FOSSIL INSECTS FROM THE CREEDE FORMATION, COLORADO

Part 1. Introduction, Neuroptera, Isoptera and Diptera

By F. M. Carpenter, T. E. Snyder, C. P. Alexander, M. T. James and F. M. Hull

Introduction

By F. M. Carpenter

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During the past twenty-five years, intensive geologic work in the Rocky Mountain region has revealed several Tertiary lake-bed deposits, the presence of which had not previously been suspected. One of these beds, termed the Creede formation by Emmons and Larson (1923), is extensively exposed on the slopes of Willow Creek, near the town of Creede, Colorado. The formation is highly fossiliferous with plants, and a preliminary account of its flora has been published by Knowlton (1923). In 1932, Mr. Allan Caplan, then a senior in the Creede High School, found that insects also were not uncommon in the formation, and an examination of some of his specimens convinced me that a collecting trip to this formation would be a practicable and profitable undertaking. With the aid of a grant from the Milton Fund of Harvard University, the collecting trip was made during the summer of 1934. In addition to the writer and his wife, the party consisted of Mr. C. T. Parsons, a student in Harvard College, and Mr. Caplan, who joined us at Creede. In the course of the summer about two thousand insects were secured; most of these were actually found by Mr. Caplan, while the rest of the party collected in the Green River shales of Utah.

The present series of papers is based mainly upon the specimens obtained on this trip, but it also covers a collection of

about two hundred other Creede insects, sent to me for determination by Professor Case of the University of Michigan, who had previously secured them from Mr. Caplan. All of the fossils have been sorted into orders and most of them into families or superfamilies. As in the case of the insects of the Latah formation and of the Manitoban amber, I have referred these Creede fossils to specialists on various groups of living insects. Although this procedure tends to delay in large measure the publication of the results, it is the only way capable of yielding authentic determinations and conclusions. Since several more years may elapse before all the specimens of the Creede collection have passed through the hands of specialists, it has seemed advisable to publish the results in several parts, all under the same general title, whenever a sufficient number of manuscripts have been completed. The descriptive part of the present paper deals with the fossils belonging to the following orders and families: Neuroptera (F. M. Carpenter), Isoptera (T. E. Snyder), Diptera, Tipulidae (C. P. Alexander), Bibionidae (M. J. James), and Syrphidae (F. M. Hull). To these specialists and those who are working upon other families I am grateful for their indispensable cooperation.

Since this is the first extensive account of the Creede insects, it is pertinent to include a brief discussion of their geologic occurrence and environment. The geology of Creede district has been thoroughly investigated by Emmons and Larsen (1923). According to them, the Creede formation was deposited in a lake that occupied a valley carved out of the rocks of the Potosi volcanic series. The lower part of the formation consists chiefly of fine-textured, thin-bedded, rhyolite tuffs, usually light grey or light brown. Thicker beds of sandy material, lenses of conglomerate, and numerous bodies of travertine are also present. It is this lower part of the formation that contains the insects and the best plant material. The upper part is of coarser texture and consists of well bedded breccia and conglomerate, with some fine tuff. The origin of the formation seems to have been much like that of the Florissant shales, which lie more than a hundred miles to the north-east. Some of the ash thrown out by local volcanoes fell into the lake and together with sand and mud was deposited at the bottom. Insects

flying over the water were of course caught and entombed by the ash.

Knowlton's study of the Creede plants led him to conclude that the Creede formation was about the same age as the Florissant deposit, i.e., upper Miocene. At the same time, however, he noticed an obvious difference in the composition of the two floras, the most abundant element in the Creede flora being Coniferae, which, although very rare at Florissant, comprised about a third of the species and nearly a half of the individual specimens. The general content of the Creede flora strongly indicates that the lake-bed was deposited at a considerable higher elevation than the Florissant shales.[1] As Cockerell has stated of the Creede flora, very few, if any, high altitude insect faunas have been preserved. The chief importance of the Creede specimens, therefore, depends not so much on their geologic age as on the environment in which they existed. It is of course far too soon to say anything definite about the biotic indications of the Creede insects, but even a cursory survey of the collection at hand, made during the sorting of the specimens into families, indicates that the fauna is an exceedingly small one, there being an extraordinary duplication of a few species. This is of course typical of existing faunas at high altitudes.

