; second pair, 9.5mm; femora and tibiæ, 3.75mm; tarsi, 5.75mm; third pair, 6.6mm; femora and tibiæ, 2.6mm; tarsi, 4mm; fourth pair, 10.2mm; femora, 2.4mm; tibiæ, 2mm; tarsi, 5.8mm.

Florissant. Two ♀, Nos. 205, and 1.806 and 1.818 of the Princeton collections.

Family DRASSIDES Sundevall.

This family is richly represented in Tertiary species; indeed, excepting Theridides, more richly than any other family of Araneides, being represented in Europe by the genera Anatone (three species), Clubiona (eight species), Macaria (five species), Melanophora (five species), Pythonissa (ten species), and Sosybius (two species), as well as by one species each of Anyphæna, Drassus, Erithus, Heteromma, and Idmonia. Every one of these are amber species, excepting one Clubiona and one Macaria from Oeningen. Our own fauna has besides this yielded four species of Clubiona and one of Anyphæna, both genera represented in amber, and one also at Oeningen. The present distribution of the species of this family is over the whole world, but the borders of the Mediterranean, eastern Europe, and western South America appear to be far the most richly represented. Some of the genera are confined to one or the other of these regions and nearly all to warm temperate regions. (November, 1881.)

CLUBIONA Latreille.

A number of species appear to fall here, although it is difficult to tell whether they should not rather be referred to the lycosoid genus Dolomedes or its vicinity, so uncertain are the clews we have to their real position; until more satisfactory specimens can be obtained they may be placed here, the more so as the species all bear some resemblance to the amber spiders referred to the same genus, C. eversa to C. tomentosa, C. arcana to C. sericea and C. lanata, C. latebrosa to C. attenuata, and C. ostentata to C. microphthalma. The Oeningen species seems to be very different, with its rounded abdomen. Very few genera of spiders are so richly endowed with fossil species as this, Theridium indeed being the only one which surpasses it, and next to it comes Pythonissa, a genus of the same family as this. The genus is widely spread in modern times. A few species are common throughout the greater part of Europe, others are confined to the Mediter-

ranean region, a very few are found in the East Indies, and a very large number are reported from Chili; the genus is therefore mostly confined to warm temperate regions. (November, 1881.)

Table of the species of Clubiona.

Cephalothorax oblong oval, nearly or more than one-half longer than broad.
- Last palpal joint of male large; abdomen about equally rounded anteriorly and posteriorly, half as long again as the cephalothorax ..... 1. *C. eversa.*
- Last palpal joint of male small; abdomen tapering posteriorly and but little longer than the cephalothorax ..... 3. *C. latebrosa.*

Cephalothorax roundish oval, only one-fourth or one-third longer than broad.
- More than five millimeters long; abdomen much larger and longer than cephalothorax . 2. *C. arcana.*
- Less than five millimeters long; abdomen scarcely larger and but little longer than cephalothorax ..... 4. *C. ostentata.*

1. CLUBIONA EVERSA.

Pl. 11, Fig. 22 (♂).

Male.—Cephalothorax obovate, equally rounded at the two ends, more than half as long again as broad; the cephalic and thoracic portions not separable; front bluntly rounded, the eyes too poorly preserved to allow any statement concerning them. Palpi nearly as long as the cephalothorax, the last joint very large, ovate, subacuminate at tip, the longer diameter almost equaling the breadth of the cephalothorax. Abdomen ovate, half as long again and nearly half as broad again as the corselet, almost equally rounded at the two ends, but largest near the base and tapering slightly more behind than in front. Whole body of a nearly uniform brown, but in one specimen the swollen palpal joint blackish. Legs moderately long, not very unequal, tapering, abundantly furnished with dark divergent spines, about as long as the width of the tibiæ.

Length of body, 5.2^{mm}; cephalothorax, 2.1^{mm}; abdomen, 3.1^{mm}; width of cephalothorax, 1.65^{mm}; abdomen, 2^{mm}; extension of palpi beyond corselet, 1.7^{mm}; longer diameter of last joint of same, 0.7^{mm}; length of first pair of legs, 6.75^{mm}; its femora, 2.25^{mm}; tibiæ, 2^{mm}; tarsi, 2.5^{mm}; second pair, 6.75^{mm}; its femora, 2.3^{mm}; tibiæ, 2.2^{mm}; tarsi, 2.25^{mm}; third pair, 5.1^{mm}; its femora, 1.6^{mm}; tibiæ, 1.5^{mm}; tarsi, 2^{mm}; fourth pair, 6.6^{mm}; its femora, 2.1^{mm}; tibiæ, 2.2^{mm}; tarsi, 2.3^{mm}.

This species is not very far removed from the amber species, C. tomentosa, but is slightly larger than it and has a less tapering cephalothorax.

Florissant. Two ♂, Nos. 5944, 8551.

2. Clubiona arcana.

Pl. 11, Fig. 4 (♂).

Male.—Cephalothorax roundish oval, about one-third longer than broad, the cephalic and thoracic portions completely blended, the front in the single individual obscure with no trace of eyes. Cheliceres apparently pretty large, the palpi very long, longer than the prothorax, the last joint large and swollen, ovate, more than half as long again as broad, and black. Abdomen a little paler than the brownish cephalothorax, long ovate, considerably longer and somewhat broader than the cephalothorax. Legs not very long, tapering considerably, amply provided with more or less divergent slender spines as long as or slightly longer than the femora.

Female.—Cephalothorax ovate, about one-third longer than broad, the cephalic and thoracic portions completely blended. Palpi nearly or quite as long as the cephalothorax. Abdomen sometimes lighter than the cephalothorax, long ovate, considerably longer and sometimes a little broader than it. Legs as in the male, the spines perhaps a little shorter, and on the tarsi arranged to a certain extent in rows, not noticeable on the male.

Length of body, ♂ 5.25^{mm}, ♀ 6.65^{mm}; of cephalothorax, ♂ 1.75^{mm}, ♀ 2.15^{mm}; of abdomen, ♂ 3.5^{mm}, ♀ 4.5^{mm}; breadth of cephalothorax, ♂ 1.3^{mm}, ♀ 1.4^{mm}; of abdomen, ♂ 1.4^{mm}, ♀ 1.75^{mm}; extent of palpi beyond cephalothorax, ♂ 2^{mm}, ♀ 2^{mm}; longer diameter of last palpal joint, ♂ 1.15^{mm}, shorter diameter, ♂ 0.5^{mm}; length of first pair of legs, ♂ 7.5^{mm}, ♀ 6.75^{mm}; its femora, ♂ 2.05^{mm}, ♀ 2.4^{mm}; tibiæ, ♂ 2.9^{mm}, ♀ 2.35^{mm}; tarsi, ♂ 2.55^{mm}, ♀ 2^{mm}; second pair, ♂ 6.45^{mm}, ♀ 6^{mm}; its femora, ♂ 1.8^{mm}, ♀ 2.2^{mm}; tibiæ, ♂ 2.5^{mm}, ♀ 1.65^{mm}; tarsi, ♂ 2.35^{mm}, ♀ 2.15^{mm}; third pair, ♂ 5.35^{mm}, ♀ 5.5^{mm}; its femora, ♂ 1.35^{mm}, ♀ 1.8^{mm}; tibiæ, ♂ 2^{mm}, ♀ 1.85^{mm}; tarsi, ♂ 2^{mm}, ♀ 1.85^{mm}; fourth pair, ♂ 7.75^{mm}, ♀ 8.3^{mm}; its femora, ♂ 2.15^{mm}, ♀ 3^{mm}; tibiæ, ♂ 2.6^{mm}, ♀2.55^{mm}; tarsi, ♂ 3^{mm}, ♀ 2.75^{mm}.

This species agrees very well in size with C. eversa (only males of course compared), or is slightly smaller, and the legs if anything a little longer; the cephalothorax is rounder and the palpal swelling much more elongated. It is somewhat like both C. sericea and C. lanata of the Prussian amber, but is somewhat smaller and has longer legs than they.

Florissant. One ♂, No. 2831; three ♀, Nos. 3253, 7087, 8082, besides a ♀ from the Princeton collection, Nos. 1.807 and 1.819.

3. Clubiona latebrosa.

Pl. 11, Fig. 18 (♂).

Male.—Cephalothorax oval, largest behind the middle, tapering considerably at either end, with no distinction in outline between the cephalic and thoracic portions; front obscure with no eyes preserved. Cheliceres pretty large. Palpi very long, almost as long as the cephalothorax, terminal joint moderately stout, obpyriform. Abdomen paler than the cephalothorax, much larger than it by reason of its greater breadth, but only about one-fourth longer, largest near the base, tapering apically to a blunt tip, its basal two-thirds covered sparsely with long, stout, dark-tipped, faintly clubbed hairs. Legs long and slender, subequal, the femora and tibiæ furnished not very abundantly with moderately long, delicately tapering, very finely pointed, slightly divergent spines.

Length of body, 9.1^{mm}; cephalothorax, 4^{mm}; abdomen, 5.1^{mm}; breadth of cephalothorax, 1.6^{mm}; abdomen, 2.6^{mm}; extension of palpi beyond front of cephalothorax, 3^{mm}; length of first pair of legs, 8.75^{mm}; second pair, 11^{mm}; third pair, 9^{mm}; fourth pair, 9.5^{mm}.

This species differs from all the others here described in its tapering abdomen and its proportionally considerably longer legs; the palpal swelling is also slenderer than usual. In its tapering abdomen as well as in other features it comes pretty near the amber species, C. attenuata, being also of the same size; it differs from it in its longer legs.

Florissant. One ♂, No. 6492.

4. Clubiona ostentata.

Pl. 11, Fig. 24 (♂).

Male.—Cephalothorax broad oval, about one-half longer than broad, well rounded, with no distinction between cephalic and thoracic portions; front well rounded, but too poorly preserved to show any eyes. Cheliceres large. Palpi very long, fully as long as the cephalothorax. The apical joint very stout, obpyriform, being largest at some distance beyond the middle, beyond rapidly tapering to an obtuse angle; it is blackish and bears within its apical two-thirds a stout ribbon bent in the middle at less than a right angle, the bend broadly curved, and the apical half tapering to a point which extends just beyond the margin of the swelling. Abdomen only a little

larger than the cephalothorax, ovate, largest in the middle, tapering almost equally in either direction, the apex slightly angled, the surface very sparsely clothed with long, extremely delicate, tapering hairs. Legs moderately long, delicately tapering, sparsely furnished with scarcely divergent spines about as long as the diameter of the joint on which they are seated.

Female.—The single specimen is rather poorly preserved, hardly admitting of description. It is stouter than the male. The cephalothorax appears to be roundish quadrate, broadest behind, scarcely longer than broad, the hind margin very broadly, the front somewhat narrowly, convex. The abdomen is somewhat larger than the cephalothorax, but only a little longer, broadest anteriorly, pretty well rounded behind. Legs much as in the male, but with slight traces of spines.

Length of body, ♂ 5.4^{mm}, ♀ 4.75^{mm}; cephalothorax, ♂ 2.65^{mm}, ♀ 2.25^{mm}; abdomen, ♂ 2.75^{mm}, ♀ 2.5^{mm}; breadth of cephalothorax, ♂ 1.75^{mm}, ♀ 2.15^{mm}; abdomen, ♂ 1.6^{mm}, ♀ 2^{mm}; extent of palpi beyond cephalothorax, ♂ 1.35^{mm}; length of palpal swelling, ♂ 0.75^{mm}; length of first pair of legs, ♂ 7^{mm}, ♀ 6.2^{mm}; femora, ♂ 2^{mm}, ♀ 1.5^{mm}; tibiæ, ♂ 2.25^{mm}, ♀ 2.6^{mm}; tarsi, ♂ 2.75^{mm}, ♀ 2.1^{mm}; second pair of legs, ♂ 6.65^{mm}, ♀ 6.1^{mm}; femora, ♂ 2^{mm}, ♀ 1.6^{mm}; tibiæ, ♂ 2.25^{mm}, ♀ 2.25^{mm}; tarsi, ♂ 2.4^{mm}, ♀ 2.25^{mm}; third pair of legs, ♂ 5.15^{mm}; femora, ♂ 1.25^{mm}; tibiæ, ♂ 1.9^{mm}; tarsi, ♂ 2^{mm}; fourth pair of legs, ♂ 6.9^{mm}, ♀ 4.6^{mm}; femora, ♂ 2^{mm}, ♀ 0.85^{mm} (?); tibiæ, ♂ 2^{mm}, ♀ 1.75^{mm} (?); tarsi, ♂ 2.9^{mm}, ♀ 2^{mm}.

This species is considerably smaller than any of the others, and is further distinguished from them by the near equality in size of the cephalothorax and abdomen It resembles a little C. microphthalma of the Baltic amber, and is of the same size as it, but the cephalic portion of the cephalothorax is not distinguished by a constriction as there, and our species has somewhat stouter legs.

Florissant. Two ♂, Nos. 199, 5507 and 5910; one ♀, No. 9624.

ANYPHÆNA Sundevall.

To this genus I refer a single species, manifestly belonging in this vicinity, and approaching it, so far as may be judged by the general appearance of the specimen, as closely as any other form. Traces of the eyes can be seen in this specimen, and if correctly interpreted their arrangement is not exactly that of Anyphæna, although it is not very different from that

of this and allied genera of Drassidæ. For the present, at least, it may remain here.

A single species of Anyphæna has before been recorded in a fossil state, A. fuscata, found in amber, but it differs very much from our species, and the arrangement of the eyes in particular is altogether different. All the species of the genus now living have been found in southern Europe and Algeria excepting one, which is reported from the Pacific Islands; and our species thus indicates a warmer climate than the locality at present enjoys.

ANYPHÆNA INTERITA.

Pl. 11, Fig. 5.

Cephalothorax subcircular, the cephalic and thoracic portions wholly blended, the anterior and posterior margins a little flattened, so as to be nearly straight, fully as broad as long, furnished with short, tapering hairs. Eyes apparently formed of two approximated pairs of small ocelli close together in a slightly curved line opening forward next the middle of the front margin; two slightly larger directly behind each of these pairs, and slightly more distant from each other than either is from the pair in front, and two much larger lateral ocelli situated next the front base of the front pair of legs close to the margin, and forming with the posterior middle eyes a very slightly curved series of nearly equidistant ocelli opening forward. The pair of approximated eyes and the one in their rear are faint and more or less conjectural. If this position of the eyes is correct the spider should not be placed in Anyphæna, but would certainly appear to fall near it and Clubiona. Cheliceres very stout, projecting in front of the cephalothorax by half the length of the latter, and together considerably more than half as broad as it, well rounded apically. Palpi of female rather longer than the cephalothorax, moderately stout. Abdomen apparently pedunculate, the peduncle long and slender, the abdomen plump oval, well and very regularly rounded in front, and but for the rapid tapering of the extreme apex rather more broadly rounded behind. Legs short, subequal, moderately stout, especially the femora, tapering throughout, well armed with pretty large tapering spines of equal length on the whole leg, and about as long as the width of the tibiæ, somewhat divergent and irregularly disposed on the femora, beyond arranged apparently in two or three rows and scarcely at all divergent.

Length of body (as preserved), 11.5^{mm}; of cephalothorax, 2.75^{mm}; of abdomen (without pedicel), 6^{mm}; of pedicel, 1^{mm}; breadth of cephalothorax, 3.1^{mm}; of abdomen, 4.1^{mm}; length of cheliceres, 1.6^{mm}; of palpi beyond corselet, 3.3^{mm}; of first pair of legs, 8^{mm}; its femora, 2.5^{mm}; tibiæ, 2.6^{mm}; tarsi, 2.9^{mm}; of second pair of legs, 9.2^{mm}; its femora, 2.6^{mm}; tibiæ, 3.25^{mm}; tarsi, 3.35^{mm}; of third pair of legs, 7.5^{mm}; its femora, 2.3^{mm}; tibiæ, 2.5^{mm}; tarsi, 2.7^{mm}; of fourth pair of legs, 10.75^{mm}; its femora, 2.9^{mm}; tibiæ, 3.2^{mm}; tarsi, 4.15^{mm}.

Florissant One ♀ (and reverse), Nos. 8269 and 8281.

Family AGALENIDES Koch.

This family of Tubitelariæ is also fairly represented in Tertiary times, three species each having been found in amber, of the genera Amaurobius and Tegenaria, and one each of Agalena and Argyroneta, besides which Oeningen furnishes an Argyroneta and Rott an Argyroneta and a Histopona. To this list we can add from this country two species of Titanœca, more nearly allied apparently to the amber species of Amaurobius than to any other fossils. Far the largest part of the species of this family are known from Europe, but a few from America. (November, 1881.)

Gourret has recently described a Tegenaria from Aix.

TITANŒCA Thorell.

Two species are placed in this genus from their close general resemblance to the type of the same, Hahn's Theridium quadriguttatum of Europe. The genus has never before been found fossil, but is not far removed from Amaurobius, of which three species are known in the European Tertiaries. The living species of the genus are confined, so far as I discover, to the Mediterranean district and central Europe, as are most of the species of Amaurobius, but a few of the latter are reported from the warmer parts of America. As in so many other cases, therefore, the presence of these species indicates a warm temperate climate. (November, 1881.)

Table of the species of Titanœca.

Cephalothorax small and oval, about half as long as the abdomen ..... 1. *T. ingenua.*
Cephalothorax large and elongate, about three-fourths the length of the abdomen .....2. *T. hesterna.*

1. Titanœca ingenua.

Pl. 11, Figs. 29, 32 (♀).

Cephalothorax oval, about half as long again as broad, largest a little behind the middle, the front not produced but regularly rounded, the lateral curve being slightly convex throughout its course, and thus showing no line of separation between the cephalic and thoracic portions. Arrangement of eyes not determinable. Cheliceres stout. Palpi moderately stout, equal, about as long as the cephalothorax, the terminal joint roundly pointed at tip. Abdomen plump, subrotund, at least four or five times larger than the cephalothorax, being more than twice as broad and fully twice as long as it, slightly more tapering at the base than at the apex, only half as long again as broad, and of a uniform tint, or possibly a little duskier along the medio-dorsal portion. Legs moderately slender, short, subequal, abundantly furnished with hairs, which seem (conspicuously in one specimen, No. 13520, less distinctly in others) to be more abundant laterally than upon the upper surface, and armed with many very long and slender only slightly diverging spines on all the legs, and especially on the femora and tibiæ of the two hinder pairs. All the specimens appear to be females.

Length of body, 9.6^{mm}; of cephalothorax, 3.1^{mm}; abdomen, 6.5^{mm}; breadth of cephalothorax, 2.4^{mm}; abdomen, 5.9^{mm}; length of first pair of legs, 8^{mm}; second pair, 7.6^{mm}; third pair, 7^{mm}; fourth pair, 8.75^{mm}.

The shape of the cephalothorax and abdomen sufficiently separate this species from the following, with which otherwise it agrees closely in general appearance.

Florissant. Four ♀, Nos. 9792, 11203, 13520, 14031.

2. Titanœca hesterna.

Cephalothorax obpyriform, the cephalic portion a little produced and tapering anteriorly less than the fully rounded thoracic part, and somewhat truncate anteriorly, the front scarcely convex, the posterior border well rounded; the widest portion of the cephalothorax is in the middle of the thoracic part or of the hinder two-thirds of the whole, and it is nearly half as long again as broad. Arrangement of eyes not determinable. Cheliceres stout. Palpi moderately stout, equal, a little shorter than the cephalothorax, the apical joint roundly pointed at tip. Abdomen ovate, about

half as broad again as the cephalothorax, nearly twice as long as broad, but only half as long again as the cephalothorax, tapering apically as much as if not more than basally. Legs moderately slender, short, subequal, abundantly furnished with hairs and with spines, even to the tips of the tarsi, especially on the two hinder pairs of legs, much as in T. ingenua and with the same thinness of covering above as there, one specimen especially (12977) showing it in the same marked degree as one of the preceding species. As there also, all the specimens appear to be females.

Length of body, 7.1^{mm}; cephalothorax, 2.3^{mm}; cheliceres, 1.5^{mm}; abdomen, 5^{mm}; breadth of cephalothorax anteriorly, 1.4^{mm}; greatest breadth, 2.1^{mm}; breadth of abdomen, 2.75^{mm}; length of first pair of legs, 7^{mm}; second pair, 7.3^{mm}; third pair, 5.5^{mm}; fourth pair, 8^{mm}.

The slenderer form of the whole body and the less disparity in size between the cephalothorax and abdomen mark this species as distinct from the preceding.

Florissant. Four ♀, Nos. 5656, 12006, 12977, and Princeton collection, No. 1.809.

Suborder RETITELARIÆ Thorell.

Next to the last equivalent group, these spiders, which make a loose web or snare apparently constructed without any regular plan, are the most numerous in Tertiary deposits, forming in Europe, as we have seen, 29 per cent of the total fauna. This, as before, is dependent in large measure upon their representation in amber, which contains forty-eight of the fifty-five described species. The number known from the European strata is, however, greater than in any other of the larger groups, while the American species of the same here brought to light are for once considerably less numerous than the European. All the species belong to the Theridides, which is also far the richest in forms at the present day. (November, 1881.)

Family THERIDIDES Koch.

There is no single family of spiders so abundantly represented in Tertiary deposits as the Theridides. No less than fifty-four species, or more than one-fourth the whole number of fossil Araneides of Europe, belong to this group and represent fourteen genera. Theridium is richest, with sixteen species; then follow Thyelia with eleven; Zilla, Micryphantes, and

Ero with five each; Linyphia with three, Corynites and Erigone with two, and Anandrus,[1] Clya, Dielacata, Euryopus, Flegia, and Schellenbergia with one each. Flegia, Corynitis, Anandrus, Thyelia, Clya, Dielacata, and Schellenbergia are all peculiar to the Tertiaries, Schellenbergia to Oeningen, the others to amber. Nearly all the species are from amber, but beside the Schellenbergia from Oeningen there is a species of Erigone and two of Linyphia from Rott, and two species of Theridium from Oeningen as well as another from Aix.

America, however, does not bear her proportionate share in this representation, being poorer even than the stratified deposits of Europe, whereas in every other group it is either better represented or falls short by only a single species. There is a single species of Linyphia, two of Theridium, and some egg-cocoons referred for convenience to the comprehensive genus Aranea. That two of the three species known in the perfect state should belong to the genus most highly favored in the European Tertiaries is a point worth noting.

The family is best represented in Europe (especially in the Mediterranean district) and warm temperate America, but a few have been found in the East Indies. (November, 1881.)

Gourret, in his recent investigation of the spiders of Aix, found but a single species of this family among the eighteen Araneides described by him. He referred it to Ariamnes.

ARANEA Linné.

Under this broad generic name are placed notices of some egg-cocoons which are like those made by species of this group and which have been found at no less than three distinct localities. I am not aware that any such remains have before been noticed.

ARANEA COLUMBIÆ.

Pl. 11, Figs. 1, 2.

Aranea columbiæ Scudder, Rep. Progr. Geol. Surv. Can., 1876–'77, 463–464 (1878).

Among the stones obtained by Mr. Dawson in British Columbia are several containing the flattened remains of the egg-cocoons of Araneides. There are no less than eight of them, of different shapes and sizes, occurring

[1] Anandrus is credited with one species, but it is not described (Menge, Lebenszeichen, etc., p. 7).

by pairs, none of them reverses of others. They occur on stones numbered 38 to 41. As the form of the egg-cocoons in Araneides is so various, and the number of specimens found indicates a probability of obtaining at some time the probable constructor of the webs, I have only applied an ancient, broad generic name to these products of the insect, for the sake of indicating the nature of all the fossil remains from Quesnel. It is probable that the spider will be found most nearly allied to Theridium, species of which construct pedunculate egg-cocoons not very different from these. The cocoons vary slightly in size, and more in shape, owing no doubt to their varying position when crushed; probably they were globular, or possibly slightly oval in shape; averaging about five millimeters in the longer and four millimeters in the shorter diameter; of a firm structure; testaceous in color, and hung by a slender thread, less, or much less than quarter the length of the egg-cocoon (averaging, perhaps, one millimeter in length), to a thickened mass of web, attached to some object or to the insect's web.

That they have been preserved by pairs upon the stones has no significance, and, indeed, may be due simply to the way the stones were broken; for they lie at varying distances apart, with no sign of connection, and placed with no definite relations to each other. Two of them show no sign of the pedicel, but this is certainly due to poor preservation; and a single one, the least circular (40*a*) not only has no pedicel, but appears to be formed of a lighter, flimsier tissue, and may belong to a different species. The following are the longer and shorter diameter, and length of pedicel, of each specimen:

Number of specimen.	Long diameter.	Short diameter.	Length of pedicel.
	Mm.	*Mm.*	*Mm.*
No. 38*b*	5.0	3.5	1.5
No. 38*c*	6.0	4.0	0.8
No. 39*a*	4.0	3.6	1.2
No. 39*b*	4.0	3.5	.....
No. 40*a*	5.5	2.5	.....
No. 40*b*	5.2	3.7	1.0
No. 41*a*	5.0	3 9	(*)
No. 41*b*	4.5	4.2	(*)

* Base only of pedicel preserved.

The egg-cocoon of a spider (No. 4201), of exactly the same size, shape, and general appearance as those described above, excepting that from

a break in the stone there is no trace of a pedicel, was found by me in the shales at Green River, Wyoming.

A single specimen (No. 8935), of an egg-cocoon was also found at Florissant, Colorado, having the same general appearance, but with no trace of a pedicel and slightly larger than any of the others, being 6^{mm} long and 4^{mm} broad. It is of course impossible to say that it is the same species.

Still another (No. 1.173) was brought by the Princeton expedition from Florissant, differing in the opposite direction, being considerably smaller and so preserved as to appear broader than long. It is provided with a pedicel 1.4^{mm} long, but is itself only 2^{mm} long and 2.5^{mm} broad.

Quesnel, Green River, Florissant.

THERIDIUM Walckenaer.

No less than sixteen fossil species of this genus have been described, thirteen from amber, one from the beds of Aix, at about the same horizon, and two from Oeningen. Those from Oeningen and Aix are very different from the two here described, and those figured from amber are scarcely nearer, though T. opertaneum bears some resemblance to T. granulatum, and T. seclusum to T. hirtum. The vast majority of the numerous known living species of this genus are from Europe, but not a few occur in our country, especially in the Southern States, and one or two are reported from other parts of the world. It is therefore almost exclusively a north temperate genus, but is by no means confined to the warmer parts, and its occurrence at Florissant has no special significance as to the climate of the times. (November, 1881.)

Table of the species of Theridium.

Large species; the cephalothorax much longer than broad (♀) ..... 1. *T. opertaneum.*
Small species; the cephalothorax nearly circular (♂) ..... 2. *T. seclusum.*

1. THERIDIUM OPERTANEUM.

Pl. 11, Fig. 3 (♀).

Female.—Cephalothorax elongated, comparatively slender, nearly equal, about twice as long as broad. Legs slender, imperfectly preserved, not very long, sparsely furnished with rather short delicate spines, not longer than the width of the legs. Abdomen very large, nearly globular, nearly three times as broad as the cephalothorax, of a greenish tinge, though the whole body is brown.

Length of body, 11^{mm}; of cephalothorax, 5^{mm}; breadth of same, 2.2^{mm}; of abdomen, 6.4^{mm}; length of first pair of femora, 6^{mm}; second pair, 5^{mm}; second tibiæ, 4^{mm}; third femora, 2^{mm}; third tibiæ, 2.4^{mm}; fourth femora, 3.25^{mm}.

Besides its very much greater size, this species differs greatly from the other in the form of the cephalothorax.

Florissant. One ♀, No. 13521, preserved on a dorsal view.

2. THERIDIUM SECLUSUM.

Pl. 11, Fig. 20 (♂).

Male.—Cephalothorax stout, square oval, a little longer only than broad, the front broadly and regularly rounded. Cheliceres rather stout, as long as half the width of the corselet, tapering a little, rounded at the apex, the outer edge straight, the inner rounded. Last joint of palpi nearly as large as the cheliceres, oval, on a stalk as long as the cephalothorax. These two parts are incorrectly represented on the plate, where the palpi and cheliceres appear as one great piece. Abdomen rather small, oval, narrower than the cephalothorax, but of about the same length. Legs long and slender, the first pair particularly long, and the second pair considerably longer than the fourth, which is unusually slender: all the legs are furnished with numerous spines, apparently arranged in three rows and clustered much more numerously at the distal end of the femora and tibiæ than elsewhere; the spines are moderately slender and about as long as the width of the joints, separated from one another by about their own length, sometimes a little less.

Length of body, 4.5^{mm}; of abdomen, 2.25^{mm}; width of cephalothorax, 1.65^{mm}; of abdomen, 1.2^{mm}; length of cheliceres, 0.75^{mm}; of first pair of legs, 15^{mm}; its femora, 4.5^{mm}; tibiæ, 4.5^{mm}; tarsi, 6^{mm}; second pair of legs, 12^{mm}; femora, 3.75^{mm}; tibiæ, 3.75^{mm}; tarsi, 4.5^{mm}; third pair of legs, 5.25^{mm}; femora, 1.4^{mm}; tibiæ, 1.1^{mm}; tarsi, 2.75^{mm}; fourth pair of legs, 9^{mm}; femora, 3.5^{mm} (?); tibiæ, 1.5^{mm} (?); tarsi, 4^{mm}.

The species is very much smaller than T. opertaneum, besides having a very different corselet.

Florissant. Nos. 2286, 7816, 9026. All the specimens appear to be males.

LINYPHIA Latreille.

Two species of this genus have been described from Rott, and one (formerly considered two) species from amber. The single species we can here add to the number is tolerably nearly allied to the amber species, as well as to L. rottensis of the Rhenish brown coal, though it is much larger than the latter. The living species are found abundantly in all parts of Europe, excepting possibly the most southern, and several species are recorded from Georgia and from Chili. Its presence at Florissant would rather indicate a mean temperate climate. The species are lively and savage in character, constructing a rather complicated sheet of web, under the middle of which they lie in wait in an inverted position for their prey. (November, 1881.)

LINYPHIA RETENSA.

Pl. 11, Figs. 25, 27 (♂).

A single male and its reverse represent this species; the reverse was broken, and the posterior portion figured before its anterior half was found; hence the specimen is numbered three times; it is tolerably well preserved, especially the legs. The better preserved half shows a nearly uniform dusky figure upon the stone, but on the reverse the abdomen is much darker, almost black, and the palpi also are darker than the cephalothorax. The latter is regularly oval, the anterior extremity the more pointed; upon this some ocelli may be seen, of which there are apparently two approximate but independent ones next the middle, and on one side a pair of confluent eyes of the same size, all next the anterior edge. The last palpal joint is large, subcircular, or somewhat pyriform, furnished interiorly with a stout, strongly bent ribbon, and is perched on a stalk long enough to carry it by its own width beyond the margin of the corselet. Abdomen regularly obovate, a trifle broader in front than behind, somewhat longer than the corselet, and roundly pointed behind. Legs very long and slender, excepting the third pair, which are short, all the femora rather sparsely furnished with very delicate spines.

Length of body, 7.1^{mm}; of abdomen, 4^{mm}; breadth of cephalothorax, 2^{mm}; of abdomen, 2.15^{mm}; diameter of palpal swelling, 1^{mm}; length of first pair of legs, 19^{mm}; second pair, 15.5^{mm}; third pair, 6.9^{mm}; fourth pair, 14^{mm}; first pair femora, 6^{mm}; tibiæ, 7^{mm}; tarsi, 6^{mm}; second pair femora, 5^{mm};

tibiæ, 5.5^{mm}; tarsi, 5^{mm}[1]; third pair of femora, 2.5^{mm}; tibiæ, 2.4^{mm}; tarsi, 2^{mm}; fourth pair of femora, 4.5^{mm}; tibiæ, 4.5^{mm}; tarsi, 5^{mm}.

This species differs from L. cheiracantha in its considerably larger size, the absence of distant spines upon the legs, and its much more slender cephalothorax and longer legs.

Florissant. One ♂, Nos. 12976 and 13212 and 14032.

Suborder ORBITELARIÆ Thorell.

The symmetrical-web constructing spiders, though not rare in Tertiary deposits, are not so common as their abundance in recent times would lead one to anticipate, for, as we have seen, only 8 per cent of the European fossil spiders belong to this group, and all or nearly all of them are Epeirides. In this number are not included two or three species described by older authors under the name of Aranea, the precise location of which is and must probably always remain uncertain. Thirteen species are credited to amber, two to Rott, and one to Oeningen. In our own country the case is very different, for nearly one-half of our species (44 per cent) are to be referred to this group, and all also are Epeirides. It is the one considerable point in which the American fauna may be contrasted with the European. In Rott alone of all the European localities (where the Orbitelariæ form one-fourth of the known fauna) do we have any approach to the proportionate number of this great group. (November, 1881.)

Family EPEIRIDES Sundevall.

The genera of Epeirides represented in the European Tertiaries are Epeira (five species), of which two come from Rott and one from Oeningen, Græa (four species), Antopia (three species), Onca (two species), and Epeiridion and Siga (one species each). The American fauna is nearly as rich, richer for once than the amber, whence come all the European species except those specified above, embracing seven or more species of Epeira, four of an extinct genus, Tethneus, and one each of Tetragnatha and Nephila, genera before unknown in the fossil state. Not only, then, is the American fauna peculiar for its richness in species of this family, but no other shows so many novel forms for the Tertiary epoch. One of these latter genera predominates in America and the other is a tropical genus, which lends addi-

[1] The terminal part of the right tarsi as given in Fig. 27 does not belong to the tarsi.

tional interest to their discovery. The species are spread all over the globe in both temperate and torrid regions. (November, 1881.)

At Aix, Gourret found but a single member of this family, which he referred to a distinct genus called Cercidiella.

TETRAGNATHA Latreille.

This genus has never before been recognized in a fossil state. Although represented in every continent, it is only in America and particularly in the warmer parts of North America that it is at all abundant; here some species range north to New England, but it is essentially a genus of the Southern States; these spiders frequent the borders of ponds and hence it is not strange that we should find them in the lake deposits of Florissant, although their presence there certainly indicates a warmer climate than the present. The species here described does not appear to have special affinities with the American species with which I have been able to compare it, being stouter bodied than they. (November, 1881.)

TETRAGNATHA TERTIARIA.

Pl. 11, Fig. 11 (♂).

Tetragnatha tertiaria Scudder, Zittel, Handb. d. Paleont., I, ii, 744, Fig. 927 (1885).

A single male and its reverse represent the under surface of this species; as preserved, it is of a pale rusty color, the cephalothoracic appendages much darker than the abdomen, which is as pale as the legs, or than the cephalothorax, which is nearly as pale. The cephalothorax is circular or scarcely longitudinally oval, the exposed ventral portion between the bases of the mandibles and legs shield-shaped or heart-shaped. The mandibles are very large, longer than the cephalothorax, broader on the apical than on the basal half and thus formed of two parts, a basal, straight, equal piece, as broad as the third or fourth legs and about double the length of the coxæ, and an apical ovate portion, not unlike the apical joint of the palpi, somewhat longer than the basal portion and fully half as broad again as the front legs. Beyond these, and separated from them by a little space, and therefore supported by a long pedicel, which however is not preserved, are the apical palpal joints, a little smaller than the apical portion of the mandibles and of about the same shape, in the interior of which a strongly curved corneous thread can be made out, forming more than a complete

circle. The legs, of which only the third and fourth pairs are perfect, are very long, excepting the third pair; the femora and perhaps the tibiæ have a superior series of alternately diverging, slender, very distant spines, farther from one another than their own lengths. The abdomen is long obovate, subcylindrical, a little the largest at the base, as long as the cephalothorax and cheliceres together.

Length of body, 10^{mm}; of abdomen, 5^{mm}; breadth of cephalothorax, 2.5^{mm}; of abdomen, 2.3^{mm}; length of mandibles, 3.2^{mm}; breadth of the basal portion, 0.7^{mm}; of the apical portion, 1.3^{mm}; greatest diameter of last palpal joint, 1.25^{mm}; least diameter of same, 1.15^{mm}; length of femora of first pair of legs, 8.75^{mm}; of second, 7^{mm}; of third, 3.5^{mm}; of fourth, 7^{mm}; length of third pair of legs, 9.5^{mm}; of fourth pair, 18.5^{mm}.

Florissant. One ♂, Nos. 5000 and 5898.

TETHNEUS, gen. nov. (*Θνήσκω*).

Under this name are here grouped several evidently nearly allied species of spiders, which closely resemble in general aspect those placed under Epeira, but which differ also from them in certain features, and in these same characteristics appear to differ also from all other Epeirides, to which family they evidently belong. They are compact in form, with short and stout legs of not very unequal length, and in particular the first two pairs of legs are unusually heavy. The second and fourth pairs of legs are of nearly equal length, or the second pair may be slightly longer; the femora of the first and second pairs of legs are at base as broad as or even broader than half the width of the cephalothorax, and the longest legs are less, generally considerably less, than twice as long as the body. The species are of medium size.

Table of the species of Tethneus.

Cephalic and thoracic portions of the corselet separated by a distinct rectangular incision.
- Last palpal joint of male globose ..... 1. *T. guyoti.*
- Last palpal joint of male elongated ..... 4. *T. provectus.*

No line of demarkation between the two parts of the corselet.
- Smaller species, cephalothorax regularly obovate ..... 2. *T. obduratus.*
- Larger species, cephalothorax ovate, nearly pyriform ..... 3. *T. hentzii.*

1. TETHNEUS GUYOTI.

Pl. 11, Figs. 8 (♂), 10 (♀).

Cephalothorax roundly obovate, not much longer than broad, broadest behind the middle, the cephalic separated from the thoracic portion by a deep incision, reaching nearly to the middle of the whole section; and behind

it is a distinct, short, median furrow. The front is well rounded; nothing can be said of the eyes; the last palpal joint of the male is very large and globose, the basal joints evidently short. Abdomen a little larger than the cephalothorax and of the same general form, but more regularly obovate. Legs, especially in the male, rather short, the femora being also very stout; tibiæ and tarsi (but not the femora) furnished with a superior row of irregularly alternating, somewhat divergent, long and slender spines on either side.

Length of body, ♂ 7.75, ♀ 8.5mm; of cephalothorax, ♂ 3.5, ♀ 4.25mm; width of same, ♂ 3.8, ♀ 3.25mm; length of abdomen, ♂ 4.25, ♀ 4.25mm; width of same, ♂ 4, ♀ 3.5mm; diameter of last palpal joint, ♂ 1.4mm; length of first pair of legs, ♂ 12.75–12, ♀ 13.5mm; its tibia, ♂ 4.2–4mm; tarsi, ♂ 5.1–4.5mm; width of femora, ♂ 1.2–1, ♀ 0.8mm; second pair, ♂ 11.75–10.5, ♀ 14.25mm; its tibia, ♂ 4–3.25mm; tarsi, ♂ 3.75–3.75mm; third pair, ♂ 7.75–6.5, ♀ 8.5mm; its tibia, ♂ 2.5-2, ♀ 2.5mm; tarsi, ♂ 2.5–2.25, ♀ 3.5mm; fourth pair, ♂ 9.25–8, ♀ 12.75mm; its tibia, ♂ 3.25–2.5, ♀ 4mm; tarsi, ♂ 3-2.5, ♀ 4.25mm.

The second measurements of the legs of the male are of a smaller individual. It will be seen that the second pair of legs are proportionately longer in the female than in the male, where they are shorter than in the first pair.

The species is represented by four individuals, one of them in duplicate. All but one are males and, excepting one male, all are tolerably preserved.

Named for the late Prof. Arnold Guyot, to whose kindness I am indebted for the opportunity of studying the Princeton collection of Florissant insects.

Florissant. ♀, No. 320; ♂, Nos. 8265, 8311, and from the Princeton collection, one ♂, Nos. 1.808 and 1.854.

2. Tethneus obduratus.

Pl. 11, Fig. 31 (♀).

This species is represented by a single rather poor specimen, pretty certainly affiliated with the others of this genus, but smaller than any of them. The cephalothorax is of a very regular obovate form, nearly half as long again as broad, with a small, circular, dark, central spot; no line of demarkation of the cephalic and thoracic portions can be seen; the front is

strongly convex, but no certain trace of the eyes can be made out. The palpi (female) are stout and large, tapering apically, but bluntly pointed. The legs are very stout, but unfortunately hardly any of them perfect.

Length of cephalothorax, 3.6^{mm}: breadth, 2.7^{mm}; projection of palpi beyond front, 2^{mm}; their breadth, 0.4^{mm}; breadth of fore femora, 1^{mm}; length of femora of first pair of legs, 2^{mm}; tibiæ, 3^{mm}; femora of second pair of legs, 2.5^{mm}; tibiæ, 3^{mm}; tarsi, 3^{mm}; femora of third pair, 1.5^{mm}; tibiæ, 2^{mm}; tarsi, 2.5^{mm}; femora of fourth pair, 2.25^{mm}.

Florissant. One ♀, No. 7177.

3. Tethneus hentzii.

Pl. 11, Fig. 14 (♂).

Tethnæus hentzii Scudder, Zittel, Handb. d. Palæont., I, ii, 744, fig. 928 (1885).

This species is represented by seven individuals, one of them in duplicate and all of them males. About half of them are well preserved. The cephalothorax is short ovate, almost pyriform, broadest behind and strongly convex in front, with no demarkation between the cephalic and thoracic portions of the corselet; although there are traces of the eyes, their position and relations can not be satisfactorily determined. Palpi short, the terminal joint barely separated entirely from the front, very large and globose, a little longer than broad by reason of a broad bulbous protrusion of the anterior extremity, which, however, is not clearly apparent in all the specimens by their mode of preservation; in one specimen the upper anterior extremity, and that only, is covered with rather long and close bristly hairs, forming an open tuft. Abdomen nearly circular, a little longer than broad, only a little larger than the cephalothorax and of a lighter color than it, with a darker, broad, median patch not so deep in tint as the cephalothorax. Legs short, stout, tapering, spinous, and hairy throughout, of not greatly unequal length, the femora very stout and tapering more rapidly near the tip than elsewhere.

Length of body, 6.5^{mm}; width of same, 3^{mm}; length of cephalothorax, 3.5^{mm}; of abdomen, 3.25^{mm}; longer diameter of last joint of palpi, 1.4^{mm}; length of first pair of legs, 13.75^{mm}; its coxa, 1.4^{mm}; femur, 3.1^{mm}; tibia, 1^{mm}; first tarsal joint, consolidated with the tibia, 2.75^{mm}; the tarsus proper, 5^{mm}; length of second pair of legs, 11.5^{mm}; its coxa, 1.5^{mm}; femur, 2.7^{mm}; tibia, 1^{mm}; first tarsal joint, 2.3^{mm}; tarsus proper, 4^{mm}; length of third pair

of legs, 7.25^{mm}; its coxa, 0.75^{mm}; femur, 2^{mm}; tibia, 0.8^{mm}; first tarsal joint, 1 3^{mm}; tarsus proper, 2.4^{mm}; length of fourth pair of legs, 9.25^{mm}; its coxa, 0.75^{mm}; femur, 2.75^{mm}; tibia, 1^{mm}: first tarsal joint, 1.75^{mm}; tarsus proper, 3^{mm}.

Named for the American arachnologist, the late Prof. N. M. Hentz.

This species differs from T. guyoti in wanting any distinct demarkation of the thoracic and cephalic portions of the corselet, in the spiny character of the femora, and in the longer and more tapering legs. It is also smaller.

Florissant. Seven ♂, Nos. 1226, 1447, 3860, 6600, 8533 and 8635, 8689, 14982.

4. Tethneus provectus.

Pl. 11, Fig. 21 (♀).

Four specimens, one of them in duplicate and all of them tolerably preserved, represent both sexes of this species. Cephalothorax of female (that of the male too vague for determination of form) rounded subquadrate, broadest and subangulated behind the middle, the rapidly narrowing front almost straight anteriorly, and scarcely more than one-fourth the width of the posterior portion; cephalic separated from the thoracic portion of the corselet by a rectangular incision and by the slightly concave curve of the sides of the anterior half; the cephalic is also distinctly darker than the thoracic region. Nothing can be said of the eyes. The last palpal joint of the male is large, rounded quadrate, about twice as long as broad; the palpi of the female are as stout as the base of the front tarsi, hairy, tapering only on the apical half of the terminal joint, rather bluntly pointed, extending nearly as far beyond the front as the whole length of the cephalothorax. Abdomen as dark as the cephalic portion of the corselet, in the female plump, rounded, slightly ovate, considerably larger than the cephalothorax, the apex almost angulated; in the male rounded subfusiform, much longer than the cephalothorax, but not greatly broader. Legs very hairy but without conspicuous spines, the femora very stout, and at the tip rapidly tapering, the rest of the legs diminishing in size less noticeably than in the preceding species.

Length of body, 6.5^{mm}; of cephalothorax, 3^{mm}; of abdomen, 3.5^{mm}; breadth of cephalothorax, 2.8^{mm}; of abdomen, 3.1^{mm}; extension of palpi

beyond front, 2.2^{mm}; length of first pair of legs, 9.25^{mm}; its tibia, 3.25^{mm}; tarsi, 2.4^{mm}; second pair of legs, 8^{mm}; its tibia, 2.75^{mm}; tarsi, 2.4^{mm}; third pair of legs, 5.5^{mm}; fourth pair of legs, 7^{mm}; its tibia, 2.3^{mm}; tarsi, 2.3^{mm}. The measurements are all taken from the female.

This species is of about the same size as the last, but differs from it in its slenderer form, the shape of the cephalothorax, slightly slenderer and less tapering legs, as well as in the clothing of the same.

Florissant. One ♂, three ♀, Nos. 8141, 13519 and 13522, 13524 (♀), 14991 (♂).

EPEIRA Walckenaer.

Only a very few species have been described in a fossil state under this generic name. Heyden figured a Gea krantzii from the Miocene beds of Rott on the Rhine which Thorell considers an Epeira and which is about the size of E. delita, but which does not resemble any of our species. Heer figures an Epeira molassica from Oeningen, considerably larger than any of the Florissant Epeiræ, but perhaps more nearly resembling E. delita than any of the others. Menge names but does not describe an E. eogena from amber, three millimeters long, or of about the size of our smallest species; and finally Bertkau has more recently described and figured a second species from Rott, under the name of E. tröschelii, which bears no small resemblance to our E. meekii, with which also it agrees very well in size.

Seven species are here described and others indicated, this genus being the only one represented on both continents in Tertiary times which is richer in species in America. The genus is found in all parts of the world, and its occurrence in such numbers in the Florissant beds is a point of no significance beyond the comparison just made with the European Tertiaries. (October, 1881.)

Table of the species of Epeira.

Cephalic distinctly separated from the thoracic part of the cephalothorax.
- Large species; front of cephalothorax excised in the male ..... 1. *E. meekii.*
- Small species; front of cephalothorax regularly convex in the male ..... 2. *E. abscondita.*

Cephalic and thoracic portions of the cephalothorax completely blended.
- Abdomen narrowed in front and behind.
  - Abdomen distinctly ovate ..... 3. *E. delita.*
  - Front of abdomen quadrate, as broad as in the middle ..... 4. *E. cinefacta.*
- Abdomen nearly globular.
  - Larger species; abdomen smaller than cephalothorax ..... 5. *E. vucanalis.*
  - Smaller species; abdomen larger than cephalothorax ..... 6. *E. emertoni.*

1. Epeira meekii.

Pl. 11, Figs. 2 (♀), 17 (♂).

Cephalothorax of the male large, the thoracic portion nearly circular, scarcely longer than broad, and distinctly separated from the cephalic portion, which is subquadrate, expanding anteriorly, the sides scarcely curved, at the extreme front parallel, the front deeply and angularly incised, the whole about half as large as the thoracic portion. Cephalothorax of female moderately large, compact, the thoracic portion as in the male, but only a little larger than the square thoracic portion, the latter being equally broad in front and behind, with scarcely convex sides and a slightly excised front, and sparsely furnished, especially along the front, with stiff bristles resembling those of the palpi. The cephalothorax is marked by a rather broad, dark, median band and two fainter, dark, extreme lateral bands. Abdomen globular, scarcely longer than broad, a little shorter (♂) or a little longer (♀) than the cephalothorax, the median portion very broadly marked with brown, deepening toward the middle. Some of the eyes can be seen at the edge of the front in the female, showing simply that they are of the usual size and the two outer separated by their own diameter. The palpi of the female are tolerably stout, stouter than the tarsi, as long as the cephalothorax, abruptly terminated, and furnished somewhat abundantly with bristles, considerably longer than the width of the palpi; those of the male have the apical portion large, hemispherical, and hairy, convexity forward, together nearly as large as the cephalic portion of the cephalothorax, and separated from that by a peduncle as long as it; from the inner edge of one projects a gently subfusiform, slender, arcuate ribbon, as long as the width of the terminal joint and directed forward, with the convexity inward. The tibiæ are armed above on either side with a row of distant bristles, scarcely longer than the width of the tibia and farther apart than their length; in the female a few scattered bristles also occur on the femora, especially on the front pair. The fourth pair of legs is shorter than the second in the male, equal to or scarcely longer than the second in the female; the third pair of legs is not perfectly preserved in either of the male specimens, but in the female is half the length of the first.

Length of body, ♂ 7^{mm}, ♀ 8^{mm}; of cephalothorax, ♂ 2.8^{mm}, ♀ 3.5^{mm}; of abdomen, ♂ 4.2^{mm}, ♀ 4.5^{mm}; width of same, ♂ 3^{mm}, ♀ 4.2^{mm}; length of first

pair of legs, ♂ 16.5mm, ♀ 14mm; tibiæ, ♂ 5mm, ♀ 4mm; tarsi, ♂ 5mm, ♀ 5.75mm; second pair of legs, ♂ 15mm, ♀ 12.75mm; tibiæ, ♂ 3.25mm, ♀ 2.5mm; tarsi, ♂ 6mm, ♀ 5.5mm; third pair of legs, ♀ 7mm; tibiæ, ♀ 1.75mm; tarsi, ♀ 3mm; fourth pair of legs, ♂ 12mm, ♀ 13mm; tibiæ, ♂ 3.5mm, ♀ 3.5mm; tarsi, ♂ 4.4mm, ♀ 5mm; length of palpi, ♂ 1.75mm, ♀ 2.1mm.

This species is readily distinguished from the others of the genus here described by its considerably larger size. It is named after the late Mr. F. B. Meek, much of whose paleontological work was done in conjunction with Dr. Hayden. It resembles in general appearance as well as in size the less well preserved E. tröschelii Bertkau from Rott on the Rhine, but has proportionally longer legs and especially much longer hind legs; the disproportion of size between the cephalothorax and abdomen is also greater.

Florissant. Three specimens; two ♂, Nos. 9211, 8221, one ♀, No. 3204.

2. Epeira abscondita.

Pl. 11, Fig. 7 (♂).

Male.—Cephalothorax subrotund, the cephalic portion hemispherical, almost black, about half the size of the thoracic part and separated from it in the lateral outline by a distinct incision; front broadly and regularly rounded; thoracic portion with well rounded sides, the middle half very much darker than the rest, forming a broad, median, dark brown band. Abdomen subrotund, longer than broad, scarcely compressed, of the same size as the cephalothorax, with faint indications of a broad median band, deepest in tint at the extremities of the segments. The eyes can not be seen. The palpi are sessile, the terminal joint appearing just beyond the front, large and globose, perhaps a little broader posteriorly than anteriorly. The legs are stout, especially the femora, not very long, the tibiæ furnished with distant, widely divergent, delicate bristles, considerably longer than the width of the tibia, situated on either side. They are not completely preserved, but have been worked out of the stone since the plate was engraved, so that they are more perfect than would there appear. The fourth pair, though not completely preserved, is apparently longer than the second, as the basal joints are longer.

Length of body, 4.25mm; of cephalothorax, 2mm; of abdomen, 2.25mm; width of same, 1.8mm; length of first pair of legs, 11.25mm; tibiæ, 3mm; tarsi, 4.6mm; second pair of legs, 9.75mm; tibiæ, 2.5mm; tarsi, 3.4mm; third pair of

legs (broken), 5.5^{mm}; fourth pair of legs (broken), 8^{mm}; of part previous to tibia, 3.2^{mm}; diameter of palpi, 0.45^{mm}.

This species differs from E. meekii in size, in the shape of the cephalothorax, the stouter femora, and more sparsely armed tibiæ.

Florissant. One ♂, No. 7583.

3. Epeira delita.

Pl. 11, Fig. 6 (♂ ?).

Cephalothorax rounded obovate, the cephalic and thoracic portions completely blended, the sides uniformly rounded, the front very convex, with no eyes that can be seen; neither are the palpi preserved, the part figured between the front legs having no relation to the spider; it is judged to be a male from the small size of the abdomen which is ovate, no larger than the cephalothorax, largest in front of the middle, but here slightly narrower than the cephalothorax, tapering slightly behind, and well rounded at the extremity. The legs have very stout femora, those of the front pair tapering in the middle, and both femora and tibiæ and even the basal part of the tarsi, but especially the tibiæ, armed with very long, very distant, delicate, divergent spinules considerably longer than, sometimes almost twice as long as, the width of the tibiæ; the basal joint of the tibiæ tapers perceptibly. The second pair of legs is represented too long in the plate, though it is unusually long, not greatly falling behind the first pair and exceeding the fourth in length nearly as much as that exceeds the third pair.

Length of body, 4.75^{mm}; of cephalothorax, 2.25^{mm}; width of same, 2^{mm}; length of abdomen, 2.5^{mm}; of first pair of legs, 11.5^{mm}; tibiæ, 3.5^{mm}; tarsi, 5^{mm}; second pair of legs, 9.8^{mm}; tibiæ, 3.25^{mm}; tarsi, 4.2^{mm}; third pair of legs, 7.5^{mm}; tibiæ, 2^{mm}; tarsi, 2.5^{mm}; fourth pair of legs, 9^{mm}; tibiæ, 2.25^{mm}; tarsi, 3.75^{mm}.

This species agrees well with E. abscondita in size, but is readily distinguished both from it and from E. meekii in the uniform character of the cephalothorax and the relative length of the legs.

Florissant. One ♂, No. 13523.

4. Epeira cinefacta.

Pl. 11, Fig. 16 (♂).

Male.—Cephalothorax globose, blackish, the dividing line between it and the abdomen concealed by the overhanging quadrate front of the

abdomen, and the cephalic and thoracic portions completely blended; possibly it is slightly longer than broad. The eyes can not be made out; the terminal joint of the palpi (as preserved, sessile) is moderately large, globular or slightly ovate, black, but none of the internal structure can be made out. Abdomen subquadrate, tapering very slightly from in front backward, the front straight with well rounded lateral angles, the posterior extremity well rounded, the whole nearly twice as long as broad, the sides nearly straight. Legs closely resembling those of E. delita, the second pair being unusually long, but even more than in that species exceeding proportionally the extent of the fourth pair; the femora are only moderately stout, and, like the tibiæ, though to a less extent, are furnished with delicate spinules, less divergent but more abundant than usual, exceeding in length the width of the tibiæ.

Length of body, 3^{mm}; width of cephalothorax, 1^{mm}; length of abdomen, 2.25^{mm}; its width anteriorly, 1.65^{mm}; posteriorly, 1.2^{mm}; diameter of last palpal joint, 0.35^{mm}; length of first pair of legs, 9^{mm}; tibiæ, 2.9^{mm}; tarsi, 4^{mm}; second pair of legs, 8^{mm}; tibiæ, 2.1^{mm}; tarsi, 3.5^{mm}; third pair of legs, 4.85^{mm}; tibiæ, 1.3^{mm}; tarsi, 2.1^{mm}; fourth pair of legs, 6.5^{mm}; tibiæ, 2^{mm}; tarsi, 2.5^{mm}.

This species differs from all others of the genus here described in the shape of the abdomen, which is elongate, and the sides of which are not rounded but subparallel. In the characteristics of the legs, however, it resembles the preceding. A single male, represented by both obverse and reverse, is better preserved than the figure in the plate would indicate, as the form of the whole abdomen can be seen as well as of the last palpal joint. The figure morever indicates the shape of the body altogether wrongly, as the cephalothorax should be smaller and the abdomen should taper considerably behind, as the measurements show.

Florissant. One ♂, No. 8576 and 8806.

5. Epeira vulcanalis.

Male.—Cephalothorax nearly globular, scarcely longer than broad, the cephalic and thoracic portions completely blended, but marked by a large semicircular depression anteriorly, occupying a little more than the front, i. e., encroaching upon the lateral margin, and of a darker brown than the thoracic portion. Front somewhat convex, with insufficient trace of eyes. Cheliceres stout, as long as the cephalic portion of the corselet, tapering, bluntly rounded at the tip. Last joint of palpi very large, nearly as large

as the cephalic part of the corselet, blackish, globular, its proximal end as preserved lying just beyond the tip of the cheliceres, the stalk not preserved. Abdomen lighter colored than the cephalothorax, smaller than it, subglobular, a little flattened at base, with a pair of subdorsal series of black points in a slightly curving row, its convexity outward; the anal plate darker, circular, not half so large as the apical joint of palpi. Legs long, of very unequal length, the femur much stouter than the tapering parts beyond, furnished rather abundantly with diverging spines nearly to the tip.

Length of body, 3.5^{mm}; of cephalothorax, 1.7^{mm}; of abdomen, 1.5^{mm}; of cephalic portion of corselet, 0.6^{mm}; of cheliceres, 0.65^{mm}; breadth of cephalothorax, 1 6^{mm}; of abdomen, 1.6^{mm}; diameter of palpal swelling, 0.65^{mm}; length of first pair of legs, 7.25^{mm}; femora, 2^{mm}; tibiæ, 2^{mm}; tarsi, 3.25^{mm}; second pair of legs, 6^{mm}; femora, 1.4^{mm}; tibiæ, 2^{mm}; tarsi, 2.6^{mm}; third pair of legs, 2.9^{mm}; tarsi, 1.4^{mm}; fourth pair of legs, 4.7^{mm}; femora, 1.65^{mm}; tibiæ, 1.25^{mm}; tarsi, 1.8^{mm}.

This species resembles E. emertoni in general aspect, but is much larger than it, and differs from it in several important points, such as the rotundity and especially the much greater size of the cephalothorax as compared with the abdomen, and the greater stoutness of the femora.

Florissant. One ♂, No. 5784.

6. Epeira emertoni.

Pl. 11, Figs. 15 (♂), 19 (♀).

Male.—Cephalothorax dark brown, subglobose, a little longer than broad, the cephalic only distinguished from the thoracic portion by a slight bend in the curved outline; front well rounded with no sign of eyes; last joint of palpi blackish, very large, globular, more than half as large as the cephalic portion of the cephalothorax, nearly twice as broad as the length of the basal joints, containing a falcate ribbon of slender and uniform width, nearly as long as the diameter of the joint, bent at its distal edge, bluntly pointed at the tip, which is situated near the middle. Abdomen light brown, globular, slightly larger than the cephalothorax. Legs moderately long, rather sparsely haired, the femora tolerably stout and furnished with distant, slender, divergent spinules, hardly so long as the width of the joint, and which also appear in one or two places only on the tibiæ.

Female.—Cephalothorax black, globular, with no sign of distinction between the cephalic and thoracic portions; neither eyes nor palpi are pre-

served. Abdomen dark brown, especially in a very broad median band occupying fully half the width of the dorsal aspect, short ovate, nearly half as broad again as the cephalothorax, and only about one-third as long again as broad. Legs apparently rather short (they are not well preserved and mostly bent beneath the body), sparsely haired, with slight trace of spinules.

Length of body, ♂ 2.25mm, ♀ 3.75mm; of cephalothorax, ♂ 1mm, ♀ 1.35mm; width of same, ♂ 0.9mm, ♀ 1.3mm; length of abdomen, ♂ 1.25mm, ♀ 2.4mm; width of same, ♂ 1mm, ♀ 1.8mm; diameter of last palpal joint, ♂ 0.35mm; length of first pair of legs, ♂ 4.65mm, ♀ 3.25mm (plus tarsi); tibiæ, ♂ 1.5mm, ♀ 1mm; tarsi, ♂ 1.75mm; of second pair of legs, ♂ 4.2mm, ♀ 2 6mm (plus tarsi); tibiæ, ♂ 1.3mm, ♀ 0.8mm; tarsi, ♂ 1.75mm; of third pair of legs, ♂ 2mm; of fourth pair of legs, ♂ 3.25mm.

It is possible of course that this ♂ and ♀ do not belong together, in which case the male as the most perfectly preserved should be considered the type of the species. It is smaller than any other of the species referred here to Epeira, excepting perhaps the one to which no name is given, and it differs from all in the globular or nearly globular form of the cephalothorax as well as in other characteristics, as will appear on comparing the descriptions. The species is named for Mr. J. H. Emerton, whose papers on North American Arachnidæ have been of much assistance to the writer.

Florissant. One ♂, one ♀, Nos. 8777, 5117.

A single specimen, apparently a female, which is also provisionally referred to this species, is considerably smaller than the other female and has more densely hairy legs (almost the only parts preserved), the lengths of which are as follows: first pair, 3.5mm; second pair, 3.25mm; third pair, 1.7mm; fourth pair, 3.25mm.

Florissant. One ♀, No. 10998.

Epeira sp.

Pl. 11, Fig. 1.

A single specimen, figured in Pl. 11, Fig. 1, is the only representative of a species apparently of Epeira, certainly distinct from the others, but too poorly preserved to indicate more. The outlines of the body are almost altogether obliterated, and it can only be said that it is one of the smallest species, being larger only than the smallest specimen referred to E. emertoni, but clearly distinct from that in the much greater stoutness of the femora, which are indeed unusually robust, and the length of the third pair

of legs, which appear nearly to equal the fourth. It is impossible to say to what sex it belongs.

Length of first pair of legs, 5.5^{mm}; of third pair, 7^{mm}; tibia, 2^{mm}; tarsi, 2.5^{mm}; of femora and tibia of fourth pair, 4^{mm}; width of its femora, 0.7^{mm}; length of its tibia, 2^{mm}.

Florissant. No. 9285.

Epeira sp.

Several specimens represent legs of the same or allied species of spider of about the size of Epeira riparia Hentz; the femora and tibiæ and the sides of the tarsi are abundantly supplied with longitudinal rows of fine, long, black spines, the claw double. Another preserves the spines alone of the same sort of leg.

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

Green River, Wyoming. Nos. 3, 4^{a}, 36, 4199, 4200.

Epeira sp.

Still another, from the same locality as the last, shows the hairy, subfusiform, ovate body of a spider apparently a little smaller than the above.

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

Green River, Wyoming. No. 63.

Nephila Leach.

This interesting tropical genus has never before been found fossil, and although the species here described differs considerably from any with which I have been able to compare it, it is interesting to see some special points of comparison with a common species of our Southern States, as will be noticed further on. Its presence at Florissant decidedly indicates a warmer climate than the present, though not necessarily one much warmer

Nephila pennatipes.

Pl. 11, Fig. 12.

Nephila pennatipes Scudder, Zittel, Handb. d. Palæont., I, ii, 744, Fig. 926 (1885).

Cephalic portion of corselet square, with rounded angles, the front margin slightly excised in the middle; two eyes only can be made out, situated posterior to the front margin by nearly their own diameter, of moderate size, less than one-fourth the width of the terminal joint of the palpus, and placed rather nearer the middle line than the outer edge of the body. Palpi stout, not very long, bluntly rounded at tip and extending in

front of the body by a little more than half the width of the front of the corselet. (These organs are incorrectly given in the plate, which was drawn before the specimen had been properly prepared.)

The first pair of legs are the longest, the third the shortest, and the second and fourth of equal length, moderately slender, the first and fourth, and to a less degree the second, furnished at the extremity of the tibiæ with a brush of coarse divergent hairs, giving this portion of the leg the appearance of being about half as broad again as it should be; all the joints of the legs can not be made out, but, to judge by analogy, the brush would appear to occupy about half (the distal half) of the tibia; there appears to be no such brush on the third pair of legs, nor any marked increase of hairiness or stoutness of the hairs at the tips of the femora. The legs have also been worked out of the stone since the plate was drawn, so that they are nearly complete, with the exception of the appendages. With this omission the tarsi compose scarcely less than two-fifths of the whole leg.

The thoracic portion of the cephalothorax is subglobular, a little broader than the corselet and just equaling the width of the abdomen at its greatest at the end of the basal third; the abdomen is oblong ovate, about two and a half times longer than broad, with well rounded apex.

Length of body, 14^{mm}; of abdomen, 8.5^{mm}; width, 3.7^{mm}; length of palpi beyond the front of body, 2^{mm}; length of first pair of legs, 26^{mm}; first tarsal joint, 8.25^{mm}; second joint, 2.25^{mm}; of hair-tuft, 3.5–3.75^{mm}; second pair of legs, 23^{mm}; first tarsal joint, 7.25^{mm}; second joint, 2.25^{mm}; of hair-tuft, 2.5^{mm}; third pair of legs, 13.5^{mm}; first tarsal joint, 4.5^{mm}; second joint, 1.5^{mm}; fourth pair of legs, 23^{mm}; first tarsal joint, 7^{mm}; second joint, 2^{mm}; of hair-tuft, 4.5^{mm}; diameter of eyes, 0.12^{mm}.

The general resemblance of this spider to Nephila plumipes Koch of our southern Atlantic sea-board, familiar to us by the researches of Wilder, will strike every American naturalist at a glance. It is, however, a much smaller species, if the fossil be fully grown, and differs from it in some striking points, very probably of generic importance. The eyes differ considerably, although the position of only two of those of the fossil species is known; the corselet is squarer in the fossil, and per contra the abdomen is oval and not quadrate; while the tarsi are unusually long in proportion to the whole leg; the tufts of hairs occur only on the extremity of the tibiæ. Nephila is essentially a tropical genus.

Florissant. One ♀, No. 11651.

NEUROPTERA Linné.

Using this term in its large sense, as, for convenience, we have done here, there is no group of fossil insects more interesting. In no other, unless it be the cockroaches among Orthoptera, do we find a considerable representation in all the rocks which have yielded fossil remains Still the time has, perhaps, not yet come for a careful historical survey of the group, since we are annually receiving large additions to our knowledge of the extinct types, and a considerable number of those known have been insufficiently studied. Such a study, too, belongs essentially to the student of the older types, and would be less appropriate here, for it may certainly be stated with confidence that the types of existing Neuroptera were thoroughly established at the beginning of the Tertiaries. With a single exception, Ballostoma, no large group existed then and has since expired, nor is there a single existing type of any prominence which has not been found in the Tertiaries, unless we look upon the aberrant and until lately hardly known Scolopendrella as belonging here. Yet a large proportion of the genera of Tertiary Neuroptera are extinct; that is, differentiation has gone on with the lapse of time, until the original characteristic features of an early group have been lost and new ones taken their place, and no species referred to in the following pages exists at the present time. The differences between the Tertiary and existing forms are never very great, usually rather small, but they are constant and everywhere found.

The number of known Tertiary Neuroptera is considerable. For the sake of graphic comparison I have presented the facts as far as possible in the following table, where, in the European columns, the numbers at the right are the real total, the others representing those known from the rocks alone (excluding the amber) for the sake of comparing more fairly the yield of the European and American rocks. The numbers on the American side represent with a single exception (Phryganea hyperborea from Greenland) the result of my own studies only, and therefore the numerical estimate is presumably more correct than in the European; in the latter I have endeavored to give a fair statement of the numbers, including a considerable proportion of mere indications, the value of which had to be weighed, sometimes in a somewhat summary manner.

Tabular statement of the known species of Tertiary Neuroptera.

		European.			European.	
	American.	Excl. amber.	Incl. amber.	American.	Excl. amber.	Incl. amber.
Ballostoma	1					
Lepismatidæ (Cinura)	1	0	18			
Poduridæ (Collembola)	0	0	10			
Thysanura				2	0	28
Termitina				6	10	16
Embidina				0	0	1
Psocina				1	0	13
Perlina				0	1	11
Ephemerina				6	1	7
Agrionidæ	8	9	10			
Calopterygidæ	0	1	2			
Agrionina	**8**	**10**	**12**			
Gomphidæ	0	3	5			
Æschnidæ	2	4	5			
Æschnina	**2**	**7**	**10**			
Cordulidæ	0	2	2			
Libellulidæ	1	15	15			
Libellulina	**1**	***17**	**17**			
Odonata				11	34	39
Sialidæ	0	1	2			
Raphidiidæ	4	0	1			
Sialina	**4**	**1**	**3**			
Hemerobidæ	2	1	8			
Chrysopidæ	4	0	0			
Hemerobina	**6**	**1**	**8**			
Ascalaphina	0	2	2			
Myrmeleontina	0	1	1			
Coniopterygidæ	0	0	1			
Panorpidæ	2	1	4			
Planipennia				12	6	19
Hydroptilidæ	0	0	2			
Rhyacophilidæ	0	0	2			
Hydropsychidæ	17	0	16			
Leptoceridæ	2	0	5			
Sericostomidæ	0	0	4			
Limnophilidæ	†2	†2	3			
Phryganidæ	4	†5	8			
Trichoptera				25	7	40
Total				63	59	174

Grand total, 237.

* This number is largely made up of larvæ, which may be the same as some of the imagos.

† Including larval cases.

This table brings to light some curious discordances when the species from the American and European rocks are compared. This indeed is marked in every instance where the numbers are considerable on either side, excepting in the Termitina, where we have six American to ten European species. Europe shows a decided superiority in the Odonata, where thirty-four species are offset by only eleven species in America; and it is not a little curious (though not unexpected, considering the nature of the deposit) that it is here only that the amber fauna adds scarcely at all to the European preponderance. The American Thysanura find no counterpart in the European rocks, though the amber fauna counts no less than twenty-eight species, while the American representatives of the Ephemerina (six species), the Planipennia (twelve species), and the Trichoptera (twenty-five species) far outweigh the European examples, Ephemerina (one species), Planipennia (six species), Trichoptera (seven species). This American preponderance is in every instance counterbalanced when the total Tertiary yield of Europe is brought to view, the Ephemerina showing seven species, the Planipennia nineteen species, and the Trichoptera forty species.