Order Neuroptera

Family Chrysopidæ

By F. M. Carpenter

Eleven specimens of this family are contained in the collection from Creede. This is proportionally a much greater number than has been found in the Florissant shales, which have produced only about the same number in a total of approximately 40,000 specimens. Two species are represented in the Creede series, one apparently being identical with a Florissant species, and the other, already described, being peculiar to the Creede formation. The phylogenetic significance of the Tertiary Chrysopidae has already been discussed in an earlier paper (1935).

[1]At the present time, however, both lake deposits have an elevation of about 8200 ft.

Palaeochrysa creedei Carp.

Palæochrysa creedei Carpenter, 1935, Journ. Paleont., **9**: 265, fig. 3.

This species, although similar to the following, is characterized by the extraordinary length of the basal Banksian cell of the fore and hind wings.[2] The holotype is No. 4316 ab, Museum of Comparative Zoology.

Palaeochrysa stricta Scudd. (Fig. 1)

Palæochrysa stricta Scudder, 1850, U. S. Geol. Survey Terr. Rept., **13**: 166; pl. 14, fig. 13, 14.

There are ten Chrysopids (4462-4471) in the Creede collection which seem to be identical in every way with this

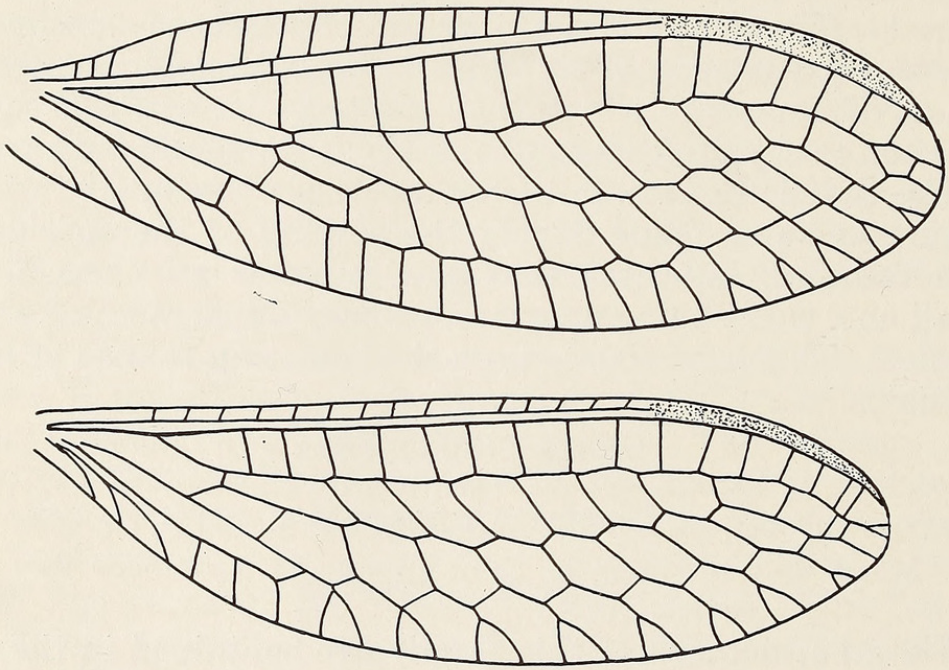

Fig. 1. *Palæochrysa stricta* Scudd. A. Fore wing (No. 4462, M. C. Z.), length, 12 mm. B. Hind wing (No. 4464, M. C. Z.), length, 9.8 mm. Miocene of Creede, Colorado.

species, previously known solely from the Florissant shales. Since this is the only Creede species of those so far determined which appears to be common to the two beds, I have included drawings of its venation. It should, however, be borne in mind that among the Recent Chrysopidae the venation of closely related species usually shows no differences.

[2]In my account of the fossil Chrysopidae (Journ. Paleont., **9**: 259-271, 1935) the captions for figures 2 and 7 should be interchanged.

Family Raphidiidae

Raphidia creedei Carp.

Raphidia creedei Carpenter, 1936, Proc. Amer. Acad. Arts Sci., **71**: 150, fig. 12.