If the smaller groups are considered, there are some closer correspondences, as when we find eight species of American Agrionina to ten in the European rocks, two American to one European Hemerobidæ and Panorpidæ, two American to two European Limnophilidæ, and four American to five European Phryganidæ. The discrepancies, however, are not less marked, for we find of groups unrepresented in European rocks four species each of Raphidiidæ and Chrysopidæ, seventeen of Hydropsychidæ, and two of Leptoceridæ in American strata, which in the first two instances are hardly or not at all represented in amber. On the other hand, the European rocks show species of Calopterygidæ (one), Gomphidæ (three), Cordulidæ (two), Sialidæ (one), Ascalaphina (two), and Myrmeleontidæ (one), where the American rocks are wholly destitute. On the whole, the European rocks, as compared with the American, are rich in Odonata and poor in Ephemerina, Planipennia, and Trichoptera. While, if the entire Tertiary yield of Europe is considered, America nowhere shows a considerable preponderance of forms excepting in the small planipennian groups of Raphidiidæ and Chrysopidæ, while Europe has a very striking preponderance in Thysanura, Psocina, Perlina, Æschnina, Libellulina, and Hemerobidæ, having in none of these cases less than four times as many species as America. (February, 1884.)

Order THYSANURA Latreille.

All we have hitherto known of fossil Thysanura has been derived from inclusions in amber,[1] of which about eighteen species of six or seven genera of Lepismatidæ and ten species of four genera of Poduridæ are known; among them are some very remarkable forms. Florissant has yielded two species of this group, the first that have been found in rock deposits, and one of them in considerable numbers, representing a species of exceptional interest.

Suborder BALLOSTOMA Scudder.

For characters see under the single species, at the end.

PLANOCEPHALUS Scudder.

PLANOCEPHALUS ASELLOIDES.

(See figures in text below.)

Planocephalus aselloides Scudd., Mem. Nat. Acad. Sciences, III, 85–90 Figs. (1885); in Zittel, Handb. Palæont., I, ii, 772, Fig. 972 (1885); Bertk., Sitzungsb. niederrh. Gesellsch. Natur. u. Heilk., 1885, 298 (1885).

Among the remains of animals in my hands found in the ancient lake basin of Florissant are about forty specimens of an onisciform arthropod, about a centimeter in length, whose affinities have proved very perplexing. This does not result from poorness of preservation, for among the numerous specimens apparently all the prominent external features are found completely preserved, and even the course of some of the internal organs may occasionally be traced; but it presents such anomalies of structure that we are at a loss where to look for its nearest kin.

It appears to be an aquatic animal. Its body consists of three large subequal thoracic joints, and an abdomen about half as large again as any one of them, with occasional indications of a feeble division into four segments. These are the only jointed divisions that can be found in the body, there being no distinct head. The thoracic segments are so considered because each bears a pair of legs, which occur nowhere else. Their dorsal plates are large, flat longitudinally, and arched transversely, smooth, and deeply and narrowly notched in the middle of the front margin. The first plate, in which the median notch is more conspicuous and open than in the

[1] Since this was written Brongniart has described a species from the Carboniferous deposits of Commentry, France.

others, also narrows and becomes more arched in front, so as to form a sort of hood. The legs are very broad and compressed, and adapted to swimming, which was apparently their use, as there would be no need of such compression to crawl into chinks when the body is so much arched. They consist of a femur, tibia, and two tarsal joints, terminated by a single curved claw. The femur is very large, subovate, inserted (presumably by a coxa) in large cavities, those of opposite sides separated by their own width, and situated a little behind the middle of each segment. The tibia is also very large and subovate, but more elongated and squarer at the ends, being about twice as long as broad, and fringed on the anterior edge by a row of delicate hairs as long as the width of the joint. Of the two tarsal joints, the

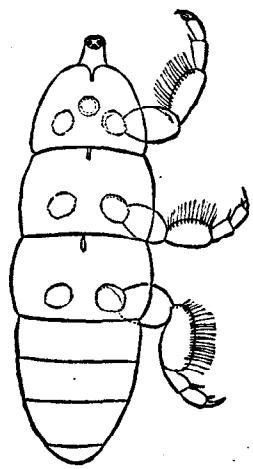


Fig. 1.

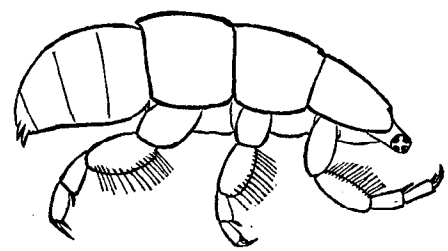


Fig. 2.

Fig. 3.

Fig. 1, dorsal view; Fig. 2, lateral view; Fig. 3, transverse sectional view of Planocephalus aselloides from the Oligocene of Florissant, Colorado, restored, and magnified about six diameters.

basal is a little the larger, being both longer and stouter. Each is armed at the tip internally with a tolerably stout spine of moderate length, and together they are a little longer than the tibia, much slenderer, and quadrate in form. The terminal claw is about half as long as the terminal joint. The hind legs are somewhat stouter and the middle pair a little shorter than the others; but otherwise they closely resemble each other.

The different segments of the thorax, as stated, are protected above by the development of distinct chitinous plates, the lower edges of which are clearly marked, and extend downward to the concealment, on a side view, of the lower part of the body. The abdomen, however, seems to have no such specialization of the integument of the upper surface. It is stout, apparently well rounded transversely, and tapers to a produced but blunt tip, which is armed with a pair of slightly recurved stout claws, two or

three times as long as the leg-claws, arranged as if to drag the body backward. The abdomen is faintly divided into four segments, often entirely obscured. Of these the terminal usually appears shorter than the others, which are subequal.

These divisions of the body are all that appear to have belonged to the animal; and it is the most remarkable fact in its organization that it certainly had no distinct chitinous head. This is the more surprising from the clearness with which the thoracic segments are marked. All that one can find preserved is what appears to be a ring of buccal plates terminating anteriorly the alimentary canal, and which was evidently capable of being thrust forward a long distance beyond the body. If it were not for the unusual preservation of the alimentary canal we should be forced to consider the head as lost from all the specimens, notwithstanding the nearly perfect preservation of the other parts; but in several specimens the alimentary tube can be traced with ease half through the body, terminating in front in these more or less clearly preserved chitinous plates, arranged to form a circle a little smaller than the coxal cavities. What is most remarkable is the extension of this alimentary tube and accompanying buccal plates like a proboscis far beyond the limits of the body; sometimes forward (apparently through the anterior notch) to a distance in front of the first segment equal to half the length of the latter; more often directed downward as well as outward, perhaps between the front legs, and occasionally extending beyond the body to nearly or quite *the entire length of the same.* It seems to leave its direct course within the body at about the middle of the first thoracic segment, directly in front of which position the buccal plates appear in one or two specimens, apparently in the position of repose. The various positions in which these buccal plates are found outside the body, both when their connection with the tube is traceable and when it is obscure or fails, shows how perfectly movable a proboscis the creature possessed. The external parts of the head, then, may be said to have been probably composed entirely of a flexible, extensible membrane capable of protrusion as a fleshy proboscis, separated by no line of demarkation from the first thoracic segment, and bearing as appendages only a series of buccal plates for mouth-parts, and beyond this nothing—neither cranium, eyes, antennæ, nor palpi. In the absence of eyes, one would naturally look for the development of tactile organs of some sort; but nothing of the kind is

discoverable on the most careful special search, unless such an office may be performed by long delicate hairs which seem, in some few instances, to be scattered distantly over the projected mouth-tube.

A special study of the buccal plates in the twenty-four or twenty-five specimens which best show them gives no very satisfactory explanation of their form and relations. They have been said to form a ring, because in a considerable number they are so arranged; but it may be doubted whether this appearance is not due to the flaking of the chitinous parts. Like the lips of the notches of the thoracic segments, the buccal apparatus was evidently more dense and thicker than other tegumentary parts, for these are darker colored than the other parts and often carbonaceous. In this condition the central portions seem liable to flake away and leave the thinner edges with ragged fragments of the carbonaceous inner portions attached, thus frequently forming a sort of irregular ring of dark chitine. On the other hand, it is just as common for fragments to become chipped out from the edges, or for rounded bits to fall out here and there, producing thereby an almost endless variety of present appearances. Among these it is difficult to trace the clew to the original arrangement and form of the plates. One might anticipate that these would have occurred around the central orifice of a proboscis; and if anything of this sort was present it would appear the most probable (though extremely doubtful) that there were four subtriangular plates of pretty large size, the lateral the larger, nearly meeting by their tips at the center. From specimens, however, which are least broken, it would seem quite as probable that the apparatus consisted of two attingent or overlapping circular plates, placed transversely, densest centrally, which by their consolidation form an oval rounded mass. How such a pair of plates, or compound plates, could have subserved any purpose in the procuring of food I can not understand, but that such is their not unfrequent appearance, especially when seen through and protected by the thoracic shield of the first segment, is nevertheless the fact. It is to be hoped that other specimens may set this matter at rest. Those at hand allow no more definite statement than has been made. About three-fourths of the specimens of this species show the buccal plates more or less distinctly. In all but three they lie outside the body, usually at a distance from it of about half the length of the first thoracic segment. In a fourth specimen they lie half protruding at the front edge of the body.

These buccal plates, as already stated, are the only hard parts of the head, and the only appendages. Indeed, the only claim this portion of the body has to be called the head at all is that it is certainly the anterior extremity of the digestive canal. On account of this peculiarity of the organization of the head, the creature, which is certainly widely different from anything known, may be called Planocephalus ($\pi\lambda\alpha\nu\acute{\alpha}\omega$, $\kappa\epsilon\varphi\alpha\lambda\acute{\eta}$), and on account of its onisciform body, Planocephalus aselloides.

The first impression the sight of this strange headless creature conveys is that of an isopod crustacean. But the limited number of legs at once puts its reference to the Crustacea out of question, since no abdominal legs at all are present. Even in the parasitic Crustacea, where some of the legs are aborted, the same is the case with the segments themselves and with the joints of the legs which remain. The clear distinction which obtains between the thoracic and abdominal regions, and the limitation of the jointed legs to a single pair on each thoracic segment seems to lead one strongly to the conviction that these important elements of its construction place it among insects. The structure of the legs and the small tapering abdomen furnished with small anal appendages tend to the same conclusion.

Where among insects it should be placed is more questionable. Thinking it possibly a larval form, careful search has been made among all the groups into which it could by any possibility be presumed to fall, viz, among the Neuroptera and Coleoptera, but nothing in the slightest degree seeming to be related to it could be found, and its conspicuous size rendered it the less probable that a kindred form would be overlooked On account, however, of its apterous character, and the discovery in recent years of certain curious types of animals (all of them, however, very minute), whose affinities have provoked more than usual discussion, my attention was early drawn toward certain resemblances which Planocephalus bears to the Pauropida among Myriapods and to the Thysanura, and here, if anywhere, its affinities seem likely to be found.

Its passing resemblance to the obtected forms of Pauropoda which Ryder has published under the name of Eurypauropodidæ is certainly very considerable, especially when it is remembered that the young of Pauropoda bear only three pairs of legs. The position of the more mobile part of the head of Eurypauropus beneath the cephalic shield is the same that the head of Planocephalus bears to the first thoracic shield; and the mouth parts in

both are confined to a somewhat similar circular area; there are no eyes in either, and the legs terminate in a single curved claw.

On the other hand, not only are antennæ of a highly organized character developed in Pauropoda, but the upper portion of the head carries a cephalic shield as large and conspicuous as the others; two pairs of legs are developed in the adult on every or nearly every segment of the body, and always on the abdominal to the same extent as on the thoracic segments, no abdomen being distinct from a thorax as in Planocephalus, but all the joints of the body entirely similar; the legs of the Pauropoda are formed on the myriapodal type, consisting of cylindrical undifferentiated joints, while those of Planocephalus are hexapodal in character, having a clearly defined femur and tibia, and a two-jointed tarsus conspicuously smaller and shorter than the preceding joints, of different form and apically spined.

The closer, therefore, we compare these two types the less important seem the points of resemblance and the more important the points of divergence between them; for in the clear distinction of the thorax and abdomen, the absence of abdominal legs, and the structure of the legs themselves—fundamental features of its organization—Planocephalus clearly belongs to the true hexapod type of insects.

Its probable reference to the Thysanura may be defended on both negative and positive grounds. There is no other group of hexapods to which it could be considered as more likely to belong, and there are some special thysanuran features in its structure, anomalous as it is. Since Packard has shown the reasonableness of placing the Symphyla (=Scolopendrella) of Ryder in the Thysanura, with the Collembola and Cinura as coordinate groups, the range of the Thysanura has been extended, and as a group of equivalent taxonomic value to the larger divisions of winged insects it has seemed itself to gain a better *ratio vivendi*. It is not necessary, therefore, in considering the relations of Planocephalus to Thysanura as a whole, to limit ourselves to points of comparison which it may have to one or another of its subordinate groups, but consider any points of resemblance we may find to any of these groups indifferently. The thoracic segments remind us not a little of some Cinura, while the abdomen as a whole recalls many of the Collembola, its approximated pair of specialized anal appendages being also like the variously developed organs of all Thysanura, and unlike anything we can recall in any myriapod. The legs, in the develop-

ment of the basal joints and in the smaller double-jointed tarsus, are closely related to those of some Cinura—built indeed upon the same general pattern, excepting that in Planocephalus they are specially developed for swimming. In the claw of our fossil genus we have something decidedly thysanuriform. We have heretofore spoken of the two tarsal joints as each armed apically with an interior spine, but that of the final joint arises from the base of the curving claw, and takes on more or less its direction, though only half as long as it, causing it to resemble very closely the smaller digit of the claw of both Collembola and Cinura, which is always inferior to the larger, and not infrequently, as in Lepidocyrtus, etc., straight instead of curved

Of course, the rudimentary character of the head and the entire obliteration of the cephalic plates render our fossil very distinct from any known type of Thysanura. But these features separate it quite as widely from any other group that may be suggested for it, and, taking into account the considerable development of the thoracic portions, we must look upon Planocephalus as in some sense a lowly form, descended from a type in which the head was developed at least to some extent, and this renders it more probable that we have here found its proper place. Moreover when we examine the mouth-parts of Podura, we find them partially withdrawn within the head, reduced in external presentation to a small circle at the end of a conical protrusion of the under side of the head. Take away the cephalic plates, withdraw the mouth-parts to the same protection of the first thoracic segment which they now enjoy under the cephalic dome, imagine further that the mouth-parts could be protruded to their original position when covered by a cephalic shield, and we have about the same condition of things we find in Planocephalus; indeed the extensibility of the mouth-parts beyond the thoracic shield seems quite what one might expect after the loss of the hard parts of the head; and the mouth-parts of Planocephalus bear much the same relative position to the first thoracic shield which those of Podura bear to the cephalic shield.

Assuming, then, that Planocephalus is a true hexapod, its general relations are certainly with the Thysanura rather than with any other group; while the character of the legs, the half developed double claw, and the anal appendages specialized to peculiar use are characters which are positively thysanuran. Add to this that we find in Podura something in a remote degree analogous to the extraordinary mouth-parts of Planocephalus,

which we should in vain seek elsewhere, and the probability that we find here its nearest allies is rendered very strong, and the more so from the diversity of form and type in this group since the addition to it of Scolopendrella. The discovery of a collophore or something homologous to it would, we conceive, be decisive on the point; but the lateral preservation of nearly all the specimens of this fossil, and the obscurity of the base of the abdomen in nearly all, not only forbid its determination in those yet found, but render it doubtful if it will ever be discovered.

The position of this group among the Thysanura must be an independent one between the Cinura and the Symphyla and of an equivalent value to them. For such a group the name of BALLOSTOMA is proposed, in reference to the remarkable power possessed of thrusting forward the gullet and mouth-parts. It would be characterized by the peculiarity named, by the lack of any chitinous frame-work of the head, the equal development of three thoracic segments developed dorsally as shields, and all separated from a cylindrical abdomen, which is armed at tip with a pair of hooks for crawling; legs largely developed and with expanded and flattened femora and tibiæ, the tarsi two-jointed. The principal points toward which attention should be directed for the more perfect elucidation of its structure are the buccal plates and a possible collophore.

Bertkau compares Planocephalus with an insect from the brown coal of Rott, Rhenish Prussia, described by Heyden as a mite under the name Limnochares antiquus. This Bertkau regards as a larval Galgulid, one of the Hemiptera, and he believes Planocephalus something similar; but he does not seem to me to justify this latter view, and the abundance of Planocephalus with the absence of mature Galgulidæ at Florissant seem an obstacle not easily thrown aside.

Ordinary length when extended, 7–8^{mm}; breadth, 2.5–3^{mm}; diameter, of mouth-parts, 0.5^{mm}.

Florissant. Sixty-six specimens, of which the best are Nos. 302, 574, 3508, 5229, 6933, 7907, 9782, 9896, 10551, 12807.

Suborder CINURA Packard.

Family LEPISMATIDÆ Burmeister.

This group has heretofore been found fossil only in amber, where eighteen species of six or seven genera are known; but a single species has been found in the shales of Florissant, Colorado.

LEPISMA Linné.

The species provisionally placed here seems to differ decidedly from known types in the structural characters of the legs, but the single specimen preserved being very imperfect, it is not at present generically distinguished. In the equality of the caudal setæ it is nearest Lepisma, but the legs are very different. The femora resemble closely the broad coxæ of some species of Lepisma, and would have been taken as coxæ but for the slender, elongated joint which follows; one of the legs, too, more perfectly preserved than the others, shows the short tarsus following the tibiæ, and leaves no room for doubt that the broadly expanded ovate disks on either side of the body represent the femora, to which succeed a slender, rod-like tibia of equal length and of uniform slenderness. The abdomen consists of ten joints, tapering very gently, but at the extremity more rapidly.

Two amber species were referred to this genus by Koch and Berendt, one of which was thought to be almost identical with Lepisma saccharina, but Menge pointed out that, notwithstanding the resemblance between the two, they differ at almost every point. The group is cosmopolitan.

LEPISMA PLATYMERA.

Pl. 12, Fig. 18.

A single specimen in which the head, if preserved, is separated from the body, and the greater part of the thorax is lost, but the whole of the abdomen with the caudal setæ, some of the lateral bristles, and most of the legs are fairly preserved; the latter do not appear in the figure. The abdomen is slender and only slightly tapering, excepting on the last three segments, which narrow more rapidly, so that the tip of the abdomen is about half as broad as its base. The legs are very remarkable for the size and great expansion of the femora and the contrasted linear tibiæ; the

femora are ovate flattened disks, distally subacuminate, more than twice as long as broad, as long as (fore and middle femora), or even longer than (hind femora), the width of the base of the abdomen; the tibiæ are as long as the femora and scarcely stouter than the caudal setæ, while the tarsi are scarcely if any slenderer than the tibiæ and less than half their length; a few lateral bristles nearly as long as the width of the abdomen can be seen, indicating that one such projected from either side of each abdominal segment, that borne by the last segment being somewhat longer than the others. The caudal setæ are of nearly equal length, the central slightly longer than the lateral which divaricate gently, and are nearly if not quite as long as the body. Nothing can be made of the detached head extremity more than its slenderness, it being about half the width of the base of the abdomen. Probably the body was fusiform in outline, slender, tapering from the middle of the thorax more rapidly forward than backward. The last abdominal segment is somewhat abruptly truncate.

Length of abdomen, 5.5^{mm}; breadth at base, 2^{mm}; at tip, 0.8^{mm}; probable length of fore and middle femora, 2^{mm}; their breadth, 0.8^{mm}; probable length of hind femora, 3^{mm}; their breadth, 0.9^{mm}; length of tibiæ, 1.75^{mm}; of tarsi, 0.75^{mm} (perhaps incomplete); length of outer caudal setæ, 8^{mm}; of middle caudal seta, 8.5^{mm}.

Florissant. One specimen, No. 1693.

Family TERMITINA Stephens.

It has generally been supposed that the white ants were present and tolerably well represented in paleozoic rocks, but most of the species which have been referred to this family have been shown by recent researches to belong to the Protophasmida, and the others to various neuropteroid Palæodictyoptera. At least half a dozen species are known from the mesozoic rocks, however, most of them coming from the Lias of England, Germany, and Switzerland, the most common type being the extinct genus Clathrotermes Heer, peculiar for its numerous, transverse, gently oblique cross-veins in the costal field and for the dark, quadrate spots which usually accompany these and other cross-veins. If we are to follow E. Geinitz, the species must have been exceedingly variable. Two white ants also occur in the oolite of Bavaria, which Hagen refers to Termes proper. (1885.)

The family of Termitina is represented in the Tertiaries of Europe by twenty-nine nominal species. Hagen, however, asserts that several of those purporting to come from amber are in reality copal species, and this, with synonyms and species merely nominal, reduces the actual number to seventeen. It is doubtful if one of these, T. peccanæ Massal., is a Termes at all, and if it is, its position can not be further defined The number may therefore be considered sixteen; besides this, a species has been indicated without name from the English Tertiaries.

Of these sixteen, six come from amber, belonging to three genera (Calotermes two species, Termopsis three, and Termes one); six from Radoboj, also of three genera (Hodotermes two species, Termes two, and Eutermes two); and three from Oeningen, of two genera (Hodotermes two species, Termes one—the same as found at Radoboj). Besides these there is a Calotermes from Rott, and a Hodotermes from Schossnitz.

The section comprising the genera having a branched scapular vein is therefore represented by eleven species (Calotermes three, Termopsis three—from amber only, Hodotermes five), while the section with simple scapular has only five species (Termes three, Eutermes two). The nominal and doubtful species (and, it might be added, most of the synonyms) fall into the latter section, and should doubtless increase it somewhat. As it stands the first section has two-thirds of the fossil species.

Thirteen of these sixteen species are entered in Hagen's Monographie der Termiten; the others have since been published; and it is noteworthy that of the eighty-four modern species contained in this monograph fifty-five, or nearly two-thirds, belong to the second section; in other words, only 31 per cent of the Tertiary, but 65 per cent of the recent species, belong to the second section.

The additions to the Tertiary Termite-fauna here made are in entire keeping with these statistics; six species are described, of which four belong to the first, and two to the second, section, raising the number of Tertiary species to twenty-two, or about one-fourth the number of recent species.

Of these six species, three belong to a new extinct genus, apparently peculiar to America, but possibly including some of the species from the European Tertiaries; another is referred doubtfully, from want of sufficient data, to Hodotermes, which has yielded species from Radoboj, Oeningen,

and Schossnitz, as well as among modern types; while the other two probably fall into Eutermes, and are allied to, but considerably smaller than, the species from Radoboj placed with many modern types in the same genus. They are perhaps more nearly allied to, as they certainly agree better in size with, the two species of Termes found living in the neighboring valley of the Fontaine qui Bouille. Calotermes, which has furnished species from amber and the Rhenish basin, Termopsis, which has more fossil (amber) species than recent, and Termes proper, which is represented at Oeningen and Radoboj and in amber and the Rhenish basin, all seem to be wanting in the American Tertiaries. The composition of the white-ant fauna of the ancient Florissant, to which locality the known American fossils are confined, differs considerably from that of the localities known in the European Tertiaries, but resembles that of Radoboj more closely than it does any other, as will appear from the following table of representation:

First division.

Florissant.	Radoboj.
Parotermes insignis.	
Parotermes hagenii.	
Parotermes fodinæ.	
Hodotermes ? coloradensis.	Hodotermes haidingeri.
	Hodotermes procerus.

Second division.

	Termes pristinus.
Eutermes fossarum.	Eutermes obscurus.
Eutermes meadii.	Eutermes croaticus.

Out of one hundred and fifty-three specimens of amber white ants examined by Hagen only a single larva, and no soldier, was found; all other fossil individuals have also been winged specimens; but it is worthy of special remark that in the collection of twenty-six individuals from Florissant one is a larva. The scarcity of such forms, whether in amber or lacustrine deposits, is easily explained by the habit of life of these creatures.

The very presence of so considerable a number of Termitina (twenty-six specimens, six species[1]) in the Florissant beds is indicative of a much

[1] According to Hagen (Linn. Ent., vol. 12, p. 244) no locality in the world has yielded more than nine species of living types; they so rarely number more than four, that he had formerly indicated this as the limit, so far as known.

warmer climate formerly than the locality now enjoys. Only three species of white ants, and of these only one belonging to the section with branched scapular vein, have been recorded from the United States north of the Gulf margin, excepting on the Pacific coast, where one or two more extend as far north as San Francisco. Yet seventeen species in all are recorded from North America by Hagen in 1861, and some have since been added to the list; while his South American list (nearly all from Brazil) includes thirty-one species, of which five are repeated from the North American list. Florissant is situated in 39° north latitude, and Hagen says that the family only rarely (*wenig*), and that only in the northern hemisphere, extends beyond the fortieth degree of latitude. One species occurs as far north as Manitoba. (September, 1881.)

Table of the genera of Termitina.

Scapular vein branched.
- Submarginal vein present ..... 1. *Parotermes.*
- Submarginal vein absent ..... 2. *Hodotermes.*

Scapular vein unbranched ..... 3. *Eutermes.*

1. PAROTERMES Scudder.

Parotermes Scudd., Proc. Amer. Acad. Arts and Sci., XIX, 135 (1883).

Head rather large, short-oval in form, almost as broad anteriorly as posteriorly, well rounded behind; eyes small, ocelli wanting; antennæ longer than the head, but shorter than the head and prothorax, slender, perhaps slightly broader in the middle than at either end, composed of about twenty equal joints, shorter than broad. Prothorax from a half to a third as long as the head, narrower than or only as broad as it, broader in front than behind, subquadrate, with the hinder angles rounded off. Wings slender and straight, subequal, less than half as long again as the body, four times as long as broad; basal scale obscure in most specimens examined, moderately large, as long as the prothorax, its costal margin convex; costal margin of wing straight nearly to the tip, which tapers to a well-rounded point; marginal and mediastinal veins both present, the latter distinct and reaching nearly to the middle (sometimes only to the end of the basal third) of the costal border; scapular vein running parallel to the costal margin to the tip of the wing and emitting from five to seven very oblique gently curving superior branches at pretty regular intervals, the second arising before the middle of the vein; it also emits a couple of inferior branches

from opposite the base of two of the later branches which strike the apex of the wing, diverging from the main vein no more than the superior branches. Externomedian vein also running parallel to the costal margin throughout the greater part of the wing, and not so far removed from the scapular as the latter is from the costal margin; it has four or five simple or forked branches, mostly arising in the basal third of the wing, and with these branches takes a remarkably longitudinal course obliquely toward the hind margin and parallel to the inferior apical branches of the scapular vein; it therefore occupies the greater part of the wing. The internomedian vein is reduced to a very contracted area, consisting apparently of only a single forked vein or two in the narrowing basal part of the wing. The feeble character of the externomedian and internomedian veins, as well as of the inferior branches of the scapular vein, prevents their preservation on most of the fossils, and it is only in a few specimens that the whole or nearly the whole can be made out. There is apparently no net-work or reticulation anywhere on the membrane of the wing. The abdomen is large and ovate, generally broader than the rest of the body.

This genus, which is most nearly allied to Termopsis and Calotermes, differs from each of them in points wherein they differ from each other, and has some peculiarities of its own. It differs from Calotermes in its shorter wings (relative to the length of the body), which lack any fine reticulation, and in its want of ocelli. From Termopsis it differs in its slenderer but yet shorter wings, without reticulation, its uniform scapular vein running parallel to the costa throughout and provided with fewer and straight branches. From both it differs in the presence of distinct inferior branches to the scapular vein, but especially in the slight development of the internomedian vein, the excessive area of the externomedian vein, and the course of the latter, which is approximated much more closely than usual to the scapular vein and emits branches having an unusually longitudinal course. These last peculiarities also separate this genus still more widely from Hodotermes, with which it agrees pretty closely in many points, and in which Hagen places most of the larger Termitina described by Heer from the European Tertiaries, although they do not appear to agree with the characteristics of the genus as given by him, and certainly approach in some of their features the peculiarities of the present genus. It is, however, impossible from Heer's figures alone to judge whether they are really more closely allied

to Hodotermes or Parotermes; a nearer examination of the types themselves would perhaps decide; but at present Parotermes must be considered peculiar to the American Tertiaries.

The species are all of pretty large size. They may be separated as follows:

Table of the species of Parotermes.

Abdomen considerably broader than the thorax.
Wings produced at the apex; submarginal vein short; branches of the externomedian vein and inferior branches of scapular more oblique than the superior scapular branches.....1. *P. insignis.*
Wings rounded at the apex; submarginal vein long; branches of the submedian vein and inferior branches of the scapular as longitudinal as the superior scapular branches.....2. *P. hageni.*
Abdomen no broader than thorax .....3. *P. fodinæ.*

1. Parotermes insignis.

Pl. 12, Figs. 13, 14.

Parotermes insignis Scudd., Proc. Amer. Acad. Arts and Sci., XIX, 137–139 (1883); in Zittel, Handb. Palæont., I, ii, 773, Fig. 974 (1885).

Head broad oval, of pretty regular shape, but broadest in the middle of the hinder half, the front and hind border broadly rounded; there is a slight median longitudinal suture in the posterior half of the head. Eyes one-fifth the diameter of the head, situated with the front margin slightly more distant from the front than from the hind border of the head and the outer margin just within or at the lateral margin of the head; they do not appear to project strongly above the surface. Antennæ scarcely so long as the head and prothorax together, composed of about twenty to twenty-two joints, the basal joints twice as broad as the stem, the others broader than long and equal throughout, not enlarged toward the middle of the antennæ. Pronotum nearly twice as broad as long, as broad as the head, the front margin nearly straight with slightly rounded corners, the hind border and sides forming one nearly uniform, broad, semicircular curve; its surface appears to be flat, or at least there is no median impressed line. Mesonotum a fourth broader than long, with a distinct median impressed line, at least in the front half, subquadrate in shape, broadest in the middle of the front half, and tapering slightly and regularly behind, the front margin broadly rounded to the shoulder of the wing. Metanotum about as long as the mesonotum and of a similar shape, but tapering more rapidly behind, and likewise with a median impressed line more distinct anteriorly. Abdomen obovate, broad, and about equally rounded at either end, in the middle nearly half as broad

again as any other part of the body, in length just about equaling the entire thorax. Abdominal appendages obscurely seen in a single individual, where they are tolerably stout, tapering slightly, very bluntly terminated, and about as long as the last abdominal segment. Legs very short, the tibiæ being shorter than the width of the thorax, and armed at tip with a pair of short straight spurs; tarsi not more than half as long as the tibiæ, but the separate joints are not determinable on any of the specimens.

Wings four times as long as broad, the middle of the front pair reaching the end of the abdomen, long and very regularly obovate, the only difference in the form of the two extremities being in the gentler tapering of the base and the straighter course of the costal margin next the base. The basal scale is triangular, about as long as the mesonotum, its costal and outer margins each a very little convex. The scapular vein, its superior branches, and the mediastinal are stout, while the other veins are very feeble and only appear under favorable preservation. The submarginal vein[1] is crowded against the margin, but does not run fairly into it before the end of the basal fifth of the wing. The mediastinal vein terminates a short distance before the middle of the wing. The scapular vein runs at only a short distance from and parallel to the margin, and emits from five to eight superior branches running in an extremely longitudinal course to the costa; usually the first branch is thrown off almost as far out as the middle of the second quarter of the wing, but where the branches are numerous three branches are thrown off before the middle of the wing; in addition to the superior veins two inferior veins are emitted in the apical third of the wing, and strike the lower margin of the wing just below the apex. The externomedian vein runs subparallel to, but a little divergent from, the scapular, and nearly as far from it as it is from the costal margin, emitting four inferior simple or forked branches which cover the greater part of the hind border with their nervules; from near the middle of the wing a superior branch is also emitted, which is soon lost. The internomedian vein is forked, and strikes the margin near the middle of the basal half.

Although in the number of branches to the scapular vein the specimen showing the wings most clearly (No. 7752) differs considerably from

[1] What I here call the submarginal vein is the short simple vein, sometimes present in, at other times absent from, Termitina, which precedes the mediastinal vein. Hagen calls it the first branch of his subcosta.

the others, the vein commencing to branch at a considerably earlier point, all the specimens agree so well in every other particular that these would appear to be individual variations. It is the largest species of the genus.

Length of body, 11.5^{mm}; breadth of thorax, 2.5^{mm}; of abdomen, 3.3^{mm}; length of antennæ, 4.25^{mm}; of front wing, 13.3^{mm}; breadth of same, 3.35^{mm}; length of middle tibia, 2^{mm}; of tarsi, 1.25^{mm}; of abdominal appendages, 0.65^{mm}.

Florissant. Four specimens, Nos. 400, 7752, 9041, 14400.

2. Parotermes hagenii.

Pl. 12, Fig. 2.

Parotermes hagenii Scudd., Proc. Amer. Acad. Arts and Sci., XIX, 139–140 (1883).

Head roundish obovate, very regularly rounded, scarcely half as long again as broad, broadest at the eyes, which are scarcely behind the middle, and are deeply set, their outer border projecting but little beyond the contour of the head. Antennæ nearly as long as head and pronotum taken together, composed of about twenty-six joints, subequal beyond the base, a little tapering at the tip. Pronotum more than twice as broad as long, fully as broad as the head, the front margin slightly concave, the hind border and sides forming a regular broad curve. Mesonotum and metanotum shaped exactly as in P. insignis, and with a similar impressed line. Abdomen obovate, but with more parallel sides than in P. insignis, being only a little broader than the thorax, and nearly as long as the rest of the body, including the head. Abdominal appendages tolerably slender, equal, bluntly pointed, composed of five or six joints, the last of which appears to be two or three times as long as the others, which are equal; the whole is about half as long as the pronotum. Legs short, but longer than in P. insignis, the tibiæ being about as long as the width of the thorax, but they are imperfectly preserved on all the specimens.

Wings a little more than four times longer than broad, the middle of the front pair scarcely reaching the extremity of the abdomen, broadest in the middle, tapering almost as much apically as basally, the tip roundly pointed, the costal margin pretty straight until shortly before the tip, the lower margin broadly curved. The basal scale is of the same shape and size as in P. insignis, but with a stronger costal curve. The scapular vein and its superior branches are stout, its inferior branches and the veins below

feeble, so as only to appear under favorable circumstances, being visible in only half of the specimens before me. The submarginal vein of the front wing terminates at about the middle of the basal half of the wing, and about opposite the origin of the first superior scapular branch. The mediastinal vein extends about to the middle of the wing both in the front and hind wings. The scapular vein is related to the margin exactly as in P. insignis, and has five or six superior branches on the hind wing, six or seven on the front wing; on the front wing they originate at subequal distances apart, commencing usually at about the middle of the basal half of the wing, but when there are but six branches (which appears to be less commonly the case) the first originates at a greater distance from the base; on the hind wing there is greater irregularity; in one specimen, that figured (No. 8616), there are five branches on the left hind wing, the first originating beyond the middle of the wing, while on the right wing there is an additional vein, originating far before the second, at the middle of the basal half of the wing; in another specimen with only five veins (No. 8250) the basal branch originates somewhat beyond the middle of the basal half of the wing, and the others follow at subequal intervals; besides these superior there are two inferior nervules arising, the first at the end of the middle third of the wing, opposite a superior branch, and the second opposite the succeeding branch; sometimes a third vein appears beyond these; after parting from the scapular vein these take a longitudinal course and terminate at the tip of the wing. The externomedian vein runs subparallel to the scapular, diverging slightly from it and being as far from it as it is from the costal margin; it emits two or three inferior branches, the last scarcely beyond the middle of the wing, the basal ones of which appear to be forked, but all having an unusually longitudinal course, being only slightly deflected towards the lower margin. Nothing can be said of the internomedian vein.