This species differs from those of Florissant by the more slender wings and narrower costal area. The holotype, No. 3639 ab in the Museum of Comparative Zoology, is the best preserved fossil snake-fly which has been found, apart from those in amber. The members of the Raphidiodea are exceedingly rare in the Florissant shales, and the presence of even one in the relatively small Creede collection at hand is another indication of the biotic differences represented. Like the Florissant Raphidiodea, this Creede species belongs to a genus now restricted to the Old World.[3]

Order Isoptera

Family Rhinotermitidæ

By Thos. E. Snyder

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The single fossil wing sent to me for identification proves to represent a species of *Reticulitermes* new to science. Five fossil species of this genus are already known—four from Baltic amber and one from the Miocene shale of Florissant, Colorado. *Reticulitermes* is confined to the temperate regions of the world. A living species (*R. tibialis* Banks) occurs in localities in Colorado, but nowhere in the state at an elevation of over 7,000 feet. The wing of *tibialis* is larger than in this fossil.

Reticulitermes creedei Snyder, n. sp. (Plate 13, fig. 3)

Wing (hind wing (?)): Costal area indistinct. Median vein *not* free from stump or wing scale; closer to subcosta than to cubitus; branches to tip of wing. Cubitus running

[3]An account of the geographic distribution of the fossil and Recent Raphidiodea is contained in my revision of the Nearctic species (Proc. Amer. Acad. Arts Sci., **70**: 89-157, 1936).

in about the middle of wing area, with numerous branches, to posterior margin of wing.

Length of wing—6.5 mm.
Width of wing —1.7 mm.

Wing smaller than in *Reticulitermes fossarum* Scudder from Florissant, Colorado, in Miocene shale.

Holotype: Museum of Comparative Zoology, No. 4472 ab; collected in the Miocene shales at Creede, Colorado.

Order Diptera

Family Tipulidae

By Charles P. Alexander
Massachusetts State College

I am greatly indebted to Dr. F. M. Carpenter for the privilege of studying the series of Tipulidae collected by him at the fossil beds located near Creede, Colorado. As indicated elsewhere by Dr. Carpenter, the Creede formation is of approximately the same age as the Florissant shales (Miocene), about a hundred miles to the northeast, near Pikes Peak, Colorado.

All of the specimens pertain to the single genus *Tipula* Linnaeus and virtually all seem to belong to a single species that I am herewith describing as new under the name *Tipula carpenteri.* In almost all of these individuals, the wings are the only parts that are well preserved. Throughout the vast complex of forms now included within the limits of the genus *Tipula* (approximately 1000 species, Recent and fossil), the wing venation is singularly uniform and offers but slight aid in the subdivision of the genus into smaller groups. In the recent fauna, the definition of species in this genus is based in great part upon the structure of the male hypogygium, characters that are quite unavailable in the present fossil series. A careful analysis of wing-pattern and venation has been made since any determination of the present series must depend chiefly or solely upon such characters.

More than a score of fossil *Tipula* and closely allied groups have been described from the early Tertiary of western

North America by Scudder and Cockerell, the majority from the Florissant shales. Scudder (1894) proposed four supposedly new generic groups centering about *Tipula* that must be analyzed and evaluated in relation to the great increase in our knowledge of the Tipulidae in the past thirty years.

Manapsis Scudder (l.c., pp. 222, 223) with cell *M1* lacking or imperfectly developed. Affinities with other Tipulinae uncertain, due to the difference in venation in the two wings of the type. Several Recent Tipuline groups are now known in which cell *M1* is lacking (as *Idiotipula* Alexander, *Xenotipula* Alexander, and others).

Rhadinobrochus Scudder (l.c., pp. 223, 224) based on the character of an unusually narrow cell *1st M2*, which, in one wing of the unique type, shows an extra vein issuing therefrom, lying between veins *M1+2* and *M3* of the normal Tipuline venation. The value of this character is questionable, especially in the present instance where the venation appears to be abnormal (see Alexander, 1919).

Tipulidea Scudder (l.c., pp. 238, 239) was separated from *Tipula* s.s. only on the basis of small physical size (wing, 9.5-13.5 mm.) and the relative shortness of *Rs* which is approximately equal to *m-cu*. Both of these characters are duplicated in the recent subgenus *Schummelia* Edwards of the genus *Tipula*. The status of *Tipulidea* must remain in question until more evidence becomes available but it seems possible that the group may be maintained as a valid subgenus of *Tipula*.

Micrapsis Scudder (l.c., pp. 242-243) is based on a single imperfect specimen. The characters upon which the group is founded are very weak, consisting of the shortness of *Rs* and of an unusually small *1st M2*, with vein *M4* forking at base of this cell, with *m-cu* placed some distance beyond the origin of *M4*. The latter combination of characters is much as in *Nephrotoma* and some *Tipula* and the status of the group is very much in question.

In my opinion, none of the four Tipuline groups discussed above is well founded and all should wait upon the discovery of further material to substantiate or disprove their claims. It appears to me that all except *Tipulidea* may well be found to be based on teratological specimens, while all are based

on uniques in an indifferent state of preservation. The figures supplied by Blake do not always conform to the descriptions of Scudder (as in *Manapsis,* where in the left wing vein *R1+2* is shown as being distinctly preserved, whereas on the right wing it is not indicated and is either atrophied or poorly evident. In *Rhadinobrochus,* the venation of the two wings of the unique type is so dissimilar that the veins of the two sides cannot be homologized).

Tipula carpenteri Alexander, n. sp. (Plate 13, figs. 1, 2)

Male.—Length about 16-17 mm.; wing 17-18 mm.

Female.—Length about 21-22 mm.; wing 20-24 mm.

General coloration dark. Praescutal pattern apparently consisting of three entire dark stripes on a somewhat paler ground. Abdomen dark, the tergites with a still darker median longitudinal stripe that is narrowly interrupted at posterior border of each segment; lateral tergal stripes narrower and less distinct; sternites with a similar but much narrower median vitta.

Antennae of male longer than in female, subequal to the combined head and thorax; flagellar segments bicolorous, the basal enlargement darker than the apex; verticils short. In female, antennae about twice the length of head. In both sexes, flagellar segments with poorly developed basal enlargements to appear subcylindrical.

Wings subhyaline, with a conspicuous brown and white pattern; brown areas include a medium-sized marking at origin of *Rs;* stigma and a confluent seam on anterior cord; *m-cu* and adjoining portions of vein *Cu;* a dark cloud in cells *M* and *Cu* at near midlength of vein *Cu,* with another similar dark area near outer end of *Cu,* chiefly in cell *M,* the two dark markings separated by a whitish or ground area at near two thirds the length of cell *M;* distal portions of cells *R2* and *R3* slightly darkened but outer half of cell *R5* somewhat paler; the white areas appear chiefly as a broad poststigmal fascia involving cell *Sc2,* basal third of cell *R2,* subbasal third of cell *R3* and the subproximal end of cell *R5;* additional obliterative areas involving base of cell *1st M2* and the adjoining basal portions of cells *M3* and *M4.* Wings relatively broad, the length about 3.6 times the

greatest width. Venation: *Rs* relatively long, about one half longer than *m-cu,* or subequal to the width of cells *R* and *M* opposite its origin; vein *R1+2* preserved; petiole of cell *M1* variable in length, from one third as long to subequal to *m; m-cu* at fork of *M3+4;* cell *2nd A* of moderate width.

Hypopygium moderately enlarged, the outer end truncated. Ovipositor with relatively stout valves.

Holotype: No. 4536, Museum of Comparative Zoology, collected by Allan Caplan; this consists of a nearly complete insect.

Paratypes (both sexes): twenty-three in the Museum of Comparative Zoology (Nos. 4473-4495), and one in the University of Michigan Museum (No. 15383). The specimens figured are the holotype and paratype no. 4489.

I take unusual pleasure in naming this interesting Miocene *Tipula* in honor of Dr. F. M. Carpenter. As shown by the figures, there is a somewhat marked variation in the wing-pattern and venation in different individuals. The possibility exists that more than a single species is included in the present series but this does not seem to be the case. In some specimens the radial cells beyond the post-stigmatic white fascia are more uniformly darkened than in others, as shown by the figures, which represent extremes within the series. In No. 4489, figured, cell *M4* is more strongly narrowed at wing-margin than in the holotype, while vein *R3* is slightly less extended. This individual, while represented chiefly by the wings, is evidently a female and is the largest specimen whose measurements are given above.

The species that is most similar to the present fly would appear to be *Tipula limi* Scudder, which is somewhat smaller, with narrower wings. Scudder describes the species as having a darkened cloud at origin of *Rs* but in neither of his figures (l.c., Pl. 8, fig. 4, ♀ ; Pl. 9, fig. 1, ♂) is this distinctly shown. This Florissant species has distinct lateral stripes on the abdominal tergites in addition to the subequal median vitta.