This species differs from P. insignis by its more laterally disposed eyes, rounder head, differently shaped wings, more longitudinally disposed branches of the externomedian vein, and longer and narrower abdomen.

Length of body, 10.5–12, av. 11^{mm}; breadth of thorax, 2.1^{mm}; of abdomen, 2.6^{mm}; length of antennæ, 4^{mm}; of front wing, 13.5–15.5, av. 14^{mm}; breadth of same, 3.35^{mm}; length of middle tibia, 1.65^{mm}; of abdominal appendages, 0.65^{mm}.

Named for Dr. H. A. Hagen, the distinguished monographer of the Termitina, living and fossil.

Florissant. Seven specimens, Nos. 4629, 4652, 5224, 6030, 8250, 8616, 14167.

3. PAROTERMES FODINÆ.

Pl. 12, Figs. 3, 22.

Parotermes fodinæ Scudd., Proc. Amer. Acad. Arts and Sci., XIX, 141 (1883).

Head oblong obovate, half as long again as broad, the eyes large, circular, about one-fifth the diameter of the head, slightly projecting beyond the sides, the anterior edge near the middle of the head. Pronotum transversely lunate, as broad as the head, less than twice as long as broad, the front margin regularly and considerably concave, the hind margins and sides forming one uniform strongly convex curve, the anterior lateral angles rounded off. Mesonotum and metanotum obscurely preserved, but apparently formed much as in the other species, the mesonotum being of about the same width as the pronotum. Abdomen rather long and comparatively slender, scarcely if at all exceeding in width the parts in front, the sides being unusually parallel, the tip well rounded, the whole as long as the rest of the body. Abdominal appendages very small, stout, being only a little more than twice as long as broad, largest in the middle, and tapering either way, the tip blunt, the whole not longer than the diameter of the eye. Legs poorly and partially preserved in a single specimen, showing them to be much as in P. hagenii, the hind tibia being only a little shorter than the width of the mesothorax.

Wings four times as long as broad, the middle of the front pair reaching the tip of the abdomen; the exact form can not be made out, but the costal margin is straight until very near the tip, and the hind border appears to be uniform and to make the wing slightly broadest just beyond the middle. The submarginal vein is unusually long, running into the costa only a little before the middle of the wing. The mediastinal terminates not far beyond the middle The scapular vein has five or six branches in the front wing, generally five in the hind wing, the first appearing always to originate at the end of the basal third of the wing. The inferior nervules of this vein and the course of the branches of the veins below can not be determined in any of the specimens, but there are faint indications of their

presence, and nothing in them appears to distinguish this species by any marked peculiarities from the others of the genus.

This species differs from the others here described in its considerably smaller size, slender abdomen, and much smaller abdominal appendages.

Length of body, 9^{mm}; breadth of thorax, 2^{mm}; length of front wing, 13^{mm}; breadth of same, 3.25^{mm}; length of hind tibia, 2^{mm}; of abdominal appendages, 0.25^{mm}.

Florissant. Four specimens, Nos. 1247, 1253, 7608, 11190 and 14391.

2. HODOTERMES Hagen.

Hagen refers to this genus two fossil species from Oeningen and two from Radoboj. Assmann also describes a species from Schossnitz, and one of the Florissant white ants is referred here doubtfully. The fossil therefore nearly equal in number the living species, which are all inhabitants of the Old World, the most northern species being found in Egypt.

HODOTERMES? COLORADENSIS.

Pl. 12, Fig. 6.

Hodotermes? coloradensis Scudd., Proc. Amer. Acad. Arts and Sci., XIX, 142-143 (1883).

Metanotum considerably narrower than the mesonotum, as long as broad, tapering posteriorly, the front border straight, the hind border rounded. Abdomen ovate, stout, less than twice as long as broad, the sides full, as broad as the mesothorax, posterior extremity rounded. Abdominal appendages long and slender, half as long as the metanotum, composed of at least six or seven joints, slightly tapering, terminating very bluntly.

Wings very long, the middle of the front pair lying far beyond the tip of the abdomen. Submarginal vein absent from all the wings. Mediastinal vein terminating at the middle of the front border. Scapular vein parallel to the front margin, with at least four branches in both wings, and in the front pair pretty certainly five branches, and perhaps six; the first branch originates in the front wing at the end of the basal fourth of the wing, in the hind wing a little farther out.

This species is readily distinguished from all the other fossil Termitina of North America by its very great size, the length of the wings being double that of any other. Although the specimen is very imperfect, the

tip and lower half of the wings being absent, as well as the head, prothorax, and legs, it differs so much from the species of Parotermes, in the absence of the submarginal vein and the great length of the abdominal appendages, that it probably can not be associated with them generically. In size and general appearance it agrees so fairly with the Tertiary species described by Heer, referred to Hodotermes by Hagen, that I place the species provisionally in the same genus, from which (as from all other genera so far as I know in which the structure of the wings would allow it to be placed), it differs by the great length of its anal appendages.

Length of body as preserved, 9^{mm} (probably it reached about 12); of abdomen, 6^{mm}; breadth of same, 4.5^{mm}; length of fore wing, 23^{mm} or more; of abdominal appendages, 1.25^{mm}; breadth of same, 0.3^{mm}.

Florissant. One specimen, No 6010.

3. EUTERMES Heer.

The remaining species fall into the division of Termitina in which the scapular vein is unbranched, and it is uncertain whether they should fall in Termes proper or in Eutermes, the veins below the scapular being in all cases poorly preserved or wholly obliterated. The limited number of antennal joints in such as have these preserved sufficiently for examination, and the occasional indication of a broad subscapular field in others, lead rather to the presumption that they should be placed in Eutermes. Two species have been found at Florissant. The genus has been well known in a fossil state, four species having been described from Radoboj in Croatia and five from Prussian amber. Indeed, the genus was first founded upon fossil species, but it was soon seen that many living forms belonged to the same group. The existing species, some thirty in number, belong almost exclusively to the tropics, and especially to those of the southern hemisphere.

The two species of Eutermes which have been found at Florissant may be separated by the following features:

Table of the species of Eutermes.

Head broader behind than in front, scarcely half as long again as broad; pronotum semicircular, the posterior curve uniform ..... 1. *E. fossarum.*

Head not broader behind than in front, fully half as long again as broad; pronotum very short, the hind margin more or less truncate ..... 2. *E. meadii.*

1. EUTERMES FOSSARUM.

Pl. 12, Fig. 20.

Eutermes fossarum Scudd., Proc. Amer. Acad. Arts and Sci., XIX, 143-144 (1883).

Head very regularly obovate, a little broader behind than in front, nearly half as long again as broad, its posterior border well rounded. Eyes rather small, situated in the middle laterally, projecting but little. Antennæ scarcely if any longer than the head, rather stout, enlarging away from the base, composed apparently of less than fifteen joints. Pronotum as broad as the head and twice as broad as long, semicircular, the front border scarcely concave, the front margins slightly rounded. Mesonotum and metanotum as broad as pronotum, quadrate, equal, about half as broad again as long. Abdomen somewhat longer than the rest of the body and slightly broader than the thorax, with gently rounded sides and well-rounded tip; no abdominal appendages are discoverable on any of the specimens. Legs poorly preserved on all specimens; apparently they are of medium length.

Wings rather more than four times as long as broad, the middle of the front pair not reaching the tip of the abdomen, very uniform and regular, of nearly equal breadth throughout the middle two-thirds, the costal margin straight until just before the tip. Scapular vein parallel to the margin, the subcostal area infumated; veins below the scapular not determinable. The basal scale appears to be small, broad, triangular, its costal border swollen.

Length of body, 6.5–7.5, av. 7.15^{mm}; of abdomen, 3.5–4.5, av. 4.15^{mm}; breadth of pronotum, 1.2^{mm}; of abdomen, 1.5^{mm}; length of antennæ, 1.2^{mm}; of front wing, 7.75–9.25, av. 8.25^{mm}; breadth of same, 2^{mm}.

Florissant. Five specimens, Nos. 2329, 6049, 7393, 11752, 14980; three of them in pretty good condition.

2. EUTERMES MEADII.

Pl. 12, Figs. 12, 17.

Eutermes meadii Scudd., Proc. Amer. Acad. Arts and Sci., XIX, 144-145 (1883).

Head very regularly obovate, broadest just behind the middle, where the small eyes, scarcely projecting, are situated, not broader behind than in front, the hind margin strongly rounded, the whole fully half as long

again as broad. Antennæ nowhere well preserved, but apparently longer and with more numerous joints than in E. fossarum. Pronotum as broad as the head (?) and very short, probably more than twice as broad as long, the hind margin not forming with the sides a continuous curve, but in its middle half only slightly convex. Mesonotum and metanotum quadrate, broader than the head, the mesonotum somewhat the larger, at least half as broad again as long. Abdomen rather stout, longer than the rest of the body, the sides nearly parallel, the tip broadly rounded, and, as far as can be made out, unprovided with terminal appendages. Legs moderately long and stout, the tibiæ armed with a pair of spines at apex, the front tibiæ about as long as the pronotum.

Wings long, slender, and uniform, four times or slightly less than four times as long as broad, the middle of the front pair reaching the tip of the abdomen, broadest at or slightly beyond the middle, the lower border slightly arcuate throughout. Costal margin straight in the basal three-fourths of the wing. Scapular vein parallel to the margin, the subcostal area scarcely infumated. Veins below the scapular not determinable. Basal scale small, triangular, equilateral, the sides straight excepting the costal, which is very slightly convex and prominent.

This species differs from the preceding by its slightly smaller size, squarer pronotum, and differently shaped head.

Length of body, 5.25–7, av. 6.3^{mm}; of abdomen, 2.8–3.5, av. 3.2^{mm}; breadth of abdomen, 1.5^{mm}; length of wing, 7.5–8^{mm}; breadth of same, 2^{mm}.

Named for Mr. T. L. Mead, whose collection of Florissant insects he has permitted me to study.

Florissant. Four specimens, No. 19 (Coll. T. L. Mead), and Nos. 31, 1203, 8062.

A single specimen of a wingless white ant has been found, apparently belonging to this species or to E. fossarum. It measures 3.75^{mm} in length, and is of the ordinary form of the worker, with rounded head and constricted prothorax, bearing a general resemblance to the only other known fossil termite larva, figured in Berendt's work, but has the head more produced anteriorly and the abdomen less distended.

Florissant. One specimen, No. 6100.

Family PSOCINA Burmeister.

Until now this group has been found fossil only in amber, but here in considerable abundance, since several of the species are represented by twenty, thirty, or even sixty individuals; and fifteen species are recognized, about one-ninth the number of living species known, but nearly one-half as many as the species now living in Germany, according to the latest monograph by Kolbe. These fossil species are divided among ten genera as follows: Troctes, one; Sphæropsocus, one; Empheria, two; Archipsocus, two; Amphientomum, one; Epipsocus, one; Cæcilius, three; Philotarsus, two; Psocus, one; Elipsocus, one. The genera Sphæropsocus, Empheria, and Archipsocus are peculiar to amber; the first mentioned, a most remarkable form, has the front wings developed into the semblance of elytra. It is worthy of note that, while in the existing fauna of Europe the groups to which Psocus and Elipsocus belong embrace about half the species, they include only one-seventh the amber fauna. Hagen and Kolbe are at variance on the interpretation of these facts. The single imperfect specimen so far found in American deposits—the only one indeed in any rock formation—proves to belong to a distinct generic type, remarkable for the wide separation of the ocelli.

PAROPSOCUS gen. nov. (*πάρος*, Psocus).

The single insect on which this new generic group is based is very fragmentary, but seems to differ so clearly from other types of Psocina, whether living or fossil, that it can only be recognized as distinct. The head is broad, not including the eyes as broad as long, the nasus prominent, very broadly convex, almost truncate; the eyes are very large, very prominent, globose, subpedicellate, being strongly constricted at base, widening the head one-half; ocelli large, exceptionally distant, the outer paired ocelli infringing on the margin of the eyes. Antennæ with the first, second, and third joints successively narrower by one-fourth, the first and second broader than long, not large, the third joint four or five times as long as broad, cylindrical, the remaining joints on the proximal third of the antennæ two or three times as long as broad, smallest at base, apically rounded. Prothorax narrow, pedunculate, free, with its angulate apex overlapping the mesonotum, longer than broad. Mesothorax much broader than the total

width of the head. Fore tibiæ slender, longer than and not half so stout as the fore femora. Abdomen very short and stout, tapering very rapidly behind.

Perhaps this genus is as nearly related to Amphientomum as to any other. A single species is at hand.

PAROPSOCUS DISJUNCTUS.

Pl. 5, Fig. 51.

The single specimen unfortunately shows only an insignificant fraction of neuration, and therein no distinctive parts, but only those which are common to all genera of Psocidæ. So far as can be seen, the head, thorax, antennæ, and legs are absolutely naked. The plate wrongly shows the left antenna as the tarsus of the fore leg. The third joint of the antennæ is shorter than the width of the head between the eyes.

Length of body, 1.6^{mm}; breadth of head, 0.45^{mm}; of thorax, 0.75^{mm}; length of third antennal joint, 0.3^{mm}.

Fossil Cañon, White River, Utah. One specimen, No. 33^{c}, W. Denton.

Family EPHEMERIDÆ Stephens.

Our previous knowledge of Tertiary Ephemeridæ is based entirely upon imagos and almost entirely confined to the statements made by Pictet and Hagen nearly thirty years ago in their account of amber Neuroptera. Four species of Baetis and one each of Potamanthus and Palingenia were there described, and two years earlier mention is made by Hagen, by name merely, of a second species of Palingenia, but in the subsequent work it is referred to Baetis. Here also Pictet's Palingenia is considered as more closely related to Baetis anomala, for which in his monograph of the Ephemeridæ Eaton establishes the genus Cronicus. Eaton also refers the Potamanthus to Leptophlebia. We have therefore from the amber three species of Baetis, one or probably two of Cronicus, and one of Leptophlebia. Besides these, Sendel figures a species which he classes "inter ephemeras minores," and Burmeister says he has seen "zwei individuen der gattung Ephemera" in the Berlin Museum.

From the Tertiary rocks we have only a reference by Schlotheim to an insect from Oeningen, which he says may be an Ephemera or a Phry-

ganea, Heer's undescribed Ephemera oeningensis, and a reference to an Australian species by Wilkinson.

It is not worth while to enter here upon any discussion of the pre-Tertiary Ephemeridæ, but one of the most interesting of modern discoveries is Frič's gigantic Palingenia feistmanteli from the coal.

The American remains referred here are rather unsatisfactory, consisting of a single imago and five different species of larvæ and pupæ. The earlier stages have not before been noticed in a fossil state. The least satisfactory is the imago, which is so rudely preserved that only its three caudal setæ of equal length give any clue to its relationship. The larvæ and pupæ agree closely in structural features, and, excepting E. interempta, seem to belong to one genus. The stoutness of the tibiæ, which are of nearly equal breadth with the femora, and particularly the size of the fore tibiæ where preserved, indicate pretty clearly that they were burrowing in habit and belong in the neighborhood of Ephemera and Palingenia; their legs, however, though longitudinally hairy, are not laterally fringed, as appears to be the case with such larvæ so far as they are known; and the respiratory organs of the abdomen are too poorly preserved to offer any assistance; the legs, however, are evidently flattened, and hence I have placed them in Ephemera rather than in Palingenia. They seem, however, to indicate the existence here of a distinct type, for they differ from such larvæ as are known in the form of the body, which is unusually stout at the thorax and particularly in the mesothorax, tapering anteriorly to such a degree that the head is very small, and it is also not produced anteriorly, or to a slight degree only; the abdomen tapers also either throughout its length or from the middle posteriorly; the respiratory organs, if of the form and position in which they are found in Ephemera and Palingenia, would certainly be clearly seen, whereas no sign of them appears upon the upper surface of the abdomen; there are, however, certain indications laterally which may be referred to them, and if so this would be an additional distinction. The unfringed legs, in which femur, tibia, and tarsus are of nearly uniform diameter, indicate a further difference from known types. So little, however, is known of the early stages of this group that it will be impossible to indicate the nearer affinities of these fossil larvæ until further information of living forms is obtained. (September, 1883.)

EPHEMERA Linné.

The species known only in the immature stages may be distinguished as follows:

Table of the species of Ephemera.

Outer caudal setæ fringed on both sides. Middle seta as long as the outer setæ.
- Setæ very much more widely fringed in the middle than toward either end; dorsal abdominal markings consisting of light blotches on a dark ground ..... 1. *E. tabifica.*
- Setæ only a little more widely fringed in the middle than toward the base or tip; dorsal abdominal markings consisting of light lines on a dark ground ..... 3. *E. macilenta.*

Outer caudal setæ fringed on the inner side only, and very much more broadly in the middle than near the base or tip. Middle seta shorter than the outer setæ ..... 2. *E. immobilis.*

Setæ of equal length and naked, or not noticeably fringed.
- Large species. Head less than half the width of thorax; dorsal abdominal markings of light lines ..... 4. *E. pumicosa.*
- Small species. Head considerably more than half as wide as the thorax; no dorsal abdominal marking ..... 5. *E. interempta.*

1. EPHEMERA TABIFICA.

Pupa.—This species differs somewhat in form from the other larger types, the abdomen being very nearly of equal size throughout and the thorax nearly twice as broad as it, while anteriorly the whole body tapers regularly, as in the succeeding species. The head is rounded quadrate, about half the width of the thorax. The legs are slenderer than in the succeeding species and short, the front pair no longer than the width of the thorax, the hind pair longer, being as long as the head and thorax together. The wing pads are blackish, about three times as long as broad, reniform in shape, the inner margin bent in the middle, and the basal halves of the inner margin of the two wings meeting to form an angle slightly less than a right angle, the apical half tapering to a rounded apex. The abdomen is long and slender, the apical joint more than half as broad as the basal, the dorsal surface blotched with large quadrate patches of lighter color than the ground, sometimes central, sometimes anterior and transverse, divided by a median line. The three caudal setæ are slender, less than half as long as the abdomen, equal, very broadly fringed on either side in the middle.

Length of body exclusive of setæ, 25^{mm}; breadth of thorax, 4.5^{mm}; of middle of abdomen, 2.6^{mm}; length of wing pads, 4.5^{mm}; of front legs, 4^{mm}; of hind legs, 8^{mm}; of setæ, 7^{mm}.

Florissant. One specimen, No. 13238.

2. Ephemera immobilis.

Pl. 12, Fig. 5.

Larva.—This is the largest of the ephemerid larvæ, and is represented by a single specimen and its reverse. The body is stout, largest at the mesothorax and metathorax, tapering rapidly and somewhat rounded in front, tapering gently behind, the hinder half of the abdomen more rapidly than the basal half. The head is small, about as broad as the terminal segment of the body, transversely rounded oval, less than half as broad as the thorax, and symmetrical, being rounded in front as behind; the mandibles, not represented on the plate, are not so long as the head, moderately stout, nearly straight and tapering. The front legs are nearly as long as the thorax, the femora and tibiæ, which are of equal width, nearly or quite as broad as the length of the prothorax; the tibia is a little longer than the femur and about half as long again as the tarsus, which is also somewhat slenderer. The other legs are longer and a little stouter, but retain the same relations, excepting that the tarsus is much longer, half as long again as the tibia and toward the tip tapering. The thoracic branchiæ form a pair of triangular equilateral pads, their inner margins straight and attingent at the mediodorsal line, their outer margins convex. The dorsal surface of the abdomen is ornamented by a pair of approximated subdorsal, longitudinal, curved, white streaks, convexities outward, reaching the posterior but not the anterior border of each segment. The caudal setæ are of unequal length, the outer more than one-third, the middle one nearly one-fourth, the length of the body. They are fringed, the outer ones on the inner surface only, the middle one on both sides by a delicate fringe of hairs, which increases in breadth from either end toward the middle, where the fringe is from a third to a fourth the width of the last abdominal segment.

Length of body, 21^{mm}; breadth of thorax, 5^{mm}; of head, 2.4^{mm}; length of fore tibia, 2.25^{mm}; breadth, 0.6^{mm}; length of hind tibia, 2.75^{mm}; breadth, 0.8^{mm}; length of outer caudal setæ, 8^{mm}; of middle seta, 5^{mm}.

The species differs from the other larvæ here described by its greater size and the peculiar fringing of the caudal setæ.

Florissant. One specimen, Nos. 8824 and 8828.

3. Ephemera macilenta.

Pl. 12, Figs. 4, 10.

Larva.—The body is stout but not so stout as in the last species, which is only slightly larger than this; it tapers also in a similar manner but is not so rounded anteriorly. The head and mandibles are of similar form and size, but the head is not so distinctly separated from the thorax as in that species, being continuous with the general outline of the body. The legs are considerably shorter than in the preceding species, but while agreeing with them in general structure the femora are stouter in relation to the tibiæ. The abdomen is similarly marked, but the stripes are shorter, reaching neither the anterior nor the posterior margins of the segments. The caudal setæ are of equal length, nearly half as long as the body, and fringed on either side with short ciliæ, scarcely longer than the breadth of the seta.

Length of body, 1.75^{mm}; breadth of thorax, 3.6^{mm}; of head, 1.85^{mm}; length of fore tibia, 1.9^{mm}; breadth, 0.35^{mm}; length of hind tibia, 2^{mm}; breadth, 0.35^{mm}; length of caudal setæ, 7.5^{mm}.

The brevity of the legs and the uniform brief ciliation of the caudal setæ distinguish this species from either of the other larvæ here described.

Florissant. Five specimens, Nos. 232, 1137, 7280, 10423, 13526.

4. Ephemera pumicosa.

Pl. 12, Figs. 7 (pupa), 15, 16 (larva).

Larva.—This species is both smaller and slenderer than any of the larvæ described above. It tapers in the same manner as the others, except in being more rapidly expanded at the thorax and in having the abdomen of more uniform width, a peculiarity seen also in the nymph referred to the same species. As in the other species, the head is of the same width as the extremity of the abdomen. The legs are poorly preserved in all the specimens, but seem to agree entirely with their appearance in the nymph. The abdomen is marked as in E. immobilis, but if anything with longer and straighter stripes. All the caudal setæ are of similar length, slender, but rather short, being only about one-third the length of the body; they are furthermore distinguished from those of the other species by being naked, as far as can be seen, though one specimen seems to show an apical bristle on either side at the end of each joint of the middle seta.

Length of body, 17^{mm}; breadth of thorax, 4^{mm}; of head, 1^{mm}; length of caudal setæ, 6^{mm}.

Pupa.—The form is altogether that of the larva, but the legs are better preserved, showing them to be as long in this species as in E. immobilis, but to differ in their almost uniform slenderness throughout, the tarsi being scarcely narrower than the femora. The wing pads are distinctly marked in dark brown and are reniform in shape, of nearly uniform width and nearly three times as long as broad, the basal half of their inner edges meeting at less than a right angle, and the distal halves parallel and approximate along the mediodorsal line, the outer edges gently concave and the tips well rounded. The stone is broken at the tip of the body in the only specimen, so that the caudal setæ are not preserved.

Florissant. Five specimens, Nos. 233, 1070, 1516, 10385 (larvæ), 10660 (pupa).

5. Ephemera interempta.

This smallest of the ephemerids from Florissant, represented by a nearly complete pupa and the terminal segments of what may be either larva or pupa, and which appears to belong here, differs considerably in structural features from the others. The former only will be described.

Pupa.—The body is tolerably stout, largest at the thorax where it tapers forward toward the head, which is fully three-quarters its width. Posteriorly the abdomen remains in its basal half very nearly as broad as the widest part of the thorax, and only tapers rapidly a little before the tip, which is more rounded than usual and scarcely one-third as broad as the thorax. The head is rounded, a little broader than long; the legs only moderately stout, all the femora subequal and about as long as the head. The wing pads are subtriangular, tapering pretty uniformly to a rather broadly rounded tip about half as broad as the base, the inner margin bent close to the base, and the basal portions of the two pads forming an angle much broader than a right angle; they differ therefore altogether in form from the two species of which nymphs are known. The abdominal joints are more than twice as broad as long and wholly devoid of the markings which distinguish all the other species. The caudal setæ are about one-third as long as the abdomen, and unfringed. Only the base of the median seta is preserved in the type, but in the other specimen referred here it is as long as the lateral.

Length of body, 9.5mm; width of head, 1.3mm; of thorax, 2mm; length of femora, 1.2mm; of wing pad, 2mm; of setæ, 2.5mm.

Florissant. Two specimens, Nos. 1.582, obtained by the Princeton expedition, and 10706.

Ephemera exsucca.

Pl. 12, Fig. 9.

A single specimen, very badly preserved, but showing unmistakably the caudal setæ. The whole is preserved as I have seen no other specimen from Florissant, as if drawn on the stone with a pale blue pencil. The body is tolerably stout for an Ephemera, the abdomen tapering a little. The expanded wings are only partially preserved, but are apparently nearly as long as the body. The three caudal setæ are very slender and of exactly the same length, a little shorter than the body. No ciliation can be detected on them.

Length of body, 9mm; breadth of thorax, 2mm; expanse of wings, 16mm; length of caudal setæ, 7mm.

Florissant. One specimen, No. 5587.

Family ODONATA Fabricius.

More than thirty years ago in his work in conjunction with de Selys on the European Odonata, Dr. Hagen contributed a chapter on the fossil species of Europe, in which about half of the species enumerated (thirty-nine in number) belonged to the Secondary and half to the Tertiary period. Since then no one has done more than Dr. Hagen to add to our knowledge, especially of the Secondary species. The time has hardly come, and the species known are as yet perhaps not sufficiently numerous, to enter on any study of the relation of the Secondary and Tertiary types; but it may be stated in a general way that, omitting all mention of larval remains, we now know nearly double the number then recorded, and the Tertiary species are considerably in excess. Of these the larger part belong to the Agrionina. (January, 1882.)

To enter into a few details, the strongly limited group of dragon-flies makes its appearance in the Lias in considerable variety and apparently as highly specialized as to-day, for no less than four tribes are present, the true Agrionidæ and the Cordulidæ alone being absent. Aeschnina are the

most abundant, the Aeschnidæ being represented by a species of Aeschna at Schambelen and the Gomphidæ by one species each of Petalura and Gomphoides from England. Calopterygidæ come next, with one species each of Tarsophlebia and Heterophlebia, both extinct genera, also from England, and finally a species of Libellula from England. The same relation holds in passing upward into the oolite, where the Agrionina are added. Here we have thirty-two species, of which half are Agrionina: four Agrionidæ, and twelve Calopterygidæ of five genera, mostly extinct, namely, Isophlebia, two; Heterophlebia, two; Stenophlebia, three; Tarsophlebia, one, and Euphæa, four; three are Aeschnidæ of the genera Anax and Aeschna; eight Gomphidæ of some undetermined genera, besides Petalura and Petalia; and finally five Libellulidæ of about as many genera, yet undescribed. A species of Gomphidæ has also been found in the Wealden of England. The lithographic slates of Bavaria afford numerous, sometimes wonderfully preserved, dragon-flies, called by the workmen Stangenreiter or Schladen-Vögel, which have been carefully studied by Hagen. They lie on the stone with expanded wings and are generally larger than modern types; sometimes the most delicate veins are perfectly preserved. Most of them are referred to extinct genera.

Considering the comparative abundance of this group in the Secondary rocks one would expect to find a better representation in the Tertiaries than is the case, for, even counting all the species founded upon the immature stages as distinct from any of those established upon wings, the Tertiary species are less than twice as numerous as those from the Secondary rocks. The subfamilies are about equally represented, though the Agrionina are a little in excess, and the species are very unequally distributed among the tribes. Thus there are twenty-two species of Agrionidæ of the following genera: Agrion, seven; Lestes, five; Argya, one; Platycnemis, two; Sterope, one; Dysagrion, three; Podagrion, one; and Lithagrion, two, the last four genera being extinct; while there is but a single species of Calopterygidæ known by a pupal form, from amber, a curious reversal of the proportion in Mesozoic rocks. The Æschnina are more equally balanced between the tribes, the Gomphidæ being represented by six species, of the genera Gomphus, Gomphoides, Ictinus, and Petalura, and the Aeschnidæ by nine; of the genera Aeschna (eight) and Anax (one). The Libellulina, however, have again only a single species of Cordulidæ,

but sixteen species of Libellulidæ, all except one, a Celithemis, referred to Libellula in a broad sense. Nearly every locality where Tertiary insects are found, even including amber, has supplied its quota of this family, and some localities, such as Oeningen, have furnished the larvæ and pupæ in great numbers. (1885.)

The Odonata furnish the first opportunity that my studies have afforded of a comparison between the insect faunas of Florissant and the Green River shales. The Florissant beds have furnished six species in the perfect state besides two larvæ; the Green River shales four species in the perfect state besides fragments of another, concerning which nothing more can be said than that it probably belongs to the Libellulina. Two of the Florissant forms belong to Æschna, besides one of the larvæ. All the remainder, four Green River species, and four from Florissant, besides a larva, belong to the Agrionina. The Green River shales are represented by one species of Podagrion and three species of Dysagrion, an extinct genus of the legion Podagrion allied to the genera Podagrion and Philogenia; the Florissant beds by two species of Agrion and two of Lithagrion, an extinct genus with the same alliances as Dysagrion; the species of Agrion are not sufficiently perfect to decide into what subgenus they will fall, but they are certainly closely related and appear to be most nearly allied to Amphiagrion or else to Pyrrhosoma or Erythromma. All the Green River species belong then to the legion Podagrion, while the Florissant species are divided between the legions Podagrion and Agrion. The resemblance of the faunas of the two localities is very apparent, though the species and even the genera are wholly distinct. The facies of both faunas is decidedly subtropical (October, 1882.)

Tribe AGRIONINA Hagen.

This group is the richest of Odonata in the Tertiaries, both in Europe and America, but curiously the legions into which it is divided by de Selys are very differently represented in the two countries. To establish better terms of comparison I have given some attention to the descriptions and figures of the mature European forms, and their study brings out some interesting points.

In Europe the legion Lestes is far the best represented; into this fall Lestes coloratus Hagen from Radoboj, first figured by Charpentier, Agrion

ligea, A. leucosia, and A. peisinoe,[1] all of Heer and from Oeningen, and probably A. iris Heer of Oeningen; a closer determination is perhaps impossible. Into it also fall Lestes vicina Hagen from Sieblos, which appears to be a Lestes in the narrowest sense, and Agrion (Sterope) parthenope Heer from Oeningen, which is either a Sympycna or exceedingly close to it. The legion next best represented is Platycnemis, since to the subgenus Platycnemis Agrion antiquum Hagen from amber and Agrion icarus Hagen from Rott pretty certainly belong. Finally, to the legion Agrion belongs Agrion aglaope Heer from Oeningen.

In America, on the other hand, the bulk of the species fall in the legion Podagrion, viz, Dysagrion fredericii, D. lakesii, and D. packardii of Green River, Podagrion abortivum from the same, and Lithagrion hyalinum and L. umbratum from Florissant. The other two species fall in the legion Agrion, viz, Agrion mascescens and A. exsularis.

The following table will show the distribution of recent and fossil species in Europe and North America:

Legion.	Recent.						Fossil.			
	Europe.		North America north of Mexico.		North America and West Indies.		Europe.		North America.	
	No.	*Per cent.*	*No.*	*Per cent.*	*No.*	*Per cent.*	*No.*	*Per cent.*	*No.*	*Per cent.*
Pseudostigma	.....	.....	5	9	6	7	.....	.....	.....	.....
Lestes	7	18	11	21	14	17	7	70	.....	.....
Podagrion	.....	.....	.....	.....	1	1	.....	.....	6	75
Platycnemis	11	29	.....	.....	.....	.....	2	20	.....	.....
Agrion	20	53	37	70	60	71	1	10	2	25
Protoneura	.....	.....	.....	.....	3	4	.....	.....	.....	.....
Total	38	.....	53	.....	84	.....	10	.....	8	.....

Concerning the present distribution of these "legions," it may be said that Pseudostigma belongs to tropical America, Podagrion and Protoneura to the tropics and South Africa, Platycnemis to the Old World, and that Lestes and Agrion are cosmopolitan. The cosmopolitan groups and the one confined to the Old World are those, and the only ones, represented in the European Tertiaries; while one of the cosmopolitan genera well repre-

[1] Hagen considered these as most nearly allied to the species for which Selys has since established the genus Chlorolestes in the legion Podagrion, but to judge from the origin of the median and subnodal sectors they certainly belong in Lestes.

sented in the United States to-day has not yet been found in its Tertiary deposits, and three-quarters of the fossil species belong to a legion essentially tropical and two-thirds of whose living representatives occur in America; to offset this, the two other legions which are peculiarly tropical (and one of them exclusively American) are wholly unrepresented in the American Tertiaries. From what we then know at the present time the relationship of the agrionid fauna of the European and American Tertiaries was not nearly so close as the living faunas of the two countries. (September, 1883.)

Legion PODAGRION de Selys.

To this legion belong most of the fossil Agrionina of North America. The species here described are the first that have been found fossil. The recent forms of this legion—not a very prolific one—occur mainly in tropical America, though nearly half the genera and about one-third of the species belong to the East Indies and South Africa. The forms here brought to notice are mostly referable to new genera which find their place in near vicinity to the South American types. One species appears to belong to the South American genus Podagrion. The relationship of these fossils may be looked upon as well defined. Their nearest living relatives are inhabitants of Brazil, Venezuela, and Colombia.

The genera here represented may be separated in the following manner:

Table of the genera of Podagrion.

Pterostigma not more than twice as long as broad, surmounting less than two cellules; supplementary sectors few; few pentagonal cellules ..... 2. *Podagrion.*

Pterostigma more than twice as long as broad, surmounting several cellules; supplementary sectors numerous; many pentagonal cellules.

Nodal sector arising from the principal at scarcely one-fifth the distance from the nodus to the pterostigma; postcostal area exclusively or almost exclusively filled with pentagonal cells; several supplementary sectors between the median and subnodal sectors..... 1. *Dysagrion.*

Nodal sector arising from the principal at about one-third the distance from the nodus to the pterostigma; postcostal area with tetragonal and very few or no pentagonal cells; no perfect supplementary sector between the median and subnodal sectors ..... 3. *Lithagrion.*

1. DYSAGRION Scudder.

Dysagrion Scudd., Bull. U. S. Geol. Geogr. Surv. Terr., IV, 534 (1878).

This new type of Agrionina belongs to the legion Podagrion as defined by Selys-Longchamps, having a normal pterostigma, much longer than broad, the median sector arising from the principal vein near the nodus, the subnodal a little further out, and many interposed supplementary sectors.

It differs somewhat remarkably, however, from any of the genera given in that author's Synopsis des Agrionines (1862) in several points, as will be seen on reviewing the following characteristics.