The various allied Miocene species having patterned wings may be separated by the accompanying key:

1. Wings with vein *Sc* relatively short, *Sc2* ending at near midlength of cell *R1* and about opposite two thirds the length of *Rs.* 2

Wings with *Sc* longer, *Sc2* ending beyond midlength of cell *R1* and nearly opposite three fourths the length of *Rs*. *carpenteri* sp. n.

2. A conspicuous darkened cloud at origin of *Rs*. 3

   No darkened cloud at origin of *Rs*. 4

3. *Rs* unusually long, approximately twice *m-cu;* wings broad, about 3.5 times as long as wide. *tartari* Scudder

   Rs of moderate length, approximately one and one half times as long as *m-cu;* wings narrower, approximately four times as long as wide. *limi* Scudder

4. A conspicuous dark cloud at near midlength of vein *Cu*, extending caudad into cell *Cu;* abdominal pattern of individual tergites transverse; size large (wing, female, 23 mm.). *maclurei* Scudder

   No dark cloud at midlength of vein *Cu;* abdominal pattern of the individual tergites longitudinal; size medium (wing, female, to 17.5 mm.). *carolinæ* Scudder

Tipula spp.

In addition to the material previously discussed, the Creede collections included seven specimens that appear to represent one or more additional species. These belong to the group with wings immaculate or virtually so and no attempt can be made to make a more detailed identification. The specimens included bear the numbers 4496.

Family Bibionidae

By Maurice T. James
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Plecia creedensis James, n. sp. (Fig. 2)

This species differs from the Florissant species and from those described by Handlirsch from the Canadian Tertiary in that vein *R2+3* arises from the radial sector a considerable distance before the apex of *R1*, is strongly and distinctly elbowed at its origin, and runs almost parallel to *R1* for a considerable distance.

♀. A yellowish species, the thorax, head, palpi, and base of the proboscis brown; the abdomen is very light yellow along the narrow posterior margins and on the venter; the antennae are slightly darkened basally. Pile concolorous

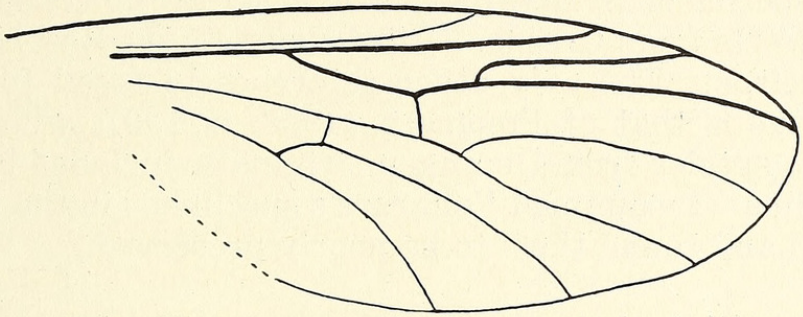

Fig. 2. *Plecia creedensis* James, n. sp., drawing of wing of holotype, No. 4523, M. C. Z.

with the background. Halteres evenly light yellow. Each tibia with a short, black preapical bristle. Wings slightly yellow-fumose, the veins yellow; those of the posterior part of the wing evident, though definitely lighter than the heavy anterior veins.

Length, 12 mm.; of abdoment, 8 mm.; of wing, 9 mm. The following measurements are in millimeters. Anterior femur, 2, tibia, 2.3, tarsus, 2.6; middle femur, 1.8, tibia, 1.8, tarsus, 1.9; posterior femur, 2.7, tibia, 2.8, tarsus, 2.4; length of head, .8, of antennae, .8, of thorax, 2.7; length of vein *Rs* to cross-vein *r-m*, 1.5, of *Rs* from *r-m* to origin of *R2+3*, .7, of cross-vein *r-m*, .4, of *M* from *r-m* to the furcation, .4; distance of apex of *R1* from base of wing, 6.4, of origin of *R2+3* from base of wing, 5.1.

Holotype (female): No. 4523, Museum of Comparative Zoology. This specimen is well preserved and is in lateral position, so that practically all characters of taxonomic importance are visible.

Paratypes: twelve females; eleven (Nos. 4524-4532) in the Museum of Comparative Zoology, and one in the Museum of the University of Colorado. Eight other specimens are present in the collection at the Museum of Comparative Zoology, but they are not designated as paratypes because of poor preservation.