The median sector arises from the principal vein more than one-third the distance from the nodus to the arculus; the subnodal arises from an extension of the nodus, which in passing below the principal is directed somewhat *inward* instead of outward, a somewhat extraordinary feature; the nodal arises from the principal only as far beyond the nodus as the median originates before it, or scarcely more than one-fifth way to the pterostigma. The reticulation of the upper half of the wing is mostly tetragonal, and in the discoidal area very open, while in the lower half of the wing it is mostly pentagonal, and dense apically; this results in part from the *great number* of interposed supplementary sectors, of which there are several between the ultranodal and nodal sectors, and several between each of the following sectors as far as the upper sector of the triangle; the upper of these curve somewhat downward as they approach the apical border. The postcostal area has at first two rows of cellules, but it expands rapidly below the nodus, and then has three and afterwards even four rows. The nodus is situated at an unusual distance outward, indeed *not very far before the middle* of the wing (rather more than one-third the distance from the base), and at a third of the distance from the arculus to the pterostigma. The petiole terminates at some distance *before* the arculus and is very slender. The wing is rather full in the middle, and the apical half of the posterior border is very full, the apex falling considerably above the middle of the wing.

These characters show the nearest alliance to Philogenia, but the genus differs strikingly from that in the position of the nodus, its retreat below the principal sector, the character of the postcostal area, and in the great number of the supplementary sectors, as well as in less important characters, such as the density of the reticulation. It seems indeed to be a very aberrant member of the legion. As the members of this group are all tropical, and those to which this is most nearly allied (as indeed two-thirds of the species) are from the New World, this is an additional instance of neotropical alliances in the insect-fauna of our Tertiaries.

It is upon the wing that I would establish this genus. Yet fragments of other parts of the body occur with the wings, showing that the legs were

probably long and slender, furnished with spine-like hairs as long as the breadth of the femora. The abdomen was moderately slender, rather longer than the wings; its ninth and tenth segments a little enlarged in the ♀, the tenth half (♀), or three-quarters (♂), as long as the ninth, and the eighth half as long again (♀), or twice as long (♂), as the ninth, and a little more than half as long as the seventh. The anal appendages were as long as the tenth segment, rounded triangular (♀) or quadrate (♂).

The species of Dysagrion found at Green River may be separated by the characters drawn from the neuration of the wing in the following table:

Table of the species of Dysagrion.

Pterostigma at least four times as long as broad; quadrilateral longer than broad; middle of the area occupied by supplementary veins between the principal and subnodal sectors filled with quadrilateral cells.

Pterostigma surmounting four cells; quadrilateral nearly as broad at base as at apex. *D. fredericii.*

Pterostigma surmounting three cells; quadrilateral nearly twice as broad at apex as at base. 2. *D. lakesii.*

Pterostigma only three times as long as broad; quadrilateral slightly broader than long; middle of the area between the principal and subnodal sectors filled with pentagonal cells...3. *D. packardii.*

1. Dysagrion fredericii.

Pl. 6, Figs. 2, 5, 6, 9, 10, 14, 17.

Dysagrion fredericii Scudd., Bull. U. S. Geol. Geogr. Surv. Terr., IV, 534–537, 775 (1878).

Several specimens of various parts of the body with wings were found by Mr. F. C. Bowditch and myself in the Green River shales, in a railway cutting by the river bank beyond Green River station. The most important are a nearly perfect wing and its reverse, which preserve all the important points of the neuration. A single antecubital appears to be present, nearer the nodus than the arculus; the principal sector, like the short sector (sector brevis), bends slightly upward just as it reaches the arculus; the cellules in the discoidal area are half as broad again as long, yet the breadth of the wing is such that the broadest part of the postcostal space, between the nodus and the middle of the wing, is more than half as broad as the rest of the wing at that point. The quadrilateral is subquadrate, about half as long again as broad, its upper and lower margins subparallel and its lower outer angle about sixty degrees; pterostigma four times as long as broad, a little dilated, oblique both within and without, but especially pointed above on the outer side, touching the costal margin throughout. The wing is wholly hyaline, excepting the infumated pterostigma, which is bordered by

thickened black veins, and surmounts four cellules at its lower margin; the veins of the wing generally are testaceous; there are twenty postcubitals.

Length of the wing, 36^{mm}; length of part beyond peduncle, 34^{mm}; breadth, 9^{mm}; distance from nodus to tip of wing, 23^{mm}; from arculus to nodus, 8^{mm}; from nodus to inner angle of pterostigma, 17^{mm}; length of pterostigma, 3.5^{mm}.

Another wing from the same beds with its reverse (Nos. 4165, 4166) is very fragmentary, showing little besides the border of the apical half of the wing with the pterostigma, and most of the postcubital nervules. I have here considered it the hind wing of the same species, from its similar size, the exact resemblance of the pterostigma, which also surmounts four cellules, and the indication of a similar profusion of intercalated supplementary nervules. It seems, however, not improbable that it may prove to be a second species of the same genus, from the great difference in form. The two borders of the outer half of the wing are nearly parallel, and the apex falls a little below the middle. This difference, however, really concerns only the posterior curve of the wing below the apex. The nodus is not preserved. Greatest breadth, 7.5^{mm}.

Considering the fragments of heads, etc., referred to under the genus as belonging to this species, we have to add Nos. 4179, 4180, and 4182 (besides No. 62 of Mr. Richardson's collection) as representing heads; Nos. 4183, 4184, the united head, thorax, and base of wings; and Nos. 4170, 4173, 4174, 4177, 4178, as parts of the abdomen. The abdomen shows a slender, dorsal, pale stripe, distinct and moderately broad on the sixth to the eighth segments, scarcely reaching either border, and posteriorly expanding into a small, round spot; and a faint dorsal line on the fourth and fifth segments, interrupted just before the tip. The appendages are simple.

Length of head (according to the mode of preservation), 4.0-4.5^{mm}; breadth of same, 5.5^{mm}; length of thorax, 5^{mm}; of pedicel of wing, 5^{mm}; of abdomen (probably 1^{mm} should be added for a break at the base), 39^{mm}; length of segments 8 to 10, 6^{mm}; breadth of ninth segment, 2.75^{mm}; of fifth segment, 2.1^{mm}; estimated length of whole body, 55^{mm}.

Named for my friend and fellow collector of Green River fossils, Mr. Frederick C. Bowditch, of Boston.

Green River, Wyoming. Three specimens, Nos. 4165 and 4166, 4167 and 4168, 15244, besides the parts of the body mentioned.

2. Dysagrion lakesii.

A nearly perfect wing and its reverse represent another species of this genus, which is more nearly allied to D. packardii than to D. fredericii, differing from the former principally in the form of the quadrilateral and the shape of the pterostigma, which, although as long as there, surmounts only three cellules. There are two antecubitals, one at, the other a little before, the arculus; the base of the principal and short sectors is straight, the cellules in the discoidal area are much as in D. fredericii, the quadrilateral is twice as long as its mean breadth, its basal margin half as long as its apical, and the vein forming the lower margin bent at a similar angle with the inferior vein of the triangle as in D. fredericii; the nodus is placed at one-third the distance from the arculus to the pterostigma. The wing is hyaline, excepting the fuliginous pterostigma, which is four times as long as broad, surmounts three cellules, and is bordered by thickened black veins; its outer margin is much more oblique than its inner; there are nineteen postcubitals.

Probable length of wing, 35^{mm}; length of part beyond peduncle, 33^{mm}; breadth, 8^{mm}; distance from arculus to nodus, 8^{mm}; from nodus to tip of wing, 22.5^{mm}; from nodus to inner corner of pterostigma, 15.5^{mm}; length of pterostigma, 3.75^{mm}.

Named for Prof. Arthur Lakes, of Colorado, my companion in exploring the fossil insect beds of the West.

Green River. One specimen, Dr. A. S. Packard, Nos. 259 and 260.

3. Dysagrion packardii.

Pl. 6, Figs. 1, 3, 11.

Dysagrion packardii Scudd., Zittel, Handb. d. Palæont., I, ii, 776, Fig. 979 (1885).

Another species of this genus is represented by a nearly complete front wing, a fragment of a wing and its reverse, and by a tolerably perfect body presumably belonging to it. The wing agrees with that of D. fredericii in form and size, but differs in the following particulars: No antecubitals exist, except in the neighborhood of the arculus, one being present nearly half-way from it to the base and another may exist in the broken part of the wing just beyond the arculus; the base of the principal and short sectors is straight; the cellules in the discoidal area are, if anything,

slenderer than in that species; the quadrilateral is of about equal lengtn and breadth, its basal only a little more than half the length of its apical margin and the vein forming its lower margin bent at a much greater angle with the inferior vein of the triangle than in the preceding species; the nodus is placed slightly beyond one-third the distance from the arculus to the pterostigma, while in the preceding species it is placed, if anything, at less than one-third that distance; the wing is hyaline, excepting the dusky pterostigma, which is about three times as long as broad, surmounts four cellules, and is bordered by thickened black veins; there are nineteen postcubitals.

The body is slender, the legs slender, but not very long, armed with long hairs, and the abdomen, which is considerably longer than the front wing, is viewed partly from the side and partly from above; the superior male appendages are shorter than the tenth segment, quadrate, apparently of equal length and breadth, with a slightly projecting tooth at the inner tip directed inwards.

Length of entire body, 49^{mm}; head, 3^{mm}; thorax, 8.5^{mm}; fore femora, 4.25^{mm}; middle femora, 5^{mm}; hind femora, 6^{mm}; abdomen, 36^{mm}; second joint, 3.5^{mm}; third, 5^{mm}; fourth to sixth, each 6^{mm}; seventh, 4.5^{mm}; eighth, 2.5^{mm}; ninth, 1.5^{mm}; tenth, 1.1^{mm}; appendages, 0.6^{mm}; breadth of head, 4.5^{mm}; second to fifth abdominal segments (side view), 2.75^{mm}; sixth and seventh abdominal segments (top view), 1.75^{mm}; eighth, 3^{mm}; ninth, 2^{mm}; tenth, 1.75^{mm}; appendages, 0.6^{mm}; length of wing, 36.5^{mm}; of part beyond peduncle, 34.5^{mm}; breadth, 8.6; distance from arculus to nodus, 9^{mm}; from nodus to tip of wing, 22.75^{mm}; from nodus to inner angle of pterostigma, 16.75^{mm}; length of pterostigma, 3^{mm}.

Named for the world-known American entomologist, Dr. A. S. Packard, of Brown University.

Green River. Three specimens, Dr. A. S. Packard, Nos. 146, 147, 252 and 253.

2. PODAGRION de Selys.

Tropical South America claims the half dozen known living species of this genus, most of which have been found in Colombia and Venezuela. The single species we refer here is somewhat imperfect but apparently belongs here, and can certainly not be far removed from it, for it agrees with it in the character of the pterostigma and the supplementary sectors. Except this no fossil species have been found.

PODAGRION ABORTIVUM.

Pl. 6, Figs. 7, 8.

Podagrion abortivum Scudd., Bull. U. S. Geol. Geogr. Surv. Terr., IV, 775-776 (1878).

The specimen represents the apical part of a wing with fragments of the middle portion. The pterostigma is a little more than twice as long as broad, and, although less oblique on the inner than on the outer side, yet lies at an angle of forty-five degrees with the costal edge, and is therefore more oblique than usual in Podagrion; its outer side is arcuate as well as very oblique, but in its entire extent the pterostigma scarcely surmounts two cellules; the outer side is much thicker than the inner, and thickens below as it passes gradually into the lower border, which, like the costal, is much thickened, and appears the more so from being independent of, although in conjunction with, the median nervure. Beyond the pterostigma the ultranodal approaches the principal nervure very closely, so that they are only half as far apart at the margin as below the pterostigma; there are two supplementary sectors, one between the ultranodal and the nodal, arising below the outer half of the pterostigma, the other between the nodal and subnodal, arising slightly farther back; both of these supplementary sectors are straight, but the nodal is slightly undulated after the origin of the supplementary sectors; all the other veins, excepting the extreme tip of the principal, are straight, and the reticulation tetragonal. The wing appears to be hyaline throughout, the pterostigma very slightly infumated, the nervures fusco-castaneous, those about the pterostigma deepening nearly to black. Apically the wing is well rounded, its apex falling in the middle and not at all produced. A species is indicated of about the size of P. macropus Sel.

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

Green River. One specimen, No. 4169.

3. LITHAGRION gen. nov. (λίθος, Agrion).

Subnodal sector originating from the nodus, the median a little more than one cellule previous to it, the nodal at a little less than one-third the distance from the nodus to the pterostigma; the latter is stout, dilated, surmounts about five cellules, its inner border a little oblique, its outer slightly

oblique in the same sense. Reticulation dense, mostly tetragonal excepting in the region of the supplementary sectors of which there are two between each pair of sectors from the ultranodal to the short sector, excepting in the interspace between the subnodal and the median; none excepting the upper ones are curved, and there is also a single very brief one between the short sector and the superior sector of the triangle. Postcostal space simple or nearly so, the inferior sector forming it extending beyond the middle of the wing but not reaching the border. Wings enlarging considerably towards the middle, strongly petiolate nearly to the base of the quadrilateral; this is several times longer than broad, enlarging slightly away from the base, the lower side from a fourth to a third longer than the upper. Nodus situated about one-third the distance from the base to the pterostigma.

This genus is closely allied to Philogenia and Podagrion, the subnodal and median sectors having a similar origin, but it is clearly distinct from either; it differs from the former in the structure of the pterostigma, which nowhere departs from the costal margin, in the straightness of the supplementary sectors, the obliquity of the apex of the quadrilateral, the greater distance of the nodus from the base of the wing and the less petiolated and more broadly expanded form of the wing. In the number and position of the supplementary sectors, however, it closely resembles it. From Podagrion it differs in the earlier departure of the nodal from the principal vein, the larger number of cellules below the pterostigma, the much greater number of supplementary sectors, and the more broadly expanded wing; it resembles it rather than Philogenia in the structure of the pterostigma, the petiolation of the wing, and the position of the nodus. It differs even more from Dysagrion, which I have placed in the same group, than from either of these two recent genera. Two species have been discovered, both from Florissant.

Table of the species of Lithagrion.

Wings clear; postcubitals few ..... 1 *L. hyalinum.*
Wings clouded except at base and apex; postcubitals numerous ..... 2. *L. umbratum.*

1. Lithagrion hyalinum.

Pl. 13, Fig. 4.

A pair of wings, barely overlapping at the postcostal margin and with the tips broken beyond the middle of the pterostigma, but otherwise in admirable preservation, represent this species; they appear to be upper wings.

The wings are hyaline and are petiolated up to the base of the quadrilateral or some distance beyond the first postcostal nervule. Ultranodal sector originating from a cross vein midway between the nodus and the pterostigma, its course regular and not zigzag throughout its extent; inferior sector of the triangle straight to near its tip, where it bends a little upward, running parallel to the margin and terminating in a cross vein, a little irregular near the tip. Pterostigma dark chocolate brown, the bordering veins thickened and black; being broken its form can not be positively stated, but it appears to be nearly four times as long as its median width and considerably expanded on the under surface, probably surmounting four or five cellules; quadrilateral more than four times its breadth at base, its lower side half as long again as the upper, the outer side very oblique. Nodus rather more than one-third the distance from the base to the pterostigma; sixteen postcubitals. Wings rather slenderer than in L. umbratum.

Probable length of wing, 33^{mm}; breadth, 6.6^{mm}; distance from nodus to pterostigma, 17^{mm}; from nodus to base, 11.5^{mm}; breadth of wing in middle of petiolated portion, 1.3^{mm}.

Florissant. One specimen, No. 8619.

2. Lithagrion umbratum.

Pl. 13, Figs. 12, 14.

Two specimens, one a complete wing, the other lacking only the extreme base and an insignificant fraction of the apical margin, represent this species. Both appear to be upper wings.

The wings are hyaline at base and tip, faintly or distinctly clouded on the disk, the clouded portion having distinct lines of separation from the hyaline area; the inner line is straight and transverse, crossing the wing from the second postcubital veinlet; the outer line is bent or curved somewhat, subparallel to the apical margin, and runs from the middle of the pterostigma to a little beyond the apex of the short sector, bending on the nodal sector. The wings are petiolated very nearly up to the first postcostal nervule, which is placed shortly before the base of the quadrilateral. Ultranodal sector originating from a cross vein a little distance beyond the nodal and shortly before a point midway between the nodus and pterostigma; its course is more or less zigzag at its origin and again in the middle, but is mostly simple; inferior sector of the triangle straight in its basal half,

beyond more or less irregular, increasingly so towards its apex, where it bends upward so as more gradually to approach the border, and finally ends close to the superior sector of the triangle in a cross vein; many of the cellules in the apical half of the postcostal space are broken by cross veins forming a broken supplementary sector here, and the same thing occurs feebly in the interspace above. Pterostigma scarcely more infumated than the disk of the wing, expanding slightly in the middle, about four times as long as broad, surmounting five to six cellules. Quadrilateral very slender, five or six times as long as its basal breadth, its lower about one-fourth longer than its upper side, its outer side oblique. Nodus rather more than one-third way from the base to the pterostigma; twenty-seven postcubitals. Wings rather stouter than in L. hyalinum.

Length of wing, 34.5^{mm}; breadth in middle, 8.5^{mm}; in middle of petiole, 1.5^{mm}; distance from nodus to pterostigma, 18^{mm}; from nodus to base, 10.5^{mm}.

Florissant. Two specimens, Nos. 6927, 8163.

Legion AGRION de Selys.

All the fossil species of this group, both in Europe and America, have been referred to the genus Agrion, which is by far the richest of its members at the present day.

AGRION Fabricius.

This genus, in recent times one of the largest and most cosmopolitan of the legion to which it belongs, is represented in the rocks by a single species in Europe, A. aglaope Heer from Oeningen, and the two species from America here described. Besides these a single immature species has been found in Europe (Oeningen) and another in America (Florissant), which are placed in this group as typical of the Agrionina.

The genus is, as stated, cosmopolitan, but its richest representation is in the tropics, and in the northern hemisphere at least it is more richly developed in the New World. The two species here described from wings are not sufficiently perfect to decide into what subgenus they will fall, but they are certainly closely related to each other and appear to be most nearly allied to Amphiagrion or else to Pyrrhosoma or Erythromma.

The American fossil species of Agrion which are represented by their wings may be separated as follows:

Table of the species of Agrion.

Four antenodal cellules below the short sector; antenodal portion of the costa scarcely arched.
1. *A. mascescens.*

Three antenodal cellules below the short sector; antenodal portion of the costa noticeably arched.
2. *A. exsularis.*

1. AGRION MASCESCENS.

Pl. 13, Figs. 8, 9.

This species is represented by a pretty well preserved specimen and its reverse showing most of the body, a part of the legs and the wings, but the latter confused by the overlying of those of one side upon those of the other. The head is preserved only enough to show its form, which has nothing peculiar, and the same may be said of the thorax. Seven joints of the slender abdomen are preserved, the second of which indicates that the specimen is a male. The head and thorax with the legs are black, but the abdomen is colorless; the legs are doubled up, the femora about as long as the breadth of the head, and the tibial spines, of which there are seven or eight in a row, are a little shorter than the interspaces between adjacent ones The wings are scarcely depressed at the nodus, the antenodal portion of the costal margin almost straight, hyaline with black veins, the pterostigma normal, rhomboidal, slightly longer than broad, alike on both wings, the only difference being in a slightly greater obliquity of the outer and inner margins (and especially of the outer) and the slightly shorter lower margin in the front wing; very pale fuliginous, fading out towards the margins, margined with heavy blackish veins, surmounting a single cellule. The inferior sector of the triangle originates far before the basal postcostal nervule, which is situated slightly nearer the second than the first antecubital nervule. The arculus is directly beneath the second antecubital nervule. There are apparently eleven postcubitals on the fore wing and there are ten on the hind wing. Quadrilateral of the fore wings with the inner and upper side of similar length and half as long as the lower side; on the hind wings the inner side is considerably shorter than the upper, and the latter nearly three-fifths the length of the lower; four antenodal cellules below the short sector; the petiolation begins unusually near the base of the wing or considerably before the first antecubital nervure. The nodal orig-

inates rather less than half-way from the nodus to the pterostigma; the subnodal terminates quite beyond the extreme tip of the pterostigma, the median below its tip, the short sector, which ends in a zigzag course, before the pterostigma and below the origin of the ultranodal; the superior sector of the triangle, which is straight to the tip, midway between the origin of the nodal and the pterostigma; and the inferior sector of the triangle, which becomes zigzag a little beyond the nodus, terminates a little before the last.

Length of wings, 21.3^{mm}; breadth, 4.6^{mm}; distance from nodus to base, 7.25^{mm}; to arculus, 3.4^{mm}; to center of pterostigma, 12.5^{mm}; breadth of head, 3.5^{mm}; diameter of eyes, 1.25^{mm}; length of thorax, 5^{mm}; of femora, 3^{mm}; of tibial spines, 0.25^{mm}; of abdomen (seven joints), 24.5^{mm}; of first joint, 0.6^{mm}; second, 1.8^{mm}; third, 4.4^{mm}; fourth, 5^{mm}; fifth, 4.6^{mm}; sixth, 4.6^{mm}; seventh, 3.4^{mm}; width of last, 1.2^{mm}.

While the venation of the wing proves that this insect belongs in the legion Agrion, the unusually short petiolation of the wing shows that it can not be referred to Telebasis, and the short spines of the tibiæ that it can not be an Argia. To which of the numerous subgenera of Agrion it should be referred can not be determined at present, but from the apparent want of postocular spots and the early origin of the inferior sector of the triangle it would appear to be most nearly allied to Amphiagrion or else to Pyrrhosoma or Erythromma. If to the former its affinities are with tropical American forms; if to the latter with temperate forms of either hemisphere.

Florissant. Two specimens, Nos. 6824, 7158.

2. Agrion exsularis.

Pl. 13, Fig. 6.

A single nearly perfect wing differs so slightly from A. mascescens that it would appear to belong to the same restricted genus, although from our ignorance of the length of its tibial spines it might be considered an Argia. The wing, which is apparently an upper one, is a little depressed at the nodus, the antenodal portion of the costal margin being somewhat arched, hyaline with black veins, the pterostigma normal, rhomboidal, slightly longer than broad, the outer and inner margins considerably oblique, the outer perhaps the more so, fuliginous, margined, especially within, with heavy black veins, surmounting rather more than one cellule. The inferior sector of the triangle originates before the basal postcostal nerv-

ule or just beneath the first antecubital; the petiolation therefore begins at this point; the basal postcostal lies midway between the two antecubitals; the arculus is directly beneath the second antecubital nervule; there are eleven postcubitals; quadrilateral with its inner side scarcely shorter than its upper, the latter half as long as the lower side; three antenodal cellules below the short sector. The ultranodal originates only two cellules before the pterostigma; the nodal at scarcely less than half-way from the nodus to the pterostigma; the subnodal terminates just below the tip of the pterostigma, the median below its middle; the short sector, which has a zigzag course in the outer fourth of the wing, terminates apparently below the base of the pterostigma or scarcely short of it.

Length of wing, 21.65^{mm} (the extreme base is not represented in the plate, although part of it is preserved); breadth, 4.35^{mm}; distance from nodus to base, 7.65^{mm}; to arculus, 3.5^{mm}; to center of pterostigma, 12.5^{mm}.

This species differs from the preceding principally in the longer petiolation of the wing, the arching of the base of the costa, the number of antenodal cellules beyond the quadrilateral, and the more apical termination of the upper sectors.

Florissant. One specimen, No. 8146.

AGRION TELLURIS.

Pl. 13, Fig. 10.

Two nymphs, evidently belonging to the same species, have been found, and, considering the impossibility of determining to which, if any, of the species of Agrionina found in the perfect state they belong, they are treated as distinct, following the precedent set by Heer, and followed by others. The head is full, well rounded in front, squarely truncate and a little angulated behind, about half as broad again as long, scarcely broader than the thorax; the antennæ, or such parts as are preserved, are very slender, a little shorter than the head, the basal joint twice as stout, about twice as long as broad. The legs are very long and slender, especially the hinder pair, which would reach to the base of the antepenultimate abdominal joint; the femora are narrowly and equidistantly four times barred with dark bands, the extreme bands at base and apex; the tibiæ are less than half as broad as the femora and have a broader median dusky band. The dark wing pads are long and slender, twice as long as the width of the abdomen, and less

than half as broad, nearly reaching the extremity of the third abdominal segment. The abdomen is equal, scarcely tapering apically, the joints twice as broad as long, entire, not excepting the last. The caudal flaps or tracheal pads are considerably more than half as long as the abdomen, the middle one, showing on the left in Fig. 10, long, slender, fusiform, pointed apically, largest a little beyond the middle; the lateral pair are much larger and asymmetrical, the inner flange, or the portion of the tracheal pad lying within the median rod, being subequal, but broadest just before the tip, as broad throughout as the broadest part of one flange of the median flap; the outer flange gradually expanding with a slight convexity from the base to a little beyond the middle, where it is twice as broad as the opposite flange, and then tapering rapidly, regularly, and with a scarcely perceptible concavity, to the tip of the median rod; the edges of the pads are delicately denticulate, distantly on the expanding basal portions, more densely on the apical tapering parts and especially on the outer edges of the lateral pads, the denticulations, like the median ribs, being black.

Length of body (excluding terminal flaps), 21^{mm}; of front femora, 3.25^{mm}; middle femora, 3.25^{mm}; hind femora, 5^{mm}; hind tibiæ, 6.25^{mm}; hind tarsi, 2 25^{mm}; wing pads, 6.5^{mm}; breadth of head, 3.5^{mm}; thorax, 3^{mm}; base of abdomen, 2.65^{mm}; tip of same, 2.1^{mm}; length of terminal flaps, 7.5^{mm}; breadth of lateral flaps, 2^{mm}.

In the present state of our knowledge of the larvæ of Agrionidæ it is impossible to indicate with any certainty the position of this nymph. The absence of any sign of the mask, too, will remain a difficulty when we are more familiar with the living forms, but the small size of the head and the shape of the antennæ and caudal flaps will afford good points for comparison.

Florissant. Two specimens, Nos. 13525, 14174.

Tribe ÆSCHNINA Hagen.

This group of larger Odonata seems to have been less richly endowed with species and genera than the other families both in past times and at present. The most recent study of the group by de Selys, which has just appeared, divides the Æschnidæ proper into five genera and twenty-three subgenera, of which Æschna, with more than half the subgenera, embraces more than half the one hundred and fifty known recent species and is cosmopolitan. It also embraces all the known fossils from the Tertiaries,

excepting one from Radoboj, an Anax, first described as Æschna metis by Heer. Four fossil species are known from the Old World and two are here described from the New. Of the Old World types one is merely mentioned by Hagen as found in amber and is represented only by the tip of a wing. A second, from Bornemouth in England, has been figured by Goss without a name. It appears to belong to the subgenus Basiæschna, but, as it is certainly incorrectly drawn in some particulars, it may be in those, such as the simplicity of the subnodal sector, upon which this suggestion is based. The other two, Æschna polydore and Æ. tyche from Oeningen, were described nearly thirty-five years ago by Heer, and are certainly very closely allied, though distinct, as Heer pointed out. They seem to belong pretty certainly to Æschna s. s., and are apparently not far removed from the European Æ. mixta Latr., as I judge from direct comparisons with the entire series referred by de Selys to Æschna s. s., which I have had the opportunity of studying in the Cambridge Museum through the favor of Dr. Hagen. Heer also directly compares the former to that species, as I subsequently noted. Our independently formed opinions have therefore completely coincided. These two species are also very nearly allied to one of the American forms, which, however, more closely resembles a common American species, Æ. constricta Say. The other American fossil belongs to Basiæschna. The resemblance of the Tertiary æschnid fauna of Europe and America appears therefore to have been tolerably close. (September, 1883.)

ÆSCHNA Fabricius.

All the fossil Æschnina known, excepting one (an Anax), belong to Æschna, two European and one American to Æschna proper, and one from each country to Basiæschna.[1]

The species of Æschna from Florissant known by their wings may be separated thus:

Table of the subgenera of Æschna.

Subnodal sector forked, its upper fork separated from the nodal by a single row of cells; pterostigma hardly more than three times as long as broad and only one-fourth as long as the space between it and the nodus ..... 1. *Æschna s. s.*

Subnodal sector simple, separated from the nodal by three rows of cells; pterostigma four or five times as long as broad, more than one-third as long as the space between it and the nodus. 2. *Basiæschna.*

[1] Vide supra.

1. Subgenus ÆSCHNA Selys.

This group of the genus Æschna is a cosmopolitan one, and includes a larger proportion of the species than any other. To it belong two European and one American fossil species, all closely allied, but the European more nearly related to an existing European species, Æ. mixta, the American to an existing American species, Æ. constricta, than to any others.

ÆSCHNA (ÆSCHNA) SOLIDA.

Pl. 13, Fig. 1.

A remarkably well preserved front wing, the extreme base only lost Wing of rather small size and rather slender, the middle line of the basal half bent at a slight angle with that of the apical half; tip of the wing uniformly rounded; nodulus above the principal sector strongly and rather regularly curved, much nearer the pterostigma than the base; nodal sector curved rather gently upward in the middle portion of its course but terminating some distance below the apex of the wing; subnodal sector forked widely a little before the pterostigma, the upper fork turning abruptly upward at its origin; the intercalated sector between the subnodal and median forked below the base of the pterostigma, its upper fork also curved upward and separated at tip from the lower fork of the subnodal by only a single row of cells, as usual; median and short sectors separated in the apical half (or less) by a double row of cells in the discoidal field below the triangle, first two, then three, and afterwards four or five rows of cells irregularly disposed. Pterostigma scarcely four times as long as broad, the inner and outer margins very oblique and parallel; color blackish castaneous, the bordering veins black. Antecubitals more than twenty-two (probably about twenty-five), postcubitals fifteen.

Length of wing more than 41^{mm} (probably 44^{mm}); breadth, 10.5^{mm}; distance from nodulus to base of pterostigma, 15^{mm}; length of pterostigma, 4^{mm}.

This species plainly belongs to the subgenus Æschna. By favor of Dr. Hagen I have compared it directly with all the species referred by Selys to that group, excepting a couple of rare forms, and unquestionably it is most closely allied to Æ. constricta, though closely resembling Æ. marchali. Indeed, the resemblance to Æ. constricta is closer than I have yet found between any well preserved Florissant insect and any living

type; it agrees better with it than Æ. constricta does with any other living form. The nodal sector of Æ. solida is not so strongly curved as in Æ. constricta, and the pterostigma of the fossil is slightly longer; these are the most important distinctions that were noted.

Florissant. One specimen, No. 8347.

2. Subgenus Basiæschna Selys.

As was stated in the general remarks under Æschnina, Goss's unnamed Æschnid from Bornemouth, England, probably belongs to this group; an interesting fact since, so far as I know, it is exclusively an American group, and one of our own fossils falls therein. It is the only subgenus of Æschna besides Æschna proper which is known in a fossil state.

Æschna (Basiæschna) separata.

Pl. 13, Fig. 15.

A complete front wing and its reverse broken near the course of the median sector and the part below crowded up against the upper portion, so as to confuse the parts next the line of fracture.

The wing is of rather small size, rather slender and straight; the tip is slightly angulated rather below the middle of the wing; nodulus placed at almost two-thirds the distance from the base to the pterostigma, scarcely directed backward above the subcostal, below that straight, directed somewhat forward and reaching the subnodal; nodal sector curved rather strongly and somewhat rapidly upward in the middle part of its course, terminating a little distance below the tip of the wing; subnodal sector simple and beyond the base of the pterostigma subparallel to the nodal; the intercalated sector between the subnodal and the median simple, but curved in the course of what would be the superior fork if it were branched, and even more strongly curved than in Æschna solida; median and short sectors separated apically by a double row of cells, but to how far from the margin can not be seen; in the discoidal field below the triangle there are at first two, then three, and afterwards four or five rows of cells, the last arranged in somewhat obscure oblique series. Pterostigma five times as long as broad, both outer and inner margin very oblique, but the outer much more so than the inner; the color uniform pale clay brown, but the thickened bordering veins black. Antecubitals twenty-three, postcubitals thirteen.

Length of wing, 44^{mm}; breadth, 10.2^{mm}; distance from base to nodulus, 21.5^{mm}; from nodulus to base of pterostigma, 13.2^{mm}; length of pterostigma, 5^{mm}.

This species differs from Æ. solida in its more pointed tip, straighter form, simple subnodal sector, which is separated from the nodal by three rows instead of one row of cells, and by the greater approximation of the nodulus to the pterostigma as well as by the greater length of the latter.

It is very closely related to Æschna janata Say, which Selys makes the type of his Basiæschna. The nodal sector has precisely the same curve just before the pterostigma, and it differs mainly in the more arcuate tip of the principal nervule intercalated between the subnodal and median sectors.

Florissant. One specimen, Nos. 8164 and 11693.

ÆSCHNA LARVATA.

Pl. 13, Fig. 11.

A single specimen of a larva has been found belonging to this genus and not improbably belonging to one of the species described; but as this can not from the nature of the case be determined it will be best to give it a distinct name for ready reference. The front half of the body is rather obscure, but the outline shows the form with sufficient distinctness. The body is largest in the middle of the abdomen, scarcely decreasing in size anteriorly, but posteriorly narrowing somewhat rapidly beyond the fourth abdominal segment; the outer edges of the posterior borders of the segments are not produced; the three anal valves are distinctly seen, are very slender and finely pointed; one of the legs is preserved, showing that it is slender and of the usual form.

Length of body, 34.5^{mm}; breadth in middle of abdomen, 7.5^{mm}; at base of abdomen, 6^{mm}; at base of anal valves, 2.5^{mm}; length of latter, 3 25^{mm}; of femur of hind (?) leg, 6^{mm}; of tibia, 4.5^{mm}; of tarsi, 4.25^{mm}.

Florissant. One specimen, No. 1816.

Tribe LIBELLULINA Hagen.

A small number of species of this tribe occur in the European Tertiaries.

LIBELLULA sp.

Pl. 6, Figs. 4, 16.

(*Libellulina*) Scudd., Bull., U. S. Geol. Geogr. Surv. Terr., IV, 775 (1878).

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

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

Green River, Wyoming. One specimen, Nos. 4175 and 4176.

Suborder PLANIPENNIA Burmeister.

The collections obtained at Florissant embrace eight genera and thirteen species of planipennian Neuroptera. All of the species and four of the genera are new, and belong to four families. The Raphidiidæ are the most numerous, embracing Raphidia, with a single species, and Inocellia with four; the species referred to Raphidia hardly belongs to it in a strict sense, since the costal vein is excessively short, there are no costal veinlets, and the sectors do not originate obliquely from the radius, but more indirectly by transverse veins; all the species of Inocellia, which fall into two sections, differ from living types and also from the species found in Oligocene amber of the Baltic in having no transverse series of regular discoidal areoles below the pterostigma. A single species of Osmylus represents the Hemerobidæ, and differs from living forms, as does also the amber species, in the simple character of the costal nervules, the much smaller number of sectors, and the limited supply of cross-veins in the basal half of the wing, giving this region a very different appearance from its rather close reticulation in modern types. It may here be noticed that as a very general rule the neuration of the wing is much closer in modern Planipennia than in their Tertiary representatives.

There are four species of Chrysopidæ, referable to two genera, each of them extinct; Chrysopidæ have not before been recognized in Tertiary strata, the single species poorly figured by Andrä, and never carefully studied, being much more probably one of the Hemerobidæ. These two genera, called Palæochrysa and Tribochrysa, are allied to the living Nothochrysa, but differ from modern types in the zigzag course of the upper cubital vein, and in its direction, which is through the middle of the wing, as well as by the smaller number of sectors and the entire absence of any transverse series of gradate veinlets; Palæochrysa is represented by a single species, Tribochrysa by three, and the genera differ from each other in the course of the upper cubital vein, which in Palæochrysa is direct and bordered by comparatively uniform cells, while in Tribochrysa it is doubly bent in the middle, and is therefore bordered by very unequal cells. Two species of Panorpidæ have been found, one of which is referable to a new genus, Holcorpa, which differs from Panorpa in the entire absence of cross-veins, and is remarkable for the spots on the wings. All these have been discovered at Florissant only. No planipennian Neuroptera have been found in the Green River shales, but the Tertiary beds of British Columbia have furnished a single species of Hemerobidæ, belonging to an extinct genus allied to Micromus, and which I have called Bothromicromus; and we have remains of one of the Sialidæ from beds of Laramie age in Colorado, which is introduced here.

The number of species of Tertiary Planipennia is nearly doubled by the discoveries already made in the American Tertiaries, but the families, and especially the genera, are very differently represented on the two continents; thus the Raphidiidæ have in Europe only one species of Inocellia, while, on the other hand, the Hemerobidæ show one or more species each of Nymphes, Sisyra, Hemerobius, and Osmylus. The Chrysopidæ, as stated, are unrepresented, although two species are known from the Jura. The Panorpidæ have one species of Panorpa and three of Bittacus, while there are also two species of Ascalaphus and one each of Myrmeleon, Chauliodes, and Coniopteryx, belonging to families not found fossil in this country. (September, 1883.)

Family SIALINA Leach.

This family is composed of two groups, each represented in our rocks. As they differ somewhat remarkably in history and distribution, such general remarks as can be made will appear in contrasting the statements which follow under each.

Subfamily SIALIDÆ Stephens.

The Sialidæ are evidently an expiring type. A considerable number of Paleozoic forms have been referred, with more or less reason, to it or its vicinity, and certainly the resemblance of its modern genera to the bulk of the ancient neuropteroid types is greater than can be affirmed of any other modern group. Yet even in the Mesozoic period we know of comparatively few examples; Hagen refers an undescribed species from the Jura to Corydalus; Westwood figures a Sialium from the Purbecks, and the species given here, belonging to the disputed Laramie beds, is known only by its egg-masses; I have also shown that the larval Mormolucoides articulatus Hitchc. from the Connecticut River sandstones is to be regarded as a sialid. In Tertiary times, where the number of insects known is vastly increased, we find no greater representation. One species only, Chauliodes prisca, from the amber, is well known; Gravenhorst and Burmeister speak of a Semblis from amber, which may be the same as Hagen's, above mentioned; and an insect's leg from Rott has been doubtfully referred here. No species of this group has been found in the American Tertiaries. So too we find the existing species very meager as compared with other families of Neuroptera; but that some existed in American Tertiaries can not be doubted by any who will compare our huge living Corydalus with the still more gigantic Corydalites from the Laramie beds. (September, 1883.)

CORYDALITES Scudder.

Corydalites Scudder, Bull. U. S. Geol. Geogr. Surv. Terr., IV, 537 (1878).

The egg-masses thus named were described by me in 1878, but it was not until the publication of a figure of one of them in Zittel's Handbuch der Palæontologie, in 1885, that their existence in beds of quite similar age in Europe was recognized. On this point I may quote from a letter written me by the Marquis de Saporta in May, 1886:

Il m'a suffi de jeter les yeux sur votre figure 981 pour reconnaître l'identité parfaite de votre Corydalites fecundum avec des corps fossiles, ayant même aspect et même composition qui ont été recueillis en assez bon nombre et *parfaitement* conservés dans notre terrains à lignites de Fuveau près d'Aix, et justement ces lignites sont maintenant rapportés universellement au Garumnien inférieur, et même plus bas au Campanien, c'est à dire, à l'horizon de la craie supérieure. Il est donc très intéressant de constater la présence de ces nids ou réunions d'œufs de Corydalis, au même niveau, en Europe comme en Amérique et probablement dans les mêmes conditions de dépôt. Les Corydalites fecundum ont été recueillis à Trets près de Fuveau dans les lits charbonneux exploités, où ils se trouvent associés à des feuilles de Nelumbium. Il est même visible que ces Nelumbium ont vécu sur place et les Corydalites ont du vivre côte à côte et placer leurs œufs dans des mêmes lieux.

CORYDALITES FECUNDUM.

Pl. 4, Figs. 5–7, 13–16, 18–21, 23.

Corydalites fecundum Scudd., Bull. U. S. Geol. Geogr. Surv. Terr., IV, 537–540 (1878); in Zittel, Handb. Palæont., I, II, 776, Figs. 981a, b (1885); White, Rep. U. S. Geol. Geogr. Surv. Terr., XI, 173–174 (1879).

Under this name I have classed an insect which laid some remarkable egg-masses, obtained in numbers by Dr. C. A. White, at Crow Creek, fifteen miles northeast of Greeley, Colorado, in lignitic beds of the Laramie group. These egg-masses are five centimeters in length by nearly two in breadth and one in height, nearly equal throughout, rounded and slightly pointed at the tips, and of a dirty yellowish brown. They are estimated to contain each about two thousand eggs definitely arranged, and coated with a covering of what was presumably albuminous matter, which also surrounds each egg. The close general resemblance of these eggs and of their clustering to that of the eggs referred by Mr. C. V. Riley to the neuropterous genus Corydalus[1] leave little doubt concerning their probable affinities. Mr. Riley's description is as follows:

The egg-mass of Corydalus cornutus is either broadly oval, circular, or (more exceptionally) even pyriform in circumference, flat on the attached side, and plano-convex [broadly convex is doubtless meant] on the exposed side. It averages 21^{mm} in length, and is covered with a white or cream colored albuminous secretion, which is generally splashed around the mass on the leaf or other object of attachment. It contains from two to three thousand eggs, each of which (Pl. 4, Figs. 17, 22) is 1.3^{mm} long and about one-third as wide [he figures them of a slenderer form], ellipsoidal, translucent, sordid white, with a delicate shell, and surrounded and separated from the adjoining eggs by a thin layer of the same white albuminous material which covers the whole. The outer layer forms a compact arch, with the anterior ends pointing inwards, and

[1] It has been suggested that these may belong rather to Chauliodes, a closely allied genus of Neuroptera; but Mr. Riley declares that they are identical with these found in the body of Corydalus.

the posterior ends showing like faint dots through the white covering. Those of the marginal row lie flat on the attached surface; the others gradually diverge outwardly, so that the central ones are at right angles with said object. Beneath this vaulted layer the rest lie on a plane with the leaf, those touching it in concentric rows, the rest packed in irregularly.[1]

In the fossil ootheca the mass is much larger and more elongated, and possesses besides one characteristic in which it differs strikingly from that of Corydalus (and on which account particularly I have used a new generic appellation), viz, the division of its mass into two longitudinal and equal halves by an albuminous wall, or rather by double albuminous walls, which may be parted above, leaving as the only connection between the two halves their common albuminous floor. There are indeed a few specimens which show no sign of this division, but a median furrow, or a deeper and more complete separation of the two halves, is so prevalent that this seems to be the only explanation to be offered for its appearance. Their absence in the few specimens is probably due to defect of preservation. The common albuminous floor and the upper and outer albuminous coating are of remarkable thickness, varying from one to three millimeters; but the coating attenuates to a mere lamella as it passes down the median furrow, so that when the mass remained quiet in the position in which it was laid, the lateral halves pressing closely against each other, the combined thickness of the two albuminous walls would together no more than equal the ordinary thickness of the albuminous partition between any two contiguous eggs. That such a partition existed even in those which do not now show it seems probable from the regularity of the furrow in every instance of its occurrence and by its prevalence; some specimens merely show a sharp groove along the middle, the halves remaining in complete juxtaposition;[2] others again are so completely separated as to be curled over and meet beneath (Figs. 19, 23).

This, together with the fact that the egg-mass is otherwise extremely regular (showing only so little plasticity as to allow one broad side to be straight, while the opposite is a little convex) and never exhibits the slightest tendency to coil longitudinally, leads me to believe that the egg-masses were laid in the water of shallow basins, upon the muddy floors, which

[1] Proc. Am. Assoc. Ad. Sci., vol. 25, pp. 277-278.

[2] These specimens are some from which weathering has removed their outer albuminous coating; perhaps, if this had remained, the furrow would have been concealed by the complete union of the attingent albuminous walls.

could be reached by the abdomen of the insect while resting upon a stone or overhanging twig. In this medium the albuminous secretion would expand to the utmost; if the bunch of eggs remained undisturbed, it would present us with the more regular hirudiniform masses that have been found; if rolled about by the disturbance of the waters, the two halves would curl toward each other more or less closely, forming a subcylindrical mass, and inclose between their approaching walls more or less of the mud in which they are rolled. This is exactly the appearance of most of them now, inclosing the same substances as that within which they and the accompanying Bulimi and other fresh-water mollusks lie embedded.[1]

These masses differ from those of Corydalus in the extraordinary amount of albuminous matter which surrounds both the entire mass (Fig. 16) and each individual egg (Fig. 7). This is perhaps to be explained by the medium in which they appear to have been laid, and will in part account for the vast size of the ootheca, which are much larger than any mass of insect eggs which I can find noticed. The size of the mass, however, is also due to the greater magnitude of the eggs themselves, which are twice as long as and proportionally larger than those of Corydalus (Figs. 17, 21), and lead to the conviction that we are to look in the rocks of the Laramie Group for an insect of great magnitude, closely allied to our Corydalus, itself the largest of all known Sialina. It can hardly be doubted that it must have been at least double the size of the living type. The number of eggs laid is about or nearly the same as in Corydalus, presuming, in either case, all to be laid at once.

Compared with the eggs, the albuminous substance surrounding them is much softer, more or less friable, and easily removed, being everywhere composed of fibers running in the same direction as the longitudinal axis of the egg. The weathering of the specimens has been such that in several instances the whole albuminous cap has been removed, and in others a large part also of the interovular partitions, leaving the eggs standing erect, each separated from its neighbors by from one-third to one-half its own thickness. In many cases the eggs can be pulled from their cells; and, although frequently flattened, they may be studied almost as well as if living.

The eggs (Fig. 21) have an average length of 2.6^{mm} and a central

[1] The deposit in which they occur is a fresh-water one; but Mr. Lesquereux informs me that brackish-water forms are found both above and below them. For details concerning the age of the deposit and the fossils associated with Corydalites, see the article by Dr. C. A. White, quoted above.

width of 0.6^{mm}; they are nearly cylindrical, but faintly arcuate, slightly attenuated at the anterior extremity, and slightly tumid on the posterior half, at the tip of which they taper rapidly, rounding off to a rather broadly convex extremity, which is flattened or often sunken in a circular central space 0.1^{mm} in diameter (Fig. 7), outside of which the surface is rather profusely filled with very shallow, obscure, circular pits, averaging 0.01^{mm} in diameter. The anterior extremity (Figs. 5, 6) terminates in a slightly elevated, thin, subtuberculate rim, inclosing a terminal portion, whose surface gradually rises centrally to form a truncated cone, and is pitted with saucer-like depressions, gradually diminishing in size up the sides of the central extension; the latter is about as long as the breadth of its tip; its extremity (Fig. 18), 0.04–0.055^{mm} in diameter, is more or less sunken, with a central circular pit (the micropyle) 0.01^{mm} in diameter; while the rounded margin of the extension is made more or less irregular by the saucer-like depressions which surmount it, but have now become of extreme minuteness.

This structure of the anterior extremity of the egg agrees with what was previously known of the egg of Sialis, but no mention of the elevated point was made in Mr. Riley's description of the egg of Corydalus. It occurs there, however, as I find by examination of eggs he has kindly sent me. These eggs of Corydalus (Figs. 17, 22) also show the sunken space at the posterior end, and the sides of the egg are marked nearly as in the fossil, the surface of the latter being broken up by scarcely elevated, slight ridges into obscure, transverse, hexagonal cells, one-tenth of a millimeter long (across the egg) and one-fifth as broad, those of adjoining rows interdigitating.

In the disposition of the eggs also these masses differ from those of Corydalus, for they are arranged in a radiating manner around the longitudinal axis of the ootheca. All of them partake of this arrangement even when, as rarely happens, there are two layers in place of one over parts of the mass; in no case are any of the eggs packed in irregularly, as is the case with a portion of those of Corydalus, according to Riley. As in Corydalus, however, the posterior ends are those which are directed toward the upper albuminous coating, which in many cases shows very slight subhexagonal or circular depressions or elevations corresponding to the position of the extremity of the egg beneath, just as in Corydalus the posterior ends of the eggs show "like faint dots through the white covering." The outer albuminous coating appears in the fossil to be made up of

as many parts as there are eggs, the interovular fibrous material extending to the surface of the ootheca, forming walls to deep cells which contain eggs, and which are corked up, as it were, by plugs of albuminous material. These plugs seem to be very similar to the cell-walls, having been composed apparently of viscous threads, also running in the same direction as the longitudinal axis of the egg; but in some cases the cell-walls beyond the eggs have become blackened, while the plugs retain their normal color and separate readily from them.

When the egg-mass was undisturbed, the outermost eggs lay horizontally, and those next the median furrow vertically (Fig. 15); the division walls of the cells were therefore thinnest below, and it appears probable that the young made their escape at the bottom of the median furrow, where the outer coating is also thinnest, though not so presented in the schematic figure. Where double layers occur, the eggs of the upper seem to be in a direct line with those of the lower layer, egg for egg, as if a cell of double length were stocked with two eggs, separated by an albuminous partition, and in this case the albuminous floor and covering are thinner than usual, so that the egg-mass is not greatly enlarged nor distorted. When two layers were thus formed, the young larvæ of the upper layer must have escaped through the emptied cells of the lower.

It only remains to add that with a single exception these masses differ comparatively little in size, most of them being nearly or quite five centimeters long, although some scarcely exceed four centimeters. The single exception is of a mass only a little more than fifteen millimeters long, six millimeters broad, and three millimeters high. It shows no furrow, but may represent only one lateral half of an egg-mass, as the walls of one side are steeper than those of the other and look like the sides of a median furrow. This mass is so small that only by presuming one-half to be gone and the albuminous covering to be thinner than usual can it be regarded as belonging to the same species with the others, although evidently of a similar nature. In case it belongs to the same species, it may be looked upon as probable that a female usually deposited all her eggs in a single bunch, but that in this case some accident preventing it, the remnant was subsequently laid in a mass of much smaller dimensions, one-half of which is preserved. This is the view I am disposed to adopt.

Crow Creek, near Greeley, Colorado (Laramie group). Dr. C. A. White. Many specimens.

Subfamily RAPHIDIIDÆ Stephens.

Hitherto only one species of this group has been found in Tertiary beds, and its earlier existence is unknown; this single instance is Inocellia erigena from amber. Now, however, we find them in the rocks themselves, as five species from Florissant are before us, one belonging probably to Raphidia, the others to Inocellia. This is perhaps one of the most striking of the facts yet discovered in the American Tertiaries; for the known species of this family not only are exclusively north temperate[1], but almost exclusively gerontogeic, the only form known from this country east of the Sierra Nevadas being a (probably introduced) European species; several, however, are known from the west coast, whose insect fauna is well known to have very strong European, or at least gerontogeic, affinities. A point of additional interest is the fact that so many species of Inocellia are found and only one of Raphidia (and that doubtful), when Raphidia is very rich and Inocellia very poor in species at the present time. As already stated, the amber species is also an Inocellia. (September, 1883.)

Table of the genera of Raphidiidæ.

Pterostigma crossed by veinlets and therefore composed of more than one cell; wings three times as long as broad ..... 1. *Raphidia.*
Pterostigma composed of a single cell; wings more than three times as long as broad ..... 2 *Inocellia.*

1. RAPHIDIA Linné.

The single species referred here differs considerably from modern forms in the brevity of the costal vein, the absence of costal transverse veinlets, and other features of the neuration which render its reference to Raphidia doubtful. It can not be referred to Inocellia on account of the structure of the pterostigma, and it should perhaps be considered as belonging to a distinct genus. If a true Raphidia it is the first one that has been found fossil.

RAPHIDIA (?) TRANQUILLA.

Pl. 14, Fig. 2 (♂).

A single specimen in which the head is wanting and the four wings are overlapping; the neuration is almost exactly similar in all the wings, and they are of equal size, but for the sake of clearness only one of them, an upper wing, has been drawn for the plate.

[1] It was by error that I alluded to these genera as indicative of a warmer climate for ancient Florissant in the Annual Report of the U. S. Geological and Geographical Survey for 1878, p. 292.

The wings are considerably longer than the abdomen, oval, rounded at the tip, with a gently convex inner margin and a nearly straight costal margin. The neuration is distinct and black and in the front wings as follows: The pterostigma is small, semi-oval, fuliginous, deepening centrally, situated in the middle of the apical half of the wing at the costal margin, cut obliquely by a curving transverse veinlet at its outer extremity. The costal margin is scarcely expanded at the base, and the costal vein is exceedingly short, terminating in the margin before the end of the basal third of the wing: this feature, with others in the neuration and the total absence (as far as can be seen) of costal transverse veinlets, renders it doubtful whether it belongs to Raphidia in a strict sense. The subcostal vein therefore forms a considerable part of the costal border and is widely separated from the radius and connected with it by a single transverse veinlet in the middle of the wing. The sectors do not arise obliquely from the radius, but are connected with it by straight transverse cross-veins, making two long and large pentagonal cells in the middle of the wing beneath the radius, equally broad at both ends. There are three long discoidal areolets, the uppermost narrow, the middle one shorter than the others, the outer limits of all of them nearer to the apical margin than to the inner limits, making the marginal areoles shorter than the discoidal; all the areolets of the central portions of the wing are large, being few in number, and they approach rather near the margin, with which they are connected by few, seldom and then simply furcate, marginal veinlets.

Length of thorax, 1.85^{mm}; of abdomen, 5.2^{mm}; of wing, 7.75^{mm}; breadth of latter, 2.55^{mm}.

Florissant. One specimen, No. 4383 (♂).

2. INOCELLIA Schneider.

The occurrence of a species of this genus in amber and its present existence only in the north temperate region of the Old World and of our extreme western coast, where the affinities of the fauna are decidedly European, render the discovery of four species in our Colorado Tertiaries one of special interest. It is curious, however, that they differ not only from the modern forms, but also from the amber species, I. erigena Menge, in lacking the regular arrangement of the cells below the pterostigma to form a transverse uniform series of discoidal areoles.

The species may be separated thus:

Table of the species of Inocellia.

Central sector of the front wing (or the sector which traverses the middle of the wing above the cubital cells) arising from a broken series of transverse veins connecting the radius and anal vein ..... 1. *I. veterana.*

Central sector of the front wing arising in the angle of, and bisecting, the basal cell formed by the junction of the radius and its basal branch.

Longitudinal row of cells below the radius of equal or subequal length.

Front wing about two and a half times longer than broad; cells just above the cubital cells no longer than they and shorter than those in the row just beneath the radius; prothorax strongly tapering ..... 2. *I. somnolenta.*

Front wing more than three times as long as broad; cells just above the cubital cells much longer than they and as long as those in the row just beneath the radius; prothorax equal. 3. *I. tumulata.*

Longitudinal row of cells next below the radius of very unequal length ..... 4. *I. eventa.*

1. INOCELLIA VETERANA.

Pl. 14, Fig. 1.

A single specimen has been found, in which the two front wings are preserved with an obscure body, lacking the head. This front wing is considerably longer than thorax and abdomen together, nearly four times as long as broad, the apical margin well rounded, not at all produced. The venation is distinct, dark castaneous; the pterostigma is of considerable size, faint castaneous, about four times as long as broad, equal, terminated interiorly by a transverse, exteriorly by a very oblique nervule. The costal margin is straight from the base to the pterostigma with no expansion whatever; the figure of the right wing on the plate is incorrect in this particular, a faint expanded vein being represented where none exists. The subcostal vein runs parallel with the costal vein in the basal half of the wing, and is connected with it by four or five transverse or oblique veinlets, then suddenly turns upward and joins it at some distance before the pterostigma. The radius runs parallel to the costal vein throughout, and is connected with the subcostal by two or three transverse veinlets. The sectors, or longitudinal veins of the central portion of the wing, do not arise at intervals obliquely from the radius as they do in the other species, as well as in the amber I eogena and in modern types, but together form a broken transverse veinlet, curving around from beyond the middle of the basal half of the radius to the anal vein and at intervals from the upper sector. It seems, therefore, to form a somewhat distinct group of Inocellia. There are two sectors springing from the first sector, one in the middle, the other

in the middle of the outer half, of the wing; beyond the origin of the first sector, or the broken set of transverse veinlets of which its base forms the origin, there are four or five very long subhexagonal cells just below the radius, the third from the base reaching the middle of the pterostigma. The number of sectors is so large that, omitting the marginal cells, there are six radiating series of cells between the radius and the anal vein. The cells of the marginal series are of very varying size and shape, but the veins which form them are very rarely forked.

Length of thorax and abdomen, 7.5^{mm}; of wing, 9^{mm}; breadth of same, 25^{mm}.

Florissant. One specimen, No. 1.385, obtained by the Princeton Expedition.

2. Inocellia somnolenta.

Pl. 14, Fig. 12 (♀).

One specimen belonging here, with its reverse, consists of a head and thorax with fragments of legs and wings, among the latter one nearly perfect front wing overlying part of a hind wing. The head is slender and very long oval in shape; the thorax stout with a greatly and regularly tapering prothorax forming anteriorly a very slender neck. Front wing well rounded, rather broad for its length, though its exact breadth can not be told from the broken edges. The neuration is distinct and black, the pterostigma faint, fuliginous, long, and equal, about four times as long as broad, squarely margined basally, obliquely margined distally. The costal margin is nearly straight, gently and slightly expanded, the subcostal vein terminating upon it before it reaches the pterostigma by nearly the length of the latter. Beyond the basal cell, which is bisected by the last sector, and corresponds to the cell situated within the broken series of transverse veinlets in I. veterana, there are immediately below the radius three very long subpentagonal cells, the second reaching beyond the middle of the pterostigma. Omitting the cells which border the margin, there are five radiating series of cells between the pterostigma and the anal vein; the cells are fairly large, varying much in shape but rarely more than twice as long as broad, the terminal veinlets next the margin frequently and widely forked.

Length of head, 2^{mm}; breadth of same, 0.8^{mm}; length of thorax, 4.5^{mm}; breadth of same, 2.4^{mm}; breadth of neck, 0.3^{mm}; probable length of prothorax, 2^{mm}; its breadth at base, 1.75^{mm}; length of fore wing, 7^{mm}; its probable breadth, 2.5^{mm}.

Florissant. One specimen, Nos. 9373 and 10389.

Another specimen shows the apical half of two overlapping fore wings, which differ so little from the preceding that I place it here at least provisionally; it differs principally in the point of immediate origin of one of the veins terminating in the apex, which in the specimen first described originates in the distal, in this specimen in the proximal of the two cells immediately below the pterostigma.

Florissant. One specimen, No. 2603.

3. Inocellia tumulata.

Pl. 14, Fig. 15 (♂).

The species is represented by a single specimen and its reverse in which the entire body and nearly the whole of the four wings are preserved. The head is obscure and ill-defined in part, with no appendages preserved, obpyriform in shape, being broadest in the middle of the anterior half or about three-fourths the length, the front broadly rounded, behind tapering rapidly, so that the base is narrower than the narrow neck formed of the prothoracic segment. This is nearly four times longer than broad, less than half as broad as the head and apparently equal, though the imperfection of the part renders this doubtful. The meso- and metathoracic mass is robust, nearly twice as broad as the head, while the abdomen is only a little broader than the head, equal, and somewhat longer than the rest of the body. The legs, excepting the fragment of a hind femur, are not preserved.

The wings, and especially the front pair, which is considerably longer than the hind pair, are longer than the thorax and abdomen together and more than three times as long as broad. One front wing is almost entirely preserved and separate from the others, so as to be easily studied; the other front wing, of which only a fragment can be seen, overlies the overlapping and reversed hind wings: they do not so closely overlap as to confuse the neuration greatly, and hence nearly the whole can be deter-

mined, or as far as it is preserved. The front wing is long and rather slender, slightly enlarging apically, so as to be broadest at the inner half of the pterostigma, the apex well rounded, the costal margin straight, at base broken so that one may not say whether the wings were here expanded or not. The veins of the front wing are black, of the hind wings blackish brown. The pterostigma of the front wings is of moderate size, very dark fuliginous, its proximal margin transverse, its distal very oblique; excepting its tapering apical portion, it is nearly equal in breadth or slightly enlarging in the middle and about twice as long as broad; the figure is here not quite correct. The subcostal vein is straight and strikes the costa at a little more than the pterostigma's distance before the latter; the space between it and the costa is broken by oblique cross-veins, of which only one remains near the middle of the wing. The radius runs close to the subcostal vein, and is connected with it by a single transverse vein at the middle of the wing. Beyond the basal cell, which is bisected obliquely by the last sector, there are, just below the radius, three moderately long pentagonal cells, the second reaching nearly to the middle of the pterostigma. Omitting the marginal cells, there are six radiating series of cells between the pterostigma and the anal vein; the cubital cells are large and broad, being not more than twice as broad as long, while all the other large cells of the wing are exceedingly long and slender, often several times longer than broad, scarcely, if at all, broader in the middle than at the ends, the transverse veins being comparatively few; the terminal veinlets of the apical half of the lower border are simply and widely forked.

In the hind wings, the lower half only of which is preserved, all the terminal veinlets appear to be forked, and excepting at the upper part of the apex, the sectors, which are broadly sinuous, appear to be very rarely connected by transverse veinlets even near the border; at least almost none can be detected.

Length of body, 11.8^{mm}; of head, 1.8^{mm}; breadth of same, 1^{mm}; length of prothorax, 1.6^{mm}; breadth of same, 0.35^{mm}; breadth of thorax, 1.7^{mm}; length of abdomen, 5.75^{mm}; breadth of same, 0.85^{mm}; length of fore wing, 9^{mm}; its breadth, 2.7^{mm}.

Florissant. One specimen, Nos. 956 and 4330 (♂).

4. Inocellia eventa.

One specimen of this species is preserved in which all four wings closely overlapping one another are attached to a partly preserved body sufficiently preserved to judge by the extremity of the abdomen that it was probably a male, and by its long slender and equal prothorax that it did not differ in this respect from I. tumulata. The base of the wings is too obscure for determination, but the course of the veins renders it probable that the central sector, of the hind wings at least, arises in the angle of the basal cell formed by the junction of the radius and its basal branch; and in the table it has accordingly been placed in that division of the genus. The general features of the neuration show at all events that it is more closely allied to I. tumulata than to any of the others.

In another specimen the wings are of equal length, the front pair very long and slender, being nearly four times as long as broad, the greatest breadth in the middle of the apical half, although the greater part of the apical half is subequal, the apex well rounded, but slightly produced, the costal margin straight beyond the (obscure) base. The veins of both wings are black. The pterostigma, apparently alike in both wings, is blackish fuliginous, of moderate size, its proximal margin transverse, its distal very oblique, forming a nearly continuous curve with its slightly convex lower margin, the whole a little more than twice as long as broad. The subcostal vein is gently curved and strikes the costa at the pterostigma's distance before the latter; the space between it and the costa is pretty broad and filled by numerous straight oblique veins. Below the radius the cell, whose distal extremity lies just beneath the termination of the costo-subcostal interspace, is exceptionally long, being nearly double the length of the cell beyond it, and the cells which lie beneath its distal extremity are bordered externally by a common line which lies beneath the proximal end of the pterostigma: the lower of these two cells being the longer, there is formed an oblique series of large conspicuous areoles like those of modern species but more distant from the apex of the wing. The hind wing differs from the front wing principally in form, the apical half being less equal, and in the shortness of the long subradial cell of the front wings, which is no longer than the next outside of it; the series of cross-veins originating above at the middle of the pterostigma is more broken, but falls wholly without the proximal end of the pterostigma, so that the three areoles form a vertical instead of an oblique series;

the cubital cells can not be determined in the front wing, but are apparently, as here, pretty large and broad and rarely if ever twice as long as broad, while nearly all the other large cells (especially in the front wings) are very long and slender as in I. tumulata, the transverse veins being few. The marginal veinlets of both wings are simply and widely forked on the lower, and sometimes on the apical, border.

Length of wings, 10.5^{mm}; breadth, 2.7^{mm}.

This species is evidently more nearly allied to I. tumulata than to any of the others, and differs from it, not only in the points brought out in the description, but also in the closer venation of the margin of the wing.

Florissant. Two specimens, Nos. 8319, 9391.

Family HEMEROBINA Hagen.

The two subfamilies Hemerobidæ and Chrysopidæ which form this group are oppositely represented in the Tertiaries of the Old and New Worlds. The former are well represented in Europe and poorly represented in this country; the latter are well furnished with species in this country and are unrepresented in Europe. The figures stand as follows: Hemerobidæ, four genera, six species, Europe, vs. two genera, two species, America; Chrysopidæ, none, Europe, vs. two genera, four species, America. Compare this with their present distribution as indicated by Hagen in his Synopsis synonymica (1866): Hemerobidæ, ten genera, forty species, Europe, vs. eight genera, thirty-one species, America; Chrysopidæ, two genera, forty-one species, Europe, vs. one genus, thirty-one species, America. Here the relation between America and Europe is almost precisely the same in the two countries, a relation which finds no sort of explanation in the distribution of the two groups in the Tertiaries. (September, 1883.)

Subfamily HEMEROBIDÆ Stephens.

Considering the abundance of American Tertiary Neuroptera and the considerable number of Hemerobidæ (four genera, six or more species) found in the Tertiary beds of Europe—mostly in amber—it is somewhat surprising to find only a couple of species in our American Tertiaries. One of these, Osmylus, from Florissant, is also represented in amber and the two species agree together in certain features which distinguish them from

modern forms The other, an extinct genus, Bothromicromus, from British Columbia, is very different from any the European Tertiaries possess.

OSMYLUS Latreille.

The species we have placed here agrees somewhat closely with the species from amber, Osm. pictus, referred by Hagen to this genus, but differs from it in its lack of any diverse coloring in the wings, as well as in some minor points of the neuration, as in the distance of the outer series of gradate veinlets from the outer border of the wing, their regular connection with one of the basal branches of the radius, the regularity of the inner series of gradate veinlets, as well as the structure of the cubital region. The two Tertiary species, however, agree together, and disagree with living types in the simple character of the costal nervules, the much smaller number of sectors, and the character of the basal half of the wing, where the sectorial interspaces are regular and broken by few and irregularly scattered cross-veins, instead of being so numerously supplied as to break up the field into an almost uniform and minute reticulation. The two fossil species would therefore appear to form a section apart. (September, 1883.)

OSMYLUS REQUIETUS.

Pl. 14, Figs. 3, 8.

Three specimens, two of them with their counterparts, have been found, in which the wings are particularly well preserved, and in which something also can be made out of the body and the antennæ. The body is of the usual form, the slender antennæ just about the length of the body, composed of multitudinous cylindrical, smooth joints, a little longer than broad and perfectly equal.

The wings are very large, the extremity of the abdomen reaching only as far as their middle when closed, and nearly three times as long as broad, broadest a little beyond the middle. They have the shape of those of Chrysopa, the costal margin being suddenly curved downward just before the tip to meet the upturned curve of the inner margin, which is bent beyond the middle of the wing and meets the costal margin below the middle of the tip of the wing, the latter barely angulated; besides, however, the costal margin is a little expanded near the base; the costal area, broad at the base and made a little more so by the slight deflection of the subcostal

vein near the base and opposite the expansion of the costal margin, narrows very gradually towards the apex, and by the deflection of the subcostal vein next the tip is carried to the very angulation at the apex, filled throughout with very numerous, oblique, straight, and simple cross-veins. The radius runs in exceedingly close proximity to the subcosta until the margin begins to curve decidedly downward, when it unites with it. I have not been able to detect certainly any basal or other cross-vein between the two, though there are in some specimens slight indications of what may be one near the origin of the main sector; they certainly do not occur elsewhere. The main sector originates from the radius near the base of the wing, runs near to and parallel with it to the apex, and is connected with it by many (eight or nine) cross-veins; from it arise eight or nine parallel, oblique, and nearly straight sectors, making in all about a dozen series of equal oblique interspaces in the wing, broken in the apical half of the wing by a couple of series of gradate veinlets, the outer not very far removed from the posterior margin and subparallel to it, finally merging in one of the basal branches of the radius, and from which spring the marginal veinlets which are usually delicately forked at the very border; the inner row is parallel to the outer and about as far from it as it is from the margin. Within this the interspaces are broken by a dozen or more irregularly scattered rather distant cross-veins, much as in Osm. pictus of the Prussian amber, but very different indeed from the living types of the genus, as already stated under the genus. The margins of the wings are sparsely furnished with delicate hairs, and similar hairs may be seen on some of the veins, especially near the margins, but at great distances, or farther apart than the length of the hairs. The hind wing does not differ essentially from the front wing, excepting in the width of the costal area.

Length of body, 9.75^{mm}; of antennæ, 10^{mm}; of front wing, 15.35^{mm}; breadth of same, 5.35^{mm}.

Florissant. Three specimens, Nos. 8839, 13012 and 13537, 13538 and 14168.

BOTHROMICROMUS Scudder.

Bothromicromus Scudd., Rep. Geol. Surv. Can., 1876–'77, 462 (1878).

This genus agrees with Micromus in lacking the recurrent vein above the costal vein next the base of the front wing, and differs from it in the very wide expansion of the costal area at this point and in the possession of

numerous sectors. In these respects it agrees with Drepanepteryx, but the wing is not falcate, and notwithstanding the wide expanse of the costal area the recurrent nervule is wanting, all the veinlets of this area arising next the base, as elsewhere, from the subcosta. The wing is shaped much as in Megalomus, to which, indeed, it is closely allied, being broad at the base, very gradually increasing in width apically, the extremity rounded, with no abrupt emargination or falcation, but with the inner angle strongly excised. At the base the costal area is nearly as broad as the remainder of the wing; the costal veinlets are all furcate and apparently connected, much as in Drepanepteryx, by a single line of inosculating veinlets, dividing the area in two nearly equal longitudinal halves. The costa and subcosta run side by side in the closest proximity, but are apparently separated to the apex. Sectors extremely numerous, with a single complete series of gradate veinlets in the middle of the wing, and another, apparently crossing only the lower half of the wing, more than half-way between this and the outer margin; veins and margins very shortly ciliated.