Family Syrphidae

By F. M. Hull
University of Mississippi

One species of Syrphidae is contained in the collection of fossil insects from Creede. This belongs to the Recent genus Platycheirus. The only other reference to fossil forms of this genus is that of Pongracz (1928, p. 190), who places here two species from Oeningen, originally included by Heer in Syrphus. I examined Pongracz's specimens in the British Museum and found them to be poorly preserved.

Platycheirus persistens n. sp. (Fig. 3)

Male. Length 10.0 mm.; of abdomen and scutellum 6.0 mm.; of wing 7.2 mm.; second specimen, length 10.0 mm.; thorax and abdomen 6.2 mm.; of wing 8.8 mm.

Head: hemispherical, obviously narrower than thorax. Eyes narrowly dichoptic. Face dark in color. No details of antennae visible. *Thorax:* dark, though very little pigment is preserved, and no details of pile can be seen. Scutellum semicircular, the margin evenly convex, the width about one and three fourths greater than the length. *Abdomen:* slender, the sides not quite parallel, but slightly convex, leaving the middle segments barely wider. The first segment juts beyond the rim of the scutellum by a fifth the latter's length. Second and third segments of nearly equal length, the former the longer. Fourth segment slightly shorter than third. Fifth segment two fifths as long as the preceding one. Hypopygium prominent and smoothly rounded. The segments are marked with brown. The posterior two-fifths of the second segment with a median wedge, pointing to and reaching the anterior border, and similar pattern on the two succeeding segments, the brown of the posterior border on the fourth segment occupying nearly the whole of the posterior half. The fifth segment is clear. *Legs: slender.* For the most part, they are not well preserved, but one set of tarsi, apparently the left hind tarsi, is well preserved and shows decided expansion and thickening of the joints. *Wings:* poorly preserved.

Female. Specimen Nos. 3950 and 3951 is without head, obverse and reverse. These wings are a little better preserved and show the third longitudinal vein and costa ending quite beyond the tip of wing, though not nearly as much as in *Rhingia*. The abdominal pattern is quite similar; beyond the fact that the segments are slightly wider, I am unable to detect differences of importance. One whole hind leg

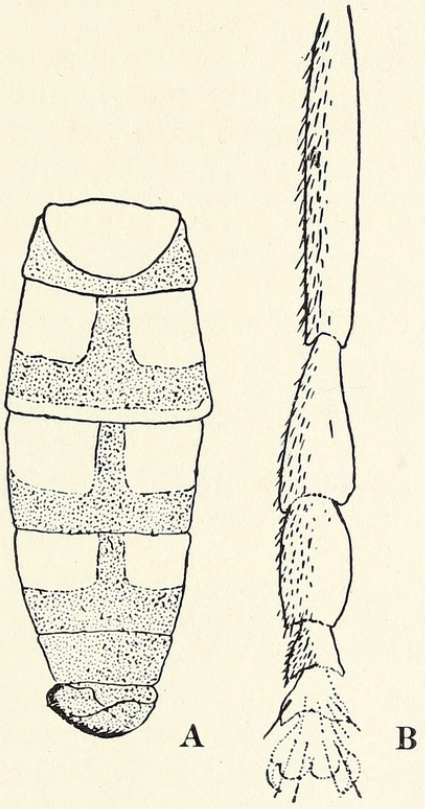

Fig. 3. *Platycheirus persistens* Hull, n. sp. A, abdomen; B, tibia and tarsus of holotype, No. 3949, M. C. Z.

(right) is preserved. The femora were slightly thickened one and two-fifths the width of tibiae and the tarsi were not dilated. The obverse is fragmentary and poor. Perhaps a trace of antennae appears upon it. The opposite hind tarsus is shown, the maculation is deceptive and the abdomen also appears disproportionately short and wide.

Holotype: 1 male, No. 3949; in the Museum of Comparative Zoology.

Paratype: 1 female, No. 3950; in the Museum of Comparative Zoology.