The genus also seems peculiar in the structure of the maxillary palpi, the basal joint of which is half as broad again as long; the second and third joints subequal, moniliform; the fourth apparently only half as broad as the previous, but of equal length, and the terminal again slenderer, but twice as long, being conical, pointed, and unarmed, while the others are furnished on the apical half with scattered setæ. Antennæ submoniliform, the joints near the base of equal length and breadth, the basal joint double the width of the others; no hairs can be seen upon the antennal joints.

Bothromicromus lachlani.

Pl. 2, Figs. 7–10.

Bothromicromus lachlani Scudd., Rep. Geol. Surv. Can., 1876–'77, 462–463 (1878).

One front wing and a part of the head with its appendages are preserved on No. 36, with a pale, brownish tint to the wing, while the reverse, on No. 37, is wholly colorless. The only parts of the head preserved are one eye and a portion of the other, indicated by a broad, black, annular ring; also a few of the basal joints of the antennæ, and both maxillary palpi, crossing each other and detached from the head. The wing is strongly expanded at the extreme costal base; beyond this the costal border is straight, with a scarcely perceptible emargination nearly to the tip. The

inner margin is almost equally straight, but faintly convex. The extreme tip of the wing falls in the middle of the upper half; below it the wing is strongly excised, but well rounded at the tip and lower outer angle. The shape of the wing, therefore, resembles closely that of Micromus hirtus of Europe. The cubitals are, if anything, more numerous than the veinlets of the costal area, and beyond the origin of the anterior cubital vein ten originate from the subcosta itself in the basal half of the wing. The first and second of these fork and subdivide several times before reaching the margin, or even long before reaching the first series of gradate veinlets, while the third to the ninth are simple, either quite or almost as far as the very margin. The tenth again forks close to its origin, and the outer sectors originate from its upper branch, which is connected with the costa by infrequent cross-nervules. The wing is of a pale woodbrown color, the veins margined with a line of dull, pale yellow, and the darker brown of the interspaces broken frequently by a slightly paler tint, so as to give the wing a minutely blotched appearance, only visible under the lens. The two series of gradate veinlets are again accompanied by a slightly darker tint, giving the wing the appearance of being crossed by two oblique, dusky lines. All the margins are minutely and sparingly ciliated, and similar black, rather distant hairs are scattered indiscriminately over the wing, both upon the membrane and veins, but showing a certain tendency to follow the course of the latter. At the extreme lower base of the wing they are seen to have their origin from minute papillæ, less than one hundredth of a millimeter in diameter, and averaging a twentieth of a millimeter apart.

Length of wing, 9.5^{mm}; greatest breadth, 4.25^{mm}; breadth at base, 3^{mm}; diameter of eye, 0.45^{mm}; length of joints of antennæ near base, 0.09^{mm}; of middle joints of maxillary palpi, 0.075^{mm}; length of maxillary palpi, 0.4^{mm}.

Named for R. McLachlan, Esq, the distinguished English neuropterologist.

Quesnel, British Columbia. Collected by Dr. G. M. Dawson, Nos. 36 and 37 of the collection.

Subfamily CHRYSOPIDÆ Brauer.

Although species referred to Chrysopa are mentioned by Andrä from the rocks of Thalheim, and by Berendt in amber, the figure given by the former and the study by Hagen of the material in the hands of the latter

render it more than probable that no Chrysopidæ are yet known from the European Tertiaries. It is therefore all the more interesting that we find at Florissant four species of this group referable to two genera hitherto unknown. (October, 1883.)

The genera may be separated by the following table:

Table of the genera of Chrysopidæ.

Upper cubital vein of front wing direct, bordered by comparatively uniform cells. ....1. *Palæochrysa.*
Upper cubital vein of front wing doubly bent in the middle, bordered by very unequal cells.
2. *Tribochrysa.*

1. PALÆOCHRYSA gen. nov. (παλαιός, χρυσός).

The only materials for establishing this genus are the wings, the structure of which does not accord with any known living or extinct type. The shape of the wings is much as in Chrysopa, and they are apically rounded; the costal area of the front wings, narrow at base, rapidly expands and then diminishes, being broadest within the basal fourth of the wing. By the apical union of the costal and subcostal veins the area terminates some distance before the apex of the wings, as in Hypochrysa. The cubital area is unusually broad, the anterior cubital vein running through the very middle of the wing, and the posterior cubital rather nearer the margin than to the anterior cubital, both continuing to the apex of the wing; in consequence of this and of the presence of only a single sector of the radius there are no transverse series of gradate veinlets whatever, but the secondary sectors are to be looked on as cross-veinlets uniting the principal longitudinal veins; one of the basal cubital cellules of the anterior wings is divided nearly equally, as in Nothochrysa.

It is difficult, perhaps, to say to which one of the modern genera it is most nearly allied, but it appears to resemble Hypochrysa as closely as any, though it agrees much more with the fossil genus Tribochrysa described beyond, where the distinctions between the two are pointed out.

Palæochrysa stricta.

Pl. 14, Figs. 13, 14.

Little besides the wings can be made out in the single specimen with its counterpart which represents this species. The front wings are a little more than two and a half times longer than broad; the costal margin, expanded a little near the base, is beyond that straight until it slopes down-

ward to form the well-rounded tip; the lower margin is rounded and full, especially away from the base, making the wing broadest beyond the middle. The hind wings are slenderer or about three and a half times longer than broad, broadest in the middle, the lower margin being uniformly rounded, while the costal margin, not expanded at the base, is straight throughout to the apical fourth, where the wing tapers considerably on both sides, being subacuminate, though the extreme apex is well rounded. The neuration, at least below the radius, is essentially the same in both wings, but next the costal margin differs considerably. In the front wings the subcostal vein terminates on the costa a little beyond the middle of the apical half of the wing, and is connected with the distant arching costa by seventeen or eighteen cross-veins, the proximal ones of which are transverse, the distal somewhat oblique; the radius runs close and parallel to the subcosta throughout the course of the latter, and thereafter at a similar distance from and parallel to the curve of the margin, as far as the very apex of the wing, connected nowhere to the veins above by cross-veins. In the hind wings the radius and subcosta are so closely united as to be nearly connected, and are so represented on the plate, and terminate together, apparently a little beyond the middle of the apical half of the wing; as in the front wings, the subcosta is connected by cross-veins to the proximate, straight costa. There is a single sector which springs from the radius a little before the middle of the basal half of the wing in the front wings (nearer the base in the hind wings) and runs midway between the radius and the upper cubital in a regular zigzag; the cells, thirteen or fourteen in number, formed by the cross-veins between the sector and the radius, as well as all those below, are broader than long and tolerably regular. The upper cubital vein courses regularly through the middle of the wing, and in its basal half, at least in the front wing, is nearly straight, while apically it is noticeably zigzag, terminating in the sector of the radius just before the tip of the wing. The lower cubital vein runs in a uniform course rather nearer the margin than the upper cubital vein, subparallel to the former, and is irregularly straight or zigzag, and also joins the sector of the radius or terminates against an apical cell at the tip of the wing; between the two cubital veins one of the basal cells is divided longitudinally into two nearly equal cells, as in the genus Nothochrysa (but which is not represented on the plate as it should be), where the oblique vein appears on the upper wing;

the marginal nervules are sometimes simple and straight, sometimes broadly forked, and differ on opposite wings. The vein below the lower cubital, called postcostal by McLachlan, terminates abruptly on the hinder margin, opposite the origin of the sector of the radius.

Length of fore wings, 15.75^{mm}; breadth, 5.4^{mm}; length of hind wings, 15^{mm}; breadth, 4.2^{mm}.

The four wings of this specimen are so overlaid by one another as to make a medley of veins which are very difficult to disentangle and interpret. It was kindly photographed for me by Mr. Samuel Wells, of Boston; the lines of each wing on the photograph were then traced separately, and from these tracings the drawings on the plate were made; these I believe to be true representations of the wings with the exception of the double cubital cell of both wings and the cross-veins of the costal area of the hind wing, which are not shown; the lower half of each wing, however, is more liable to misinterpretation than the upper.

Florissant. One specimen, Nos. 1798 and 7340.

2. TRIBOCHRYSA gen. nov. (*τρίβω*, *χρυσός*).

This genus, clearly allied to Palæochrysa, and with it apparently a forerunner of Hypochrysa, is represented by several species in the American Tertiaries, which are uncommonly well preserved, though the wings are the only parts which are present on all the specimens; and it is therefore mainly upon these that the genus is founded The head is nearly twice as broad as long, the front protuberant, rounded, and entire, the basal joint of the antennæ stout, bulbous, scarcely longer than broad, twice the diameter of the stalk, the latter nearly as long as or even longer than the body, slender, delicately tapering, composed of simple, cylindrical, apparently naked joints twice as long as broad. The thorax is stout, the prothorax broader than long, tapering anteriorly, otherwise subquadrate. The legs are slender. The wings extend far beyond the body, and are of the same form as in Chrysopa, the tip rounded or faintly subacuminate; in neuration they resemble closely those of Palæochrysa, but differ from it in one striking feature, and in this approach more modern types like Nothochrysa. In Palæochrysa the upper cubital vein runs in a slightly zigzag course through the middle of the wing in a regular, gentle curve nearly equidistant from the costal and inner margin, and terminates at the apex of the wings, no transverse series of gradate veinlets lying between it and the

primary sector. In Nothochrysa it runs in a perfectly straight course a little below the middle of the wing, but higher than in Chrysopa, directed toward but not distinctly reaching the middle of the outer half of the lower margin of the wing, and supporting the lower proximal end of one transverse series of gradate veinlets between it and the primary sector. In Tribochrysa it runs in a decidedly zigzag course, in the same general direction as in Nothochrysa in its proximal half, and then shifts suddenly to a higher level and follows thereafter a zigzag direction nearly parallel to the costa, through the very middle of the wing, joining, that is, the transverse series of gradate veinlets and making them a part of itself. Tribochrysa further differs from Nothochrysa and agrees with Palæochrysa in the slender number of secondary sectors or oblique cross-veins, so that the cells are larger and less elongated than in Nothochrysa and Chrysopa, standing thus at a wider distance from Hemerobius. The result of this movement of the first cubital vein is usually a striking inequality of the cells on either side of it, in contrast to their uniformity in Palæochrysa. There is here, therefore, as in Palæochrysa, no transverse series of gradate veinlets in the proper sense, as both series are directly united with the two cubital veins. A somewhat similar arrangement may be seen in Nothochrysa fulviceps, although that species differs from these more widely than most of its allies in the multiplicity of its secondary sectors. The same double cubital cell occurs below the second subradial cell as is found in Nothochrysa and Palæochrysa.

The species placed here seem to fall into two groups, one of the species differing from the others in being of a considerably larger size, having its first cubital vein originate directly from the radius, the proximal cells which lie above it less elongated than in the other species, and the upper (double) cubital cell quadrangular.

Table of the species of Tribochrysa.

Large species. First cubital vein arising directly from the radius; first transverse vein connecting radius and first cubital vein lying in direct continuation of the cross-vein closing the proximal end of the double cubital cell, making the upper, as well as the lower, cell quadrangular.

1. *T. vetuscula.*

Smaller species. First cubital vein arising from a basal cross-vein uniting the radius and second cubital vein; first transverse vein connecting radius and first cubital vein striking the upper margin of the double cubital cell, making the upper cell pentagonal, while the lower remains quadrangular.

Elongated proximal cells between the main sector of the radius and the first cubital vein, four in number, followed by half a dozen cells of subequal diameters.....2. *T. inequalis.*

Elongated proximals cells, as above, three in number, followed by five cells of subequal diameters.

3. *T. firmata.*

1. Tribochrysa vetuscula.

Pl. 14, Fig. 9.

The stone on which the single specimen referred here occurs has unfortunately been broken across the wings, and the apical half is lost; otherwise the specimen would be nearly perfect, the head, thorax, eyes, and antennæ being well preserved. The antennæ are unusually short, being a little shorter than the body and more tapering than usual in this family. The head is well rounded, the eyes neither very large nor prominent, the prothorax tapering a little anteriorly, the sides a little arcuate, the front slightly concave.

Only the basal half of the wings being preserved, little can be said of them, but the costal margin and area are much as in T. firmata, and the neuration is so peculiar as to separate the species readily from the others; there are about a dozen transverse veins in the costal area; the transverse veins uniting the radius and its sector are rather more numerous than in the other species of the genus; the cross-vein uniting at base the sector and the first cubital vein strikes the latter so as to form a continuation of the vein closing basally the double cubital cell; the upper of these two cells is scarcely smaller than the lower; the upper cubital vein arises directly from the radius without the support of a basal cross-vein; and the proximal cells between the sector of the radius and the upper cubital vein are, excepting the first (which is of irregular shape), not so disproportionately large as in the other species, being less than half as broad again as long, about as long as the subradial cells, and only a little oblique, differing in all these respects from both the other species.

Length of body (estimated), 12^{mm}; of head and thorax, 4.5^{mm}; antennæ, 11^{mm}; length of wings as preserved, 9.5^{mm}; probable full length, 14^{mm}; presumed breadth, 4.5^{mm}.

Florissant. One specimen, No. 11204.

2. Tribochrysa inequalis.

Tribochrysa inequalis Scudd., Zittel, Handb. d. Palæont., I, ii, 777, Fig. 982 (1885).

The single specimen referred here has all the wings superimposed on one another, but in addition a portion of the slender antennæ and the large globular eyes can be seen, with faint traces of the head, thorax, and abdomen.

Almost the entire neuration of the upper wing can be made out as well as the lower half of that of the under wing: the front wing is three times as long as broad, the costal margin uniformly arched, the basal expansion forming only a regular part of the curve: the lower margin is similarly curved but not very full, the wing being broadest nearly as far out as the middle of the outer half; the costal area is not very broad nor unequal; the subcostal vein terminates at the end of the middle third of the wing, and is connected with the costa by twelve or thirteen cross-veins, mostly slightly oblique. There are ten subradial cells. The upper cubital vein, which springs from a short cross-vein uniting the radius and lower cubital vein, in the middle of its course and somewhat beyond the middle of the wing shifts suddenly to a higher level and follows thereafter a direction nearly parallel to the costal, instead of, as before, the inner margin; in the first half of its course it runs below the middle of the wing, in the latter half above it; consequently the four cells which lie between its proximal half and the subcosta are very much elongated subrhomboidal in form, the first subtriangular, while beyond the shift they are somewhat regularly hexagonal; on the other hand the cubital cells, scarcely longer than broad at first, become in the outer part of the wing twice as broad as long and also very oblique. The basal cubital cell is divided longitudinally into two unequal parallel cells, the upper the narrower; the cross-veins next the lower margin are simple in the basal half of the wing, simply or doubly forked on the distal half. The postcostal terminates abruptly on the hind margin, slightly farther out than the origin of the sector of the radius, and is connected near the apex by a cross-vein which is the continuation of that closing basally the double cubital cell. The neuration of the hind wing, only the lower half of which is preserved, does not differ from that of the front wing in the slightest essential particular.

This species differs from T. firmata, to which it is closely allied, by its larger size, the greater number of cells below the sector (as indicated in the table of the species), and its broader costal area.

Length of body, 11^{mm}; of front wing, 14.75^{mm}; breadth of same, 4.8^{mm}.

Florissant. One specimen, No. 7982.

3. Tribochrysa firmata.

Pl. 14, Figs. 6, 7, 10, 11.

Two specimens are at hand, each in a pretty good state of preservation, showing head and antennæ, the body and wings, the latter generally somewhat confused by overlapping or folding. The head is rather small as compared with the thorax, and well rounded, with moderately prominent eyes, and antennæ a fourth longer than the body; the prothorax is also rather slender, tapering considerably, and about as long as its posterior breadth. The thorax is stout and the abdomen half as long again as the head and thorax. The wings are about three times as long as broad, broadest in the middle of the distal half, the costal margin pretty straight in the middle, rather rapidly sloping basally, and very rapidly curving almost bending downward apically, the apical margin rounded, subacuminate, the apex rather below the middle; the inner margin is regularly and gently curved. The subcostal vein joins the costal (not shown on plate) a little beyond the middle of the distal half of the wing, and the costal area thus formed is occupied by about a dozen or more straight cross-veins; there are only eight or nine subradial cells, and the cells in the series below this, while agreeing in general character with those of T. inequalis, are less numerous than there, there being only three elongated cells directly beneath the sector of the radius and only five equiaxial cells in the same series beyond them.

The two specimens show very little difference excepting in size, though on that account they were at first presumed to be distinct.

Length of body, 8.5–7.75^{mm}; of antennæ, 9.5–10.5^{mm} (in the larger specimen no doubt imperfect); breadth of head, 1–0.85^{mm}; of thorax, 1.6–1.5^{mm}; length of fore wing, 11.25–9.75^{mm}; breadth of same, 3.85–3.25^{mm}.

Florissant. Two specimens, Nos. 670, 8792.

Family PANORPIDÆ Stephens.

If the Liassic genus Orthophlebia is to be referred to this family, this group must have been as abundant in Mesozoic times as now. Only a few Tertiary species are, however, known, and those hitherto described have unspotted wings like their ancestors of the secondary epoch. Three species of Bittacus and one of Panorpa have been described from the European

beds, all but one (a Bittacus) from amber, this Bittacus, the only relic from Tertiary rocks in Europe, coming from Radoboj.

The additions we have here to offer are of some interest. Two species have been found, both of which have heavily spotted wings, more heavily spotted than most living types; one of these, a small species, is referred to Panorpa, though doubtfully, as it differs so much from known types; the other unquestionably belongs to a distinct genus having no special alliances with any known forms. Both come from Florissant. The markings of one form dark, transverse bands on clear ground, of the other large, roundish, pale blotches on a dusky ground. (October, 1883.)

The Florissant genera may be thus distinguished:

Table of the genera of Panorpidæ.

Ramules of upper branch of radius inferior; markings consisting of large pale spots on a dark ground.....1. *Holcorpa.*

Ramules of upper branch of radius superior or apical; markings consisting of dark transverse bands on a clear ground.....2. *Panorpa.*

1. HOLCORPA Scudder.

Holcorpa Scudd., Bull. U. S. Geol. Geogr. Surv. Terr., IV, 540–542 (1878).

This name[1] is proposed for a genus of Panorpidæ, unquestionably allied to Panorpa, but differing remarkably from it in the total absence of cross-nervules in the wings, excepting, perhaps, at the base. The antennæ are probably not very long (they are not completely preserved in the single specimen studied), taper very gradually in size, are composed of joints only a little longer than broad, not in the least degree moniliform, and furnished with recumbent hairs. The wings are not so elongated nor so slender as in Panorpa, very regularly rounded, both pairs similarly formed, the hinder pair shorter than the front pair, as in Panorpa. The costa is thickened, the subcosta extends beyond the middle of the wing, but does not reach the pterostigma; the radius emits a superior fork near the base of the wing, which strikes the pterostigma, or, rather, which, by bending downward and then upward, forms the pterostigma in the middle of the apical third of the wing; the radius again forks in a similar manner still far before the middle of the wing, the upper branch emitting three parallel, equidistant, inferior branchlets, the uppermost close to the margin next the pterostigma, the lowest striking the apex of the wing; the lower radial branch forks

[1] The name I have given should perhaps be written Holchorpa; but I have disregarded the aspirate, as Linné did in constructing Panorpa.

below the middle branchlet of the upper radial branch. All these veins, excepting the pterostigmatic termination of the uppermost branch of the radial, are straight. The cubitus is also straight until it forks a little before the middle of the wing; its upper branch is a little curved, and divides just below the forking of the lowest radial branch; its lower branch forks almost immediately, emitting at once three veinlets, the middle one of which is nearly continuous with the main stem, the others curving in opposite senses on either side of it. Below this the veins are not so readily determinable, and their description is omitted until further specimens are obtained; the only variation in the neuration of the two wings consists in the middle fork of the lower branch of the cubitus, which, in the hind wing, is not continuous with the main stem, but originates a very little beyond the others from the lower fork. The legs are spinous throughout; the tibiæ are also armed at the tip with very long, straight, parallel spurs, and the tarsal joints with short spurs. The abdomen is greatly elongated, the first four joints subequal and nearly as broad as the slender thorax, but as a whole tapering slightly, and not greatly surpassed by the wings, the following joints greatly attenuated, the ninth, or terminal joint, composing the forceps, unfortunately lost.

A fossil species referred to Panorpa, and figured by Brodie[1] from the Purbeck beds of England (Panorpa gracilis Gieb.), is very small, and possibly may be more nearly related to Holcorpa than to Panorpa, for while the general arrangement of the veins, with the notable exception of the cubital, is similar to what is found in Holcorpa and very different from their disposition in Panorpa, no cross-veins whatever can be traced. The figure, however, is too small, coarsely executed, and is described by Giebel[2] as supplied abundantly with cross-veins! It certainly is not in my copy of Brodie's work.

HOLCORPA MACULOSA.

Pl. 14, Figs. 4, 5.

Holcorpa maculosa Scudd., Bull. U. S. Geol. Surv. Terr., IV, 542 (1878); in Zittel, Handb. d. Palæont., I, ii, 778, Fig. 984 (1885).

A single specimen with beautifully preserved wings and fragments of the rest of the body. The antennæ (which are not fully preserved) appear to have been more than half as long as the wings, the middle joints 0.17^{mm}

[1] Foss. Ins. Sec. Rocks Engl., pl. 5, fig. 18. [2] Ins. der Vorw., 258.

long and 0.14^{mm} broad. The wings are less than three times as long as broad, and very regularly rounded; the costal vein (especially on the front wing) is thickened and covered with closely clustered, minute, spinous hairs, and similar black hairs follow in a single row the base of the radial and cubital veins. The wings are very dark, with large white or pale spots, of which three are most conspicuous, occurring similarly on all the wings. One, of a subquadrate or subovate form, broader than long, lies scarcely beyond the middle of the wing, extending from the costa to the upper branch of the cubital vein; another, nearly as large and similar in form, is subapical, extending from just beyond the last fork of the upper branch of the radial vein to or just beyond the upper fork of the lowest branch of the same; a third, smaller, transversely oval spot, lies next the inner border, below and a little outside the first mentioned, being situated just beneath the forking of the upper branch of the cubital vein; there is also more or less pale cloudiness about the basal half of the wing, and white flecks may be seen at various points near the tip, especially below the subapical spot. The abdomen resembles somewhat that of the remarkable Panorpa nemato-gaster M'Lachl. from Java, where it is greatly elongated, and possesses a curious appendage to the third joint. In the fossil species, the first three joints, taken together, taper gradually and slightly, and the third may have had a peculiar appendage at its tip, as the edge is not entire, but appears deeply excavated in the middle, possibly due, however, to its imperfect preservation; the basal half of the fourth joint partakes of the tapering of the abdomen, but its apical half is swollen and its hind margin broadly rounded; the fifth and sixth joints are a little longer and much slenderer than the preceding, subequal and cylindrical; the fifth depressed on either side at the base by a pair of foveæ; the seventh again much smaller, linear or not half the width of the sixth, increasing slightly in size apically; the eighth as large at base as the seventh at tip, enlarging slightly apically, and all the joints together half as long again as the wings. Most unfortunately, the apical joint is lost. The specimen is evidently a male.

Length of insect (excluding claw of abdomen), 30^{mm}; of abdomen (excluding claw), 23^{mm}; of front wing, 18^{mm}; breadth of same, 5.5^{mm}; length of hind wing, 16.5^{mm}; breadth of same, 5^{mm}; length of (fore or middle) tibial spurs, 1^{mm}; of one of the (hind?) tarsal joints, 1.2^{mm}.

Florissant. One specimen, No. 63.

2. PANORPA Linné.

A single species of this genus has been discovered in the Tertiaries of Europe (amber) and we add another from the Florissant beds. The former has the wings of a uniform ash-gray. The wings of the latter are heavily banded, very much more heavily than in most modern types. The living representatives of this genus belong to the northern hemisphere, and in our own country range from Canada to Mexico, so that the presence of the genus at Florissant has no particular meaning.

PANORPA RIGIDA.

The single specimen belonging here shows the tapering, attenuated abdomen of a female with the larger part of most of the wings, of which only the front pair are preserved in any recognizable manner. These show the neuration tolerably well, and it agrees better with the living Panorpa than with the contemporaneous Holcorpa; but the subcosta is unusually short, reaching just to the middle of the wing, and the cross-veins are few in number. The wing is traversed by rather narrow transverse belts of a dark color, on a clear ground, placed at equidistant intervals, besides having the entire apex of the wing dark; these belts are straight with straight edges; one traverses the middle of the wing, one lies outside of it midway between it and the apical patch, and a third as far from it toward the base of the wing; the clear area between these belts is twice as broad as the belts themselves. The costa is stout. The legs are very long and very slender, the tibiæ rather sparsely spined.

Length of wings (estimated), 11^{mm}; breadth of same, 3.5^{mm}; length of abdomen (estimated), 5^{mm}; (hind?) tibia, (probably) 5^{mm}.

Florissant. One specimen, No. 3213.

Family TRICHOPTERA Kirby.

The rarity of remains of caddis-flies in the Tertiary rocks of Europe is not a little surprising. Only three species have been figured and a fourth mentioned, all apparently represented by single specimens (from Aix, Parschlug, Mombach, and the Isle of Wight). Another species has been described from Greenland by Heer and from Chagrin Valley, Colorado, by myself. That they were abundant is proven by the description of numer-

ous larval cases from different regions of Europe, but especially from Auvergne in France; it is also proven by their abundance where we should at first little look for them, in the Prussian amber, where, according to Hagen, they are more numerous than any other group of insects, excepting Diptera, and comprise more than half the Neuroptera and Pseudoneuroptera combined. Twenty-five species have been described (by Hagen and Pictet) and several others mentioned (by them and by Kolenati) from amber, a large proportion belonging to the Hydropsychidæ and especially to Polycentropus, of which eleven species are described.

Trichoptera are, however, by no means rare at Florissant, and, as stated above, a single species has been described from western Colorado. Indeed, the Neuroptera from the prolific lake bed of Florissant are made up in large part of Trichoptera, of which many hundred specimens have been obtained. The larger part of them, indeed, are indeterminable, but there are about one hundred specimens which show the neuration of the wings or other characteristic part with some distinctness; and while all the remains of perfect insects from the European rocks are referred to the single subfamily of Phryganidæ, at Florissant Limnophilidæ, Leptoceridæ, and especially Hydropsychidæ, are also represented. The species of this last mentioned group are also much more prolific in individuals, and the preponderance in species would be even more marked were we able to include here all the species really found, since most of those which are too imperfect to be brought forward evidently belong to this group. All these groups, and indeed all the subfamilies of Trichoptera, are represented in the Prussian amber. Hydropsychidæ are by far the most numerous, as in our own Tertiaries. Then follow in the order of abundance Leptoceridæ, Sericostomidæ, Phryganidæ, Rhyacophilidæ and Hydroptilidæ, and Limnophilidæ, the last having but one representative.

While, as we have said, the bulk of the specimens of Neuroptera found at Florissant belong to the caddis-flies, the specific variety of such as will bear description is not quite so great, as 40 per cent of all belong here; but in relation to any one other large group the number of species greatly preponderates, as the group next in size in point of species is the Odonata, which has less than 20 per cent. It is not a little curious to compare this statement with Pictet's concerning the amber caddis-flies: "Of about one hundred and twenty Neuroptera examined by me sixty-

five were Phryganidæ, and of fifty species described by me twenty-two [44 per cent] belong to this family." Of these sixty-five, moreover, forty were referred to the Hydropsychidæ. Hagen, with about seven times as many specimens before him, comes to nearly the same conclusion, for he says that nearly 60 per cent of the specimens of Neuroptera are caddis-flies, and thirty-nine of the eighty-seven species of Neuroptera given in his table, or 45 per cent, are referred to the Trichoptera.

In this enumeration no account has been taken of the occurrence of larval cases of caddis-flies in Tertiary deposits, to which reference was made above. Auvergne has been famous for these which form the so-called indusial limestone deposits, so abundant are they. They were described by Bosc as long ago as the year XIII (1805) and recently have been distinguished by Oustalet under two distinct names. Hepp also described Phryganea blumii from cases found at Leistadt and Heer P. antiqua from Oeningen. A single one has even been found in amber, with its entombed larva, and Fritsch describes one from the Cretaceous of Bohemia. In this country Dr. Peale discovered similar remains, which I have described as Indusia calculosa. The two fragments of rocks brought home from the locality in Wyoming formed doubtless the floor of a former body of water and are thickly crowded with cases lying in every direction. It is very probable that at least those described here and by Bosc and Oustalet belong to the Limnophilidæ. That in the abundant fauna found in the lake basin of Florissant, including, as we see, a large number of caddis-flies, not a single larval case should have yet been found seems a little remarkable, and the more so since not a few belong to groups, the larvæ of which are known to prefer standing to running water. It is hardly to be believed that the streams in the neighborhood of this ancient lake abounded in the larvæ of caddis-flies, while the waters of the lake itself were destitute of them. It should be remembered, however (1), that the species which construct cases of conspicuous size out of hard materials mostly belong to the Limnophilidæ, of which Florissant furnishes but one species; (2), that the larvæ of the prevailing group, Hydropsychidæ, more commonly inhabit running water, and that their cases are made of grains of stone affixed to larger stones; (3), that the bottom of the lake in which the insect dêposits occur nowhere has shown, as far as I have seen, any sign of stones large enough to have served as a basis for the attachment of the smaller grains

which alone are found, and that therefore the larvæ of Hydropsychidæ must have frequented perforce the neighboring streams, where such larger stone surfaces could have been found. If cases should be found they will be likely to be those of the larger Phryganidæ (next most abundant after the Hydropsychidæ), composed of vegetable fragments. Three species and seven specimens only of this group have been found. (February, 1884.)

Subfamily HYDROPSYCHIDÆ Curtis.

Although no members of this group have been found in the stratified deposits of the Old World, about half of the numerous species described from the Baltic amber belong to it, including several genera. It is interesting, therefore, to find that about three-fourths of the Florissant caddis-flies described in this work belong here, and in the material too poorly preserved to bring before the public the greater part also belong here. Here, too, the species seem to be far the most abundant in individuals. Among those described below are not a few very aberrant forms, which I have been at a loss to determine, as certain of them seem on some accounts to be more nearly related to the Leptoceridæ. At the present day the subfamily appears also to be the most numerous in species in the northern hemisphere, and they are found all over the world. The larvæ more commonly frequent running than standing water, make fixed cases, and are believed to be to a large extent carnivorous.

Table of the genera of Hydropsychidæ.

(Only the extinct, newly described genera, in which the fifth apical cell and sometimes some of the other apical cells of the fore wings are wanting, are here tabulated.)

First apical cell present.
- Second apical cell present.
  - Median cellule one-third or scarcely more than one-third as long as the wing ..3. *Derobrochus.*
  - Median cellule one-half as long as the wing ..... 4. *Litobrochus.*
- Second apical cell absent ..... 5. *Leptobrochus.*

First apical cell absent.
- Discoidal cell open ..... 6. *Mesobrochus.*
- Discoidal cell closed ..... 7. *Paladicella.*

1. HYDROPSYCHE Pictet.

The two species placed here by us from the American Tertiaries are referred to the genus in its ancient wide sense as representative of the group to which it belongs. No fossils have previously been referred to it.

HYDROPSYCHE? OPERTA.

Pl. 5, Figs. 52, 53.

Phryganea operta Scudd., Bull. U. S. Geol. Geogr. Surv. Terr., III, 762 (1877).

A single well preserved specimen with its reverse; the wings are doubled beneath the body, and unfortunately are overlaid by the larva skin of a dipterous insect, obliterating all the important parts of the neuration. On this account it is impossible to determine it with any certainty, but it can not be referred to the Phryganidæ proper, from its slender antennæ and long and slender legs. Renewed study of the specimen since the above was published in the Bulletin leads me to believe that it is one of the Hydropsychidæ and probably not far removed from Polycentropus, but the venation is too obscure to enable one to speak confidently. The first fork, however, appears to be brief and upcurved, exactly as in Polycentropus and not as given in the plate. The head is detached from the body, and faint traces of the antennæ are preserved, but detached; apparently there are two pairs of spurs to what appear to be the middle tibiæ, and the spines of the under edge of the same tibiæ are numerous. The abdomen is very well preserved on a side view.

Length of body, 8^{mm}; (portion of) antennæ, 7^{mm}; tarsi, 3.5^{mm}; wings, 10^{mm}.

Chagrin Valley, White River, Colorado. W. Denton.

HYDROPSYCHE MARCENS.

Pl. 15, Fig. 7.

Only two specimens of this species are known; it seems to have a somewhat peculiar neuration, but its imperfection induces me to place it in the genus Hydropsyche in a general sense. The front wings are very long and slender, largest beyond the middle of the apical half, the apical margin rounded but with a slight acumination. The neuration is incorrectly given in the plate. No cross-veins can be accurately determined, but it seems apparent that the discoidal cell must be of unusual size, and even larger than the median cellule, which, on the other hand, must be rather smaller than usual. The legs and antennæ are long and slender.

Length of body, 9^{mm}; of front wings, 9–9.5^{mm}; of hind legs, 6^{mm}.

Florissant. Two specimens, Nos. 1618, 11205.

2. POLYCENTROPUS Curtis.

This is an important group of caddis-flies to the paleontologist, since nearly one-half of the many phryganids described from the Prussian amber belong to it, and it is interesting to find that we have at least one species in our own rocks. The present distribution of the species is mainly in Europe and North America, where they are numerous, with a few recorded from Ceylon. The larvæ, according to McLachlan, inhabit shallow, rapid streams, and form, Pictet says, no firm cases until about to change to pupæ. In speaking of the abundance of this group in the amber fauna McLachlan says: "Insects referred to Polycentropus in its broad sense seem to have been very common in the Tertiary period when amber was formed; their habit of concealing themselves in the crevices of the bark of trees probably caused their entanglement in the resin and subsequent fossilization."[1]

POLYCENTROPUS EXESUS.

A delicate winged, sparsely clothed species with exceedingly delicate antennæ. The body is moderately slight, the head small; basal joint of antennæ very stout, subglobular, the remainder thread-like, reaching back beyond the closed wings, the joints three to four times longer than broad and narrowly ringed with black at the incisures. Legs poorly preserved in most of the specimens, but only moderately slender, the tarsi rather densely spinous. Wings moderately slender, broadest at the anastomosis, the apex rather broadly rounded, tolerably clear, but with heavily infuscated veins; the discoidal is much longer than the median cellule, and the second apical cell is longer than the third and fourth, and of about equal length with the fifth; the anastomosis above the fifth fork lies in a curve subparallel to the apical margin.

Length of body, 7.5^{mm}; of front wing, 8^{mm}; width of same, 2.6^{mm}; length of antennæ, 11^{mm}; of hind tibiæ, 4^{mm}; of hind tarsi, 3.5^{mm}.

Florissant. Nine specimens, Nos. 67, 571, 3143, 7428, 7873, 9549, 10501, 12441, 13529.

[1] Trichoptera Europ. fauna, 398.

POLYCENTROPUS (?) EVIRATUS.

Pl. 13, Fig. 7.