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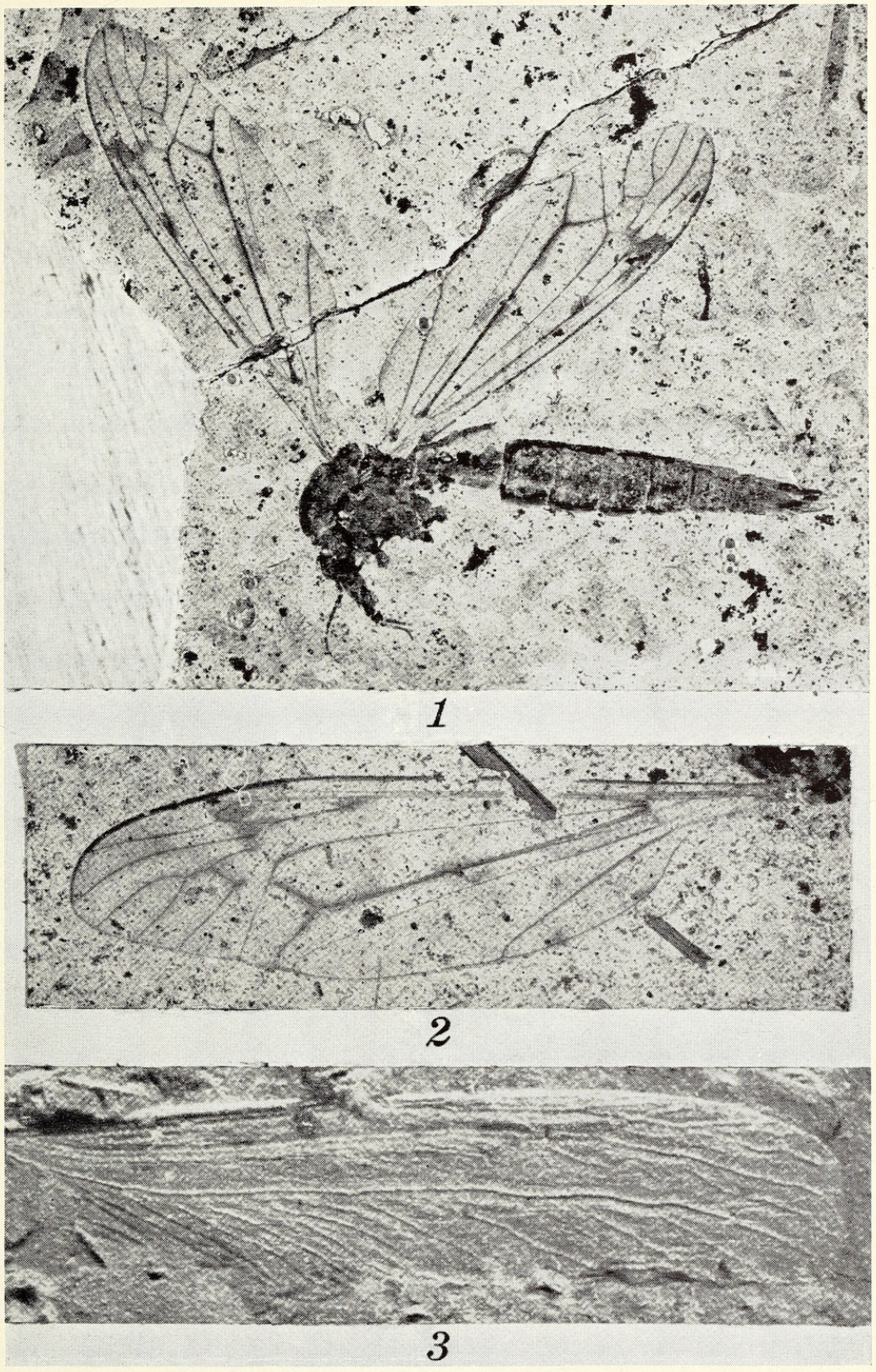
EXPLANATION OF PLATE 13

Fig. 1. *Tipula carpenteri* Alexander, n. sp. Photograph of holotype, No. 4536, Museum of Comparative Zoology. Length of wing, 18 mm.

Fig. 2. *Tipula carpenteri* Alexander, n. sp. Photograph of paratype, No. 4489, Museum of Comparative Zoology. Length of wing, 17 mm.

Fig. 3. *Reticulitermes creedei* Snyder, n. sp. Photograph of holotype, No. 4472, Museum of Comparative Zoology. Length of wing, 6.5 mm.

Psyche, 1938 Vol. 45, Plate XIII.



Fossil Insects from Creede

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