A single specimen with its reverse is placed here provisionally simply from its general resemblance to species of this group. A crushed body, heavily scaled wings, an antenna, and a fragment of a leg are all that remain. The body is stout and apparently clothed densely. The antenna is rather slender, tapering, about as half as long as the wings, and composed of joints of equal length and breadth. The wings are folded somewhat, so that their form can not fully be seen, but they are apparently not slender and are very densely scaled, concealing all neuration; the costal margin is very gently and slightly convex, curving downward to the apex only at the very tip, the apex far above the middle of the wing, and the apical margin oblique, straight, not retreating rapidly.

Length of body, 11^{mm}; of front wing, 10.5^{mm}; of antennæ, 5^{mm}.

Florissant. One specimen, Nos. 12239 and 12240.

3. DEROBROCHUS gen. nov. (δηρός, βρόχος).

A large proportion, both of the specimens and species, of Florissant caddis-flies seems to belong to this new type of Hydropsychidæ, which is allied to Polycentropus in many of its features, but is remarkable for the length of the cells and for the apparent want of any fifth apical cell. The median cellule, which is generally longer than the discoidal, is often one-third, or even more than one-third, the length of the wing, and the lower branch of the upper cubitus runs straight or nearly straight to the margin, bending sometimes near the cross-vein which, near the margin, connects it with the vein below. The uppermost apical cell, as in Polycentropus, is small, and in general the affinity of this genus to that is marked; but the absence of the fifth apical cell is believed to be sufficient ground for generic distinction, as that cell is generally found throughout the family. The cross-vein uniting the upper and lower cubitals is variously situated.

Table of the species of Derobrochus.

Base of first apical cell of front wing not, or scarcely, farther from the root of the wing than the base of some of the other apical forks.

First apical cell almost as long as the second; this not greatly longer than the third..1. *D. abstractus.*

First apical cell much shorter than the second; this nearly twice as long as the third.

First apical cell longer than the fourth .....2. *D. cœnulentus.*

First apical cell shorter than the fourth.

First apical cell curving upward .....4. *D. commoratus.*

First apical cell with no upward curve .....6. *D. frigescens.*

Base of first apical cell considerably, or very much, farther from the root of the wing than the base of any other apical fork.
Third and fourth apical cells about equally distant from base.
Second apical cell less than one-third as long again as the third.....3. *D. æternus.*
Second apical cell half as long again as the third.....5. *D. marcidus.*
Fourth apical cell reaching much nearer the base than the third.....7. *D. craterœ.*

1. Derobrochus abstractus.

A single specimen, preserved on a side view, so as to show the upper half of the under surface of the right front wing, and in addition the upper surface of the whole of the left front wing, overlying the hind wing and confusing the neuration. Little besides the wings can be seen, but the stout cylindrical basal joint of the antennæ appears, followed by a few similar but much slenderer joints. The front wing is slender, subacuminate at tip, the costal margin falling toward the tip at about the same angle as the apical margin retreats from it, the apex itself rounded off, and rather above the middle line of the wing. The first apical cell is remarkably long, the fork originating at the end of the middle third of the wing, and of the same length as the third apical cell; the second apical cell is only a little longer. The wing is apparently clear, with the veins narrowly marked with fuscous and faintly irrorate with fuscous at their tips.

Length of body, 9^{mm}; of front wing, 11^{mm}; width of same, 3.3^{mm}.

Florissant. One specimen, No. 9377.

2. Derobrochus cænulentus.

This species is represented again by a single specimen, showing a dorsal view of a vague body with outstretched front wings, one of which is nearly complete and tolerably well preserved, showing a portion at least of the neuration with clearness. The wing is not so acuminate as in the preceding species and the apex is in the middle of the wing. The first apical cell though long is shorter than in D. abstractus, but extends farther toward the base than either the third or fourth cell, these last being much shorter than in the preceding species. The discoidal cell is apparently fully as long as the median cellule, but its limits are not clearly marked; the latter is as long as the fourth fork and very slender. The wing appears to be clear with infuscated veins, and the whole costal margin broadly but faintly infuscated.

Length of wing, 8.5^{mm}; breadth of same, 2.6^{mm}; length of median cellule, 2^{mm}.

Florissant. One specimen, No. 14444.

3. Derobrochus æternus.

This species is again represented by a single specimen but in a better state of preservation than the preceding forms. It presents a side view with the upper front wing well preserved, and the lower, though visible by drooping, obscure. The legs are tolerably well preserved but confused; they are sparsely clothed with hairs and the tibial spurs can not properly be distinguished. The front wing is slender, broadest only a little way beyond the middle, the apex well rounded, and the apical margin very oblique but full. The discoidal and median cells are about equally long and slender and nearly as long as the second apical cell, which is fully one-third the length of the entire wing. The third and fourth apical cells are of about equal length and nearly twice as long as the first. The anastomosis is very simple, the cross-veins closing the discoidal cell and uniting the sector and cubitus falling together just beyond the origin of the second apical fork. The wing as preserved is clear in the apical fourth but elsewhere irrorate with fuscous, the veins everywhere infuscated.

Length of front wing, 9.75^{mm}; breadth, 4.1^{mm}.

Florissant. One specimen, No. 5308.

4. Derobrochus commoratus.

A species closely allied to the last described, and mainly distinguishable from it by its shorter and much slenderer wings. A number of specimens appear to belong here, but none of them are very well preserved. The body is slender, the legs long and slender, but with rather stout femora, the front legs short and slight. There is a single pair of spurs on the front legs, and two pairs on the hind legs. The front wings are pretty uniformly fuliginous with fuscescent veins; it is very slender, broadest close to the apex, the tip rounded and placed considerably above the middle, the apical margin much less oblique than in D. æternus. The neuration is identical with that species.

Length of body, 8.5^{mm}; of front wing, 9^{mm}; breadth of same, 2.75^{mm}; length of fore femora, 1.6^{mm}; of fore tibia, 1.1^{mm}; of middle femora, 3.25^{mm}; of hind tibia, 2.6^{mm}.

Florissant. Ten specimens, Nos. 2661, 3237, 3343, 3350, 6848, 13539, 13542 and 14170, 14029, 14171, 14312.

5. Derobrochus marcidus.

Pl. 15, Fig. 2.

A slender winged, griseous species, not far removed from D. commoratus. The body, however, is tolerably stout, densely clothed, the head small, with very slender pale antennæ, the basal joint stout and globular, the other joints slender, about twice as long as broad, and narrowly ringed apically with fuscous. The legs are very long and delicate, the middle and hind tibiæ with two pairs of spurs. Front wings griseous, rather heavily clothed with hairs, especially along the veins, which are thereby duskier; they are slender, well rounded at the apex, and not acuminate, as would appear from the figure, where the wing is partially folded; the neuration is imperfectly shown in the plate. The first apical cell is very small, the third a little longer than the fourth and much shorter than the second, which is very long, nearly reaching the middle of the wing; the length of the discoidal and median cells can not be accurately determined.

Length of body, 6.75^{mm}; of fore femora, 1.4^{mm}; mid femora, 2.2^{mm}; mid tibiæ, 2^{mm}; hind femora, 3^{mm}; hind tibiæ, 2.75^{mm}; front wings, 7–8^{mm}; width of same, 2.75^{mm}.

Florissant. Three specimens, Nos. 9416 and 9621, 10106, 12010.

6. Derobrochus frigescens.

Pl. 15, Figs. 6, 16.

Derobrochus frigescens Scudd., Zittel, Handb. d. Palæont., I, ii, 779, Fig. 986 (1885).

A somewhat stout bodied but small species, the smallest of the genus, not very heavily clothed with scales. The head is moderately large and the antennæ very slender, with a large globose basal joint. The legs are only preserved in a fragmentary way in all the specimens. The front wings are tolerably broad, broadest only a little beyond the middle, the apex scarcely subacuminate but well rounded, the apical margin oblique but full; the first apical fork is unusually straight with no upward curve, and the cell not much shorter than the third apical cell; the second apical cell is about twice as long as the third, and the fourth falls about midway between them in length; the discoidal cell and the median are of about equal length with the second apical cell, and are very slender, particularly the median. These features are not all produced in the plate.

Length of body, 6.5^{mm}; of front wing, 7^{mm}; width of same, 2.85^{mm}.

Florissant. Seven specimens, Nos. 1027, 1718, 2677, 4633, 5433, 10900, 10953.

7. Derobrochus crateræ.

Pl. 13, Fig. 13; Pl. 15, Fig. 4.

A moderate-sized species, with dusky wings, the veins infuscated. The body is moderately stout, but no parts are fairly preserved but the front wings. These are moderately slender, the tip rounded, the apical margin oblique and only a little full, the broadest part of the wing near the middle of the outer half; the first apical cell (not shown in the figures) is very small, considerably smaller than the third, which last is only a little more than half as long as the second, which is slightly longer than its stalk; discoidal and median cells very long and slender and of about equal size.

Length of body, 7–8.5^{mm}; of front wings, 8^{mm}; breadth of same, 2.6^{mm}; length of hind wings, 6^{mm}.

Florissant. Four specimens, Nos. 2514, 5059, 14235; and from the Princeton Collection No. 1.947.

4. LITOBROCHUS gen. nov. (λιτὸς, βρόχος).

This name is proposed to include a single species of Florissant Hydropsychidæ, allied to Polycentropus and Derobrochus, and especially the latter, but differing from them in some points in the neuration of the wing. Like Derobrochus, there is no fifth apical cell in the front wing, thus clearly separating it from Polycentropus. It differs from Derobrochus in the still more intensified elongation of the interior cells, and in the minuteness of the first apical cell, which is relatively not half so large as in any species of Derobrochus. The anastomosis is also very widely separated, the median cell extending far toward the margin and being half as long as the wing itself.

Litobrochus externatus.

Pl. 15, Fig. 10.

A single specimen shows the body, fore legs, and front wings. It is a tolerably large species with moderately slender body. The front legs are small and the tibia bears a single pair of spurs. The front wings are slender, broadest before the middle of the outer half, the apex produced and nearly

in the middle of the wing, the costal margin falling obliquely to the tip over a considerable area, and the apical margin equally oblique below the apex; the contrast in the length of the first and second apical cells is very marked; the cross-vein uniting the sector and cubitus falls at the origin of the second apical cell, and the median and discoidal cells originate side by side; none of the cross-veins are shown in the plate. The wing is clear, excepting for a slight infuscation along the costal edge and the infuscation of the veins.

Length of body, 10^{mm}; of front wings, 10^{mm}; breadth of same, 3.35^{mm}; length of fore femora, 1.7^{mm}; tibiæ, 1.7^{mm}.

Florissant. One specimen, No. 14210.

5. LEPTOBROCHUS gen. nov. (λεπτός, βρόχος).

This genus, which includes only one species, is remarkable for lacking not only the fifth, but the second, apical cell. In other respects it does not differ from Derobrochus, except in having, as in Litobrochus, an extremely long median cell, due, however, not to the extension of the cell toward the margin, but to its basal extension by the earlier origin of the middle branch of the upper cubital vein.

Leptobrochus luteus.

Pl. 15, Figs. 1, 3.

This abundant species is rarely well preserved. It has a slender body, long and narrow wings, very slender legs, and antennæ longer, so far as known, than any other of our fossil species, being much more than twice the length of the body (including the closed wings); the joints are about four times longer than broad, very slender, and the incisures marked with fuscous; the first joint is stout and obovate. The front wings are very long and slender, the apex produced, subacuminate and scarcely above the middle; the first apical cell is tolerably small, and the discoidal cell apparently open; the median cell, however, is closed, and the cell itself exceedingly long, the closure being a little before the origin of the third apical cell, which is not quite so long as the breadth of the wing and shorter than the fourth apical cell; these features of the neuration do not appear in the figures on the plate.

Length of body, 9mm; of front wing, 9mm; breadth of same, 2.2mm; length of antennæ, 21mm.

Florissant. Sixteen specimens, Nos. 1655, 3638, 3702, 6039, 7030, 7149, 7990, 8013 and 10341, 8065, 8325, 8392, 8857, 9578, 10016, 10239, 12014.

6. MESOBROCHUS gen. nov. (μέσος, βρόχος).

This is a peculiar group, not only for the limited number of apical cells, the first as well as the fifth being absent, but also for the great and nearly equal length of all the other apical cells and the distance of the anastomosis from the apical margin; indeed, nearly or quite a third of the wing at the apex is filled only with longitudinal and parallel veins, as in some Leptoceridæ. The median cell, on the contrary, is not very long, as it is in nearly all the other genera we have here considered; the discoidal cell appears to be open, an anomalous peculiarity for one of the Hydropsychidæ.

Table of the species of Mesobrochus.

Fore wings nearly four times as long as broad ..... 1. *M. lethæus.*
Fore wings scarcely more than three times as long as broad ..... 2. *M. imbecillus.*

1. MESOBROCHUS LETHÆUS.

Pl. 15, Fig. 11.

A small slender species. Body slender, moderately clothed with scales. Antennæ with basal joint very large, as long as the head, the rest slender and cylindrical, tapering sensibly to the tip, as long as the body (without the wings). Legs very slender. Wings very long and slender, the rounded apex in the middle line and the margins curving equally to it above and below; second apical cell nearly half as long as the wing, third and fourth stopping abruptly at the anastomosis, which falls just beneath the tip of the subcostal nervure; the discoidal cell is open and the median not very long, reaching as far toward the base as to bring the base of the second apical cell over its center; the neuration as given in the plate is wrong.

Length of body, 6mm; of front wing, 7mm; width of same, 1.85mm; length of antennæ, 6mm.

Florissant. Fourteen specimens, Nos. 544, 1665, 2268, 2520, 2566, 4584, 6884, 7792, 7898, 10720, 10899, 11132, 12015 and 12789, 13540.

2. Mesobrochus imbecillus.

Pl. 15, Fig. 13.

Closely allied to the preceding, but a smaller and comparatively stouter form. The basal joint of the antennæ is cylindrical, and though very large not so stout as in that species, but the stalk is as there. The legs are a little shorter and less slender. Wings shaped as in M. lethæus, but comparatively a little shorter; the neuration appears to be identical with that of the other species (it is wrongly given on the plate), excepting that the anastomosis is even farther to[illegible] the base of the wing.

Length of body, 5.5[mm]; of front wing, 6.25[mm]; width of same, 2[mm].

Florissant. Sixteen specimens, Nos. 1306 and 4423, 2177, 2364, 2984, 4908, 5462, 6861, 7042, 7568, 7883, 10225, 10407, 10430, 11005, 12234, 13138.

7. PALADICELLA gen. nov. (*παλαιός, α–, δίπελλα*).

Still another anomalous genus is found among the Florissant Hydropsychidæ, in some respects allied to Mesobrochus, since the first and fifth apical cells are wanting and the other apical cells are nearly equal and long. The other features, however, are very different, partly perhaps from the much greater comparative brevity and breadth of the wing. The third and fourth apical cells are so closely approximated as nearly to touch throughout their length, even to the very margin of the wing. The discoidal cell is closed and relatively much shorter than it would be in Mesobrochus were it closed at the same time; that is to say, the branch of the sector usually furnishing the first apical sector has a much later origin in Paladicella than in Mesobrochus. The name given is not meant to have any reference to the recent genus Adicella.

Paladicella eruptionis.

Pl. 15, Fig. 14.

This species is represented by a single specimen and its reverse, tolerably well preserved on a dorsal view with partially expanded wings. The body is moderately slender and not heavily clothed, the head rather small, front legs not very large. The wings are not slender, broadest before the apical third, with rounded contours, the well rounded apex above the middle, the apical margin more oblique than the costal as it falls to the apex.

The wing is tolerably clear, slightly infuscated next the costa with fuscous veins. The neuration along the middle of the outer half of the wing is not correctly given in the plate; the vein above the lowest forked vein (containing the fourth apical cell) is also equally but not so widely forked, and it does not connect (excepting by a cross-vein) with the vein above, but much farther toward the base with the vein below, its fork containing the third apical cell.

Length of body, 9^{mm}; of front wing, 10.5^{mm}; breadth of same, 4^{mm}.

Florissant. One specimen, Nos. 8422 and 13004.

8. TINODES Curtis.

The single species referred here provisionally is shown by its neuration to belong elsewhere, and is merely placed here for convenience and for want of a better place. Moreover two species have been found in amber.

TINODES (?) PALUDIGENA.

Pl. 15, Fig. 9.

An interesting little species, apparently belonging near this genus, but in which the neuration is even simpler, though being in large part obscure, the species is placed here provisionally. The body is moderately slender, the legs rather short. The front wings are not very slender, broadest in the middle of the apical half, beyond which the wing tapers rapidly and almost equally above and below to a rounded apex. Only the first and third apical cells are present and both very large and with a long stalk, the veins originating far toward the base. This alone shows it can not be a Tinodes, but the anastomosis can not be made out. The hind wing is considerably shorter than the front wing, broadest near the base, has a pretty strongly curved costal margin terminating abruptly in a pointed apex, from which the oblique apical margin retreating rapidly blends by one curve in the inner margin; the second and third apical cells only are present, of about equal and considerable length, the latter nearly reaching the middle of the wing; an interesting feature of this wing is a large spreading tuft of dark hairs longer than the width of the thorax, springing from near the base of the costal area.

Length of body, 5–6.25^{mm}; of front wing, 5.5^{mm}; of hind wing, 4^{mm}; breadth of front wing, 1.5^{mm}; of hind wing, 1.2^{mm}; length of tuft of hairs, 0.75^{mm}.

Florissant. Four specimens, Nos. 2142, 6964, 10702, 13137.

Subfamily LEPTOCERIDÆ Stephens.

No fossil species of this subfamily have been described, but Hagen mentions several species which he refers to Mystacides and Odontocerum. Two Florissant species are found, which are believed to be most nearly allied to Setodes. The larvæ of this group are found more often in running than in standing water, but frequent both; the case is usually a free sand tube; the members of the subfamily are distributed all over the world.

SETODES Rambur.

This genus, as existing at present, is found well represented in regions as wide apart and as different as North America, Europe, and the East Indies. None have before been reported fossil, and the two species we have referred here are so placed more from their general aspect than for any other more solid reason. The form and pointedness of the wings and the general structure of the antennæ and legs look evidently in this direction. The larvæ of this group inhabit both standing and running waters.

Table of the species of Setodes.

Wings at rest extending far beyond the abdomen .....1. *S. portionalis.*
Wings at rest not reaching the tip of the abdomen.....2. *S. abbreviata.*

1. SETODES PORTIONALIS.

Pl. 15, Fig. 15.

A single specimen is placed here, the pointed form of the wings, the size, and the whole aspect indicating this group of caddis-flies; the wings, however, are so thickly clothed with scales that no neuration can be distinguished. The body is tolerably slender, the antennæ and legs exceedingly long; only a portion of one antenna, as long as the body, is preserved, but this shows no indication whatever of diminution in size; it is rather stout, as stout, indeed, as the tarsi, and the joints four or five times as long as broad, cylindrical, pale brown, with dark brown incisures; the length of the basal joints is not determinable. The legs extend a long way beyond the tip of

the closed wings and are very slender; the front pair, however, are n shorter than the others. The front wings are very slender, densely pubescent, when closed extending some way beyond the tip of the body, the portion so extended tapering to a slender but rounded tip which is near the upper margin of the wing, the costal border being almost uniformly and gently convex, and not falling rapidly next the tip, while the apical margin below the tip is exceedingly oblique until the tip of the body is reached.

Length of body, 6^{mm}; of front wing, 6^{mm}; breadth of same, 1^{mm}; length of antennal joints, 0.5^{mm}; of mid tibiæ and tarsi together, 4.5^{mm}; reach of hind legs beyond body, 3.5^{mm}.

Florissant. One specimen, No. 11754.

2. Setodes abbreviata.

A single specimen only has been found, closely allied to the preceding but with remarkably abbreviated wings. The body is moderately slender, densely pubescent, the antennæ black, of the length of the body, of the same stoutness as in the preceding, but with joints scarcely so long and densely and very finely covered with hairs. Legs not perfectly preserved but a little stouter than in S. portionalis. Wings very much shorter than the body, very slender lanceolate, the apical portion narrowing, more rapidly below than above, to a sharply pointed tip, black, densely clothed with long hair-like scales.

Length of body, 6.5^{mm}; of front wing, 3.5^{mm}; breadth of wing, 0.65^{mm}.

Florissant. One specimen, No. 5218.

Subfamily LIMNOPHILIDÆ McLachlan.

A single member of this group has been found fossil in Prussian amber, a species of Halessus. Besides this, however, several larval cases have been described, some at least of which appear to belong here, as it contains at the present day all the larger caddis-flies which ornament their larval cases with shells and other odd substances. To this list we can now add from America one of each kind, a winged insect and a larval case constructed of grains of stone. The group as it exists to-day is mainly confined to the northern hemisphere, north of the tropics, but it reappears to some extent in corresponding portions of the southern hemisphere, at least in America

LIMNOPHILUS Burmeister.

This genus has never been reported fossil, and in placing in it the species below the intention is only to indicate its affinities. The genus is boreal and wide spread, and the larvæ are generally found in standing water

LIMNOPHILUS SOPORATUS.

Pl. 15, Fig. 5.

A couple of specimens are referred here, in only one of which is the neuration sufficiently distinct to be determined with any probability, and in this it is somewhat obscure and is not fully shown in the plate; nearly all the veins and cross-veins in the outer half of the wing can, however, be traced with more or less distinctness, though the cross-veins are certainly obscure; the neuration, as thus limited, is wholly that of Limnophilus. The front wings are moderately long and narrow, the costal margin rather strongly arched in the apical half, curving downward to the bluntly acuminate apex, the apical margin sharply and very obliquely truncate Discoidal cellules short, much shorter than its foot-stalk; anastomosis of the lower half of the wing continuous.

Length of front wing, 12.5^{mm}.

Florissant. Two specimens, Nos. 1441, 13007.

INDUSIA Bosc.

In certain parts of Auvergne, France, rocks are found which for a thickness of sometimes two meters or more are wholly made up of the remains of the cases of caddis-flies. These have been frequently mentioned by writers and were first described and figured by Bosc early in the century under the name of Indusia tubulosa. Oustalet in his recent treatise on the fossil insects of Auvergne,[1] describes two forms, one from Clermond and the other from St. Gérand, which he distinguishes under the names Phryganea corentina and P. gerandina, principally from their difference in size and strength, and a distinction in the minute shells—species of Paludina—of which the cases are composed.

These cases, like the somewhat similar ones composed of grains of stone which are described below, are all apparently made by species of Limno-

[1] Bibl. École Haut. Études; Sci. Nat., vol. 4, pp. 101-102.

philidæ,[1] the larvæ of which group are remarkable for the variety of objects they use for the construction of their cases. It would seem desirable at present, while placing Indusia in this group, to include in it all larval cases of extinct Trichoptera until they can be more definitely placed or distinguished.

These, however, are not the only instances of larval cases of Trichoptera found fossil. Hepp, in 1844,[2] describes some from the rocks at Leistadt, near Dürkheim, under the name of Phryganea blumii, and Heer a few years later in his classic work describes and figures a similar instance from Oeningen, under the name of Phryganea antiqua, in which the case was in part made up of bits of sticks. But the most surprising discovery of this sort is that of supposed larval cases of Phryganidæ in amber.[3] According to Dr. Hagen, Pictet thought them larval cases of a tineid, but Zeller believed they were trichopterous, the larvæ still remaining inclosed and appearing to belong near Mystacides. As phryganid larvæ are aquatic almost without exception, their discovery in amber is certainly surprising. A tube-like larval case, presumably trichopterous, has also been described under the name of Phryganæa micacea and figured by Fritsch[4] from the Cretaceous clay-schists of Kounic, Bohemia; and Marion[5] describes larval cases on the leaf of a fossil, Nymphæa, in Provence, very like those attached to similar leaves to-day.

Indusia calculosa.

Pl. 4, Fig. 4.

Indusia calculosa Scudd., Bull. U. S. Geol. Geogr. Surv. Terr., IV, 542-543 (1878); Ann. Rep. U. S. Geol. Geogr. Surv. Terr., XI, 638-639 (1879); in Zittel, Handb. d. Palæont., I, ii, 778, Fig. 985 (1885).

Dr. A. C. Peale, in his explorations under the Survey, discovered in deposits, which he considers as probably belonging to the upper Green River group, or possibly to the lower part of the Bridger group, beds of limestone, the upper floor of which is completely covered with petrified cases of caddis-flies, all belonging to a single species, which may bear the name we have applied to it above. They vary from 14 to 19^{mm} in length, from 4 to 5^{mm} in diameter at their open anterior extremity, and from 3 to

[1] See on this point McLachlan, Proc. Ent. Soc. Lond., 1882, 18–19.
[2] Jahresb. Pollichia, vol. 2, pp. 19–23.
[3] Berendt, Bernst. befindl. organ. Reste Vorw., vol. 2, pt. 1, p. 121.
[4] Archiv. naturw. Landesdurchf. Böhm., vol 1, p. 66; Vesmír, vol. 13, p. 205.
[5] Saporta, Organ. probl. anc. mers, 24–26, Pl. 3, Fig. 2.

3.2^{mm} at their posterior end, the thickness of the walls being about 0.75^{mm}. As will be seen by these measurements, the cases are a little larger at their mouth, but otherwise they are cylindrical, taper with perfect regularity, and are straight, not slightly curved, as in many phryganid cases. They are completely covered with minute, rounded, water-worn pebbles, apparently of quartz, generally subspherical or ovate, and varying from one-third to two-thirds of a millimeter in mean diameter; they thus give the cases a granulated appearance. Nearly all the cases are filled with calcareous material, but some are empty for a short distance from their mouth, and in one case the inner lining of this part of the case has a coating of minuter calcareous particles, evidently deposited therein after the case was vacated. As the present thickness of the walls indicates (as also the size of the attached pebbles), the silken interior lining of the case must have been very stout. This follows also from the appearance of one or two which have been crushed, for they have yielded along longitudinal lines, indicating a parchment-like rigidity in the entire shell. In one of the specimens the outer coating of heavier pebbles has in some way been removed by weathering, and has left a scabrous surface, apparently produced by minute, hard grains entangled in the fibrous meshes of the web; it still, however, retains its cylindrical form.

The size of the case, its form, and the material from which it is constructed seem to indicate that it belonged to some genus of Limnophilidæ near Anabolia.

Horse Creek, Wyoming. Dr. A. C. Peale.

Subfamily PHRYGANIDÆ Stephens.

This subfamily of caddis-flies, comprising the larger species, is found only in the northern portions of the globe, and is numerous neither in species nor in genera; nevertheless it is the only group of caddis-flies whose remains have hitherto been found in rocky strata, if we except the larval cases, of which there is likely to be more or less question. And it is not a little strange that they have been found in several distinct places, ranging from Aix in the Oligocene to Parschlug in the upper Miocene. Mombach, the Isle of Wight, and Atanaterdluk, in Greenland, have also furnished species. From amber also three species are known, and now we have three more species, including a new generic form, to add from the strata of Colorado

It is not, however, as in Europe, the only subfamily represented in the strata, three others being also represented and one of them much more largely. (February, 1884.)

NEURONIA Leach.

A single small species of this genus has been described from amber by Pictet and Hagen, which the latter compares with the living N. reticulata. The one here described is the first known from the rocks, and is a considerably larger species, and with somewhat peculiar neuration. The genus is well represented at the present time over all North America, and besides is found only in Europe.

NEURONIA EVANESCENS.

Pl. 13, Fig. 3.

A single specimen of a large species of phryganid is referred to Neuronia, although the neuration appears to be somewhat abnormal, the cross neuration on either side of the sector not being continuous. The insect is preserved on a lateral view, showing the head and body, the superposed wings of one side, and all but the base of the other front wing extended below the body, together with one hind leg.

The upper half of the overlapping wings is much darker than the lower half and shows some mottling near the tip, which is not the case in the other wing. The single front wing is of a uniform brownish fuliginous tint, but broadly obscured in the middle of the wing by accident of preservation over a large pale area, in which also the veins are nearly lost. This accounts for the inaccuracy of the drawing on the plate.

The front wings are subtriangular, less than two and one-half times longer than broad, their greatest breadth in the middle of the apical half; the costal margin is gently arched in the apical half, the apex roundly pointed, the apical margin almost straight in the middle half and inclined at a rather sharp angle with the costal margin.

The shape of the wings, as well as the brevity of the discal cell, renders it probable that the species should be referred to Neuronia rather than to Phryganea or Agrypnia, though it is impossible to determine clearly whether there is a cross-vein between the subcostal vein and the costa. The radius has a broad superior arch below the extremity of the subcostal which renders it probable that it exists, and that it can not therefore be referred to Agryp-

nia. The upper branch of the sector originates earlier than usual, close to the base of the discal cell, which is short, as in Neuronia, but only because the cross-veins which terminate are carried to an unusual distance toward the middle of the wing, and are therefore widely separated from the cross-veins uniting the sector with the cubitus—an unusual feature in this subfamily, and one which with its other peculiarities renders it probable that it should be generically separated from living types. There is also lacking the zigzag arrangement of the cubital cross-veins, though their exact relation can not be determined throughout. The hind leg bears two pairs of tibial spurs, as always in this subfamily.

The length of the body is indeterminable; the length of body and wings together in repose is 24^{mm}; of front wing, 20.5^{mm}; greatest breadth of same, 8.5^{mm}; length of hind tibia, 3.65^{mm}; of hind tarsi, 4.65^{mm}.

Florissant. One specimen, No. 7728.

PHRYGANEA Linné.

Species of this genus are by no means unknown in a fossil state; indeed it is the only genus of Phryganidæ which has heretofore been represented in the rocky strata by remains of the perfect insect, and while only two species are known from amber, four have been described from Tertiary rocks (Aix, Mombach, Parschlug, and Greenland) and a fifth indicated from the Isle of Wight. Very likely some of these may be found to belong elsewhere, but their large size would lend a probability to their proper reference here, since this genus and its allies contain the largest of the caddis-flies. We have here a single species to add, represented wholly by wings, but very well preserved. The genus is mostly confined to North America and Europe.

PHRYGANEA LABEFACTA.

Pl. 13, Fig. 5 (♂).

An excellently preserved front wing, lacking only a fragment broken from the lower outer angle, represents a male. It is of a nearly uniform smoky brown tinge, with much darker distinct veins, and delicately mottled with faint, pale, circular dots which are larger and therefore more noticeable than elsewhere in the upper outer half of the wing, and are absent from the center. It is of about the size of our common Neuronia semifasciata (Say) but of a different shape, being subquadrate, about three times longer than

broad and only slightly broader apically than basally. The apex is slightly pointed and the outer margin apparently slopes more rapidly below than above the apex. Though not shown in the plate, the subcosta is united near the tip to the costa by a cross-vein, and just below the apical cell thus formed the radius has a well-marked distinct arch. The cross-vein closing the cell is not shown in the plate, nor the cross-vein just below it, into which, rather than directly into the cubitus, the first nervule below the lowest branch of the sector runs. The lower cross-veins also do not appear on the plate; they run, as in the modern Phryganea grandis, with a slight jog where they cross the basal branch of the upper cubital, obliquely from the base of the second branch of the upper cubital toward the arculus. Indeed, the venation of the lower half of the wing closely resembles that of the modern European P. grandis, which is slightly larger than the fossil species. This differs from that in only one or two points; the first apical sector parts from its stem at the middle of the discoidal cell, the lower border of the cell is as full as the upper, and the cell itself is proportionally shorter.

Two other specimens agreeing in neuration with the preceding, but with the lower nervule of the upper branch of the superior cubitus forked represent females. Like the male they are represented only by upper wings, one of them perfect, the other broken squarely at the tip by the breaking of the stone in quarrying; one is a little lighter in color than the male, and, as it were, bleached out at the apex, while the other is much darker, almost of a blackish chocolate, many of the minute spots of the mottling, especially in the upper part of the wing, appearing quadrate rather than circular. The fourth (female) fork is nearly as deep as the third, extending slightly more than half-way to the base of the branch.

Length of wing, ♂ 20.25^{mm}, ♀ 19.5^{mm}; of discoidal cell, ♂ ♀ 5.5^{mm}; breadth of wing, ♂ 7^{mm}, ♀ 7.3^{mm}.

Florissant. Three specimens, Nos. 407 (♂), 1016, 3897 (♀).

LIMNOPSYCHE gen. nov. (*λίμνη, ψυχή*).

This name is proposed for a genus which differs somewhat remarkably from any Phryganidæ, but which agrees at the same time in its main features with the subfamily of Phryganidæ proper. In his monograph on the Trichoptera of the European fauna, Mr. McLachlan lays much stress on

the importance in generic characteristication of the presence or absence of specified apical cellules, of which the full complement in the anterior wing is nine; of these three belong to the area of the sector. In the present genus we have an additional apical cellule in the field of the sector, one of the ramules of the lower branch of the sector being divided. In all other species of Phryganidæ proper, to which there can be no doubt that this genus belongs, both the ramules extending to the margin from either side of the cross-vein closing the discoidal cell are simple; in Limnopsyche the upper is branched, so that there exists an "apical fork" between the "first" and "second" apical forks of McLachlan's terminology. This, however, is not the only peculiarity; the anastomosis is broken into three instead of, as in true Phryganidæ, two parts, the cross-vein uniting the sector and cubitus lying far toward the tip of the wing, while the remainder of the anastomosis has its normal place near the middle of the wing. Moreover, the median cellule, which, as in other Phryganidæ proper, is open, extends nearly to the base of the wing, interrupting still more markedly the anastomosis of the lower half of the wing.

Although only a portion of the neuration can be determined in the single pretty large species referred here, this differs so much from the existing genera of true Phryganidæ that its separation from them is indispensable.

LIMNOPSYCHE DISPERSA.

Pl. 13, Fig. 2.

There are three specimens provisionally referred to this species, but in only one can the neuration be traced sufficiently, and it is upon this, which is figured, that the species is founded. It shows a dorsal view with indistinct traces of different appendages, but with the wings of one side expanded. Especially this is true of one; it is an upper wing, but toward the lower margin a portion of the hind wing, crumpled and folded, is more or less mixed with it, so that the figure is not perfectly clear or probably correct at this point. The main features of the neuration have been pointed out in the description of the genus, but a few special points may be added. The wing is about two and a half times longer than broad, the costal margin well rounded, bringing the rounded apex down nearly to the middle of the wing, the lower margin (apparently) full. It is pale brown without mot-

tling; the discoidal cell is very long and slender, nearly one-third the length of the wing, and occupying almost exactly the middle third longitudinally. First apical sector arising from the middle of the discoidal cell; cell between the sector and cubitus of uniform width and running almost exactly through the middle of the wing, terminating some way below the apex; cross-veins uniting the sector and cubitus more than half-way from the e d of the discoidal cell to the border. As the other cross-veins are in their usual place, the anastomosis is widely scattered, whence the specific name.

The other specimens are poorly preserved; they agree with the preceding in size and present no characters in opposition to it. They show in addition portions of the antennæ, a slender stem arising from a rather stout basal joint; in both, however, the antennæ are broken shortly beyond the base.

Length of body, 8^{mm}; of front wing, 8.25^{mm}; breadth of same, 3.25^{mm}; engtb of hind wing, 7^{mm}.

Florissant. Three specimens, Nos. 809, 8606, 8995.

Part 2: Orthoptera and Hemiptera

Part 3: Coleoptera, Diptera, and Hymenoptera

Part 3: Plates, and Index