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PENNSYLVANIAN INVERTEBRATES OF THE MAZON CREEK AREA, ILLINOIS

INSECTS

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Insects

INTRODUCTION

Pennsylvanian insects have been found in only three localities in Illinois. The most important of these is the area in Will and Grundy counties that comprises the natural outcrop of the Francis Creek shale member of the Carbondale Formation on Mazon Creek, and also the artificial exposure nearby, created by strip mining for coal (see no. 1, this volume). One Pennsylvanian insect is known from Colchester, McDonough County, and five from Vermilion County, south of Danville; in contrast, 130 species have been described from Mazon Creek and the related strip-mine exposures, and seven more are included in this paper.

Descriptions of the first two species of Pennsylvanian insects to be described from the Mazon Creek sites were published in 1864 by J. D. Dana. S. H. Scudder described 36 more, including the species from Colchester and one from the Danville area. Dana and Scudder represent what has been termed the "Primitive Period" of fossil insect work in Illinois (Richardson, 1953), a period that closed with a paper by A. L. Melander in 1903. The extinct orders were not then understood; fossils were assigned to broadly conceived modern orders and were compared with modern genera or were placed in artificial groups in the belief that insect orders had not become differentiated by Pennsylvanian time.

The "Middle Period" of Illinois paleoentomology, to pursue the figure, is dominated by Anton Handlirsch, of Vienna. From 1906 to 1920, Handlirsch described 77 Illinois species, almost all from Mazon Creek. Having a great many more species for comparison, Handlirsch had a better insight than had Scudder or Dana into the problem of a natural classification. He named four new extinct orders for the Pennsylvanian insects and redefined others, giving the classification of Paleozoic insects a validity potentially equal to that of modern insects. His observations and his taxonomy have not withstood all tests of later work, but his papers are still a necessary starting point for any one working with Mazon Creek insects.

Balancing the Primitive and Middle periods there is inevitably a Modern Period, which is based on the work done by R. J. Tillyard, F. M. Carpenter, and A. V. Martynov on the Permian insects of Australia, Kansas, and Russia. Attention was for a time turned away from Illinois fossil insects, largely because few new specimens were being found; but later, F. M. Carpenter (1938, 1943b) described six species, one from Mazon Creek and the rest from the strip mines.

Since insects are very rare in the Francis Creek concretions, any significant rate of discovery of new specimens depends on a high rate of collecting. In the years 1937–46, Mr. George Langford, then engaged in business in Joliet, Illinois, spent the astounding total of 1,100 days in the field. His collections of that period are now deposited in the Illinois State Museum, Springfield; the Peabody Museum, Yale University; and the St. Paul Academy of Science, St. Paul, Minnesota. His insects are all in the collection at Springfield, and the finest ones have been described (Carpenter, 1943b). Since he joined the staff of Chicago Natural History Museum in 1946, Mr. Langford has been collecting for this institution, and to date he has found a dozen specimens of insects, the best of which are described below.

Mr. Langford's collection has been rivaled by the numerous enthusiastic amateur collectors who visit the spoil heaps of the strip mines; some insect specimens are known to be in their collections. One of these, included below, is from the collection of Mr. and Mrs. John M. McLuckie, of Coal City, Illinois. Other specimens, collected by Dr. and Mrs. Robert H. Whitfield, Mr. Jon S. Whitfield, Mrs. William D. Turnbull, and the writer, are in the Chicago Natural History Museum collection. The Walker Museum (University of Chicago) and the Chicago Academy of Sciences also have collections that include insects from Mazon Creek and the strip mines.

Including the new species described below, the Mazon Creek insect fauna as now known comprises 137 species. The composition of the fauna by orders is indicated in the Table, with the faunas of Great Britain, the Saar basin, and the northern Appalachians included for comparison. Unfortunately, the Commentry insects can not be included, as Professor Carpenter's careful and necessary revision has not yet been completely published. Probably none of the four faunas shown in the table is sufficiently well known to form a trustworthy basis for speculation; yet the differences in rank of the first three orders listed are so pronounced that they should

prove to be representative of the differences in the complete faunas, and certain tentative conclusions may be drawn on this assumption.

The Francis Creek fauna lived in a moderately open woodland lying little above sea level, near a shore, and being slowly aggraded by mud and silt deposits—a plant-covered delta plain. The composition of the insect fauna seems in accordance with this view. In contrast with the insect faunas of the other areas listed, the Mazon Creek fauna includes relatively few roaches. If roaches preferred then, as they do now, a dense and moist forest habitat, their scarcity suggests a drier, more open forest.

PENNSYLVANIAN INSECT FAUNAS

Ordinal composition of the Mazon Creek insect fauna compared with those of the British Coal Measures (from Bolton, 1921–22, and Handlirsch, 1922), the Saar-Lorraine basin (from Waterlot, 1934), and Pennsylvania and West Virginia (from Handlirsch, 1922, and Carpenter, 1934).

Order	Northern Illinois	Great Britain	Saar-Lorraine	West Virginia and Pennsylvania
	%	%	%	%
Palaeodictyoptera	18	33	55	9
Protorthoptera	57	9	4	4
Blattaria	21	47	32	84
Protodonata	1	7	—	1
Megasecoptera	2	1	—	—
Caloneurodea	1	—	—	1
Minor orders and indet.	2	1	9	1
Total species	137	46	56	89

Waterlot (1934, p. 297), commenting on the abundance of Palaeodictyoptera in the Saar basin deposits, pictured them as skimming the surface of ponds much as modern dragonflies do. Thus the Protodonata and the Palaeodictyoptera may have competed for the same ecological niches. The great relative abundance of Palaeodictyoptera in the Saar basin may have been related to the absence or scarcity of fish at that place, as Waterlot (1934, p. 298) has suggested.

On the basis of their having strong walking legs, the Protorthoptera have been pictured (Bolton, 1921, p. 7) as spending much of their life on the ground, possibly along the margins of swamps. Though their large wings were well adapted for flight, a preference for ground feeding, if the interpretation is correct, would be in accordance with the suggestion that the vegetation of the Mazon Creek delta was more sparse than that of a typical coal swamp.

The apparent dearth of Caloneurodea in Europe (excepting at Commentry) and of Megasecoptera in the northern Appalachians is probably caused by the slow rate of discovery of fossil insects rather than by their absence from those faunas. Insects of those orders and of the Protodonata were undoubtedly less abundant than were those in the three major orders.

DESCRIPTION OF SPECIES

Order **PALAEODICTYOPTERA**

The order Palaeodictyoptera has never been adequately defined. Devised in 1867 by Dohrn (under the preoccupied name of Dictyoptera) for the remarkable Permian genus *Eugereon*, the order grew by accretion until in Scudder's time (Scudder, 1885) it embraced all the Paleozoic hexapods then known. Subsequent restriction of the order leaves it now including 36 families with somewhat varied attributes, but no longer including *Eugereon*, now placed in the order Protohemiptera of Handlirsch.

The principle of priority would no doubt require that the ordinal name Palaeodictyoptera be substituted for Protohemiptera and another name (or several names) be proposed for the array now called Palaeodictyoptera. Fortunately, we are not compelled to do this, though others, notably Crampton (1930), have suggested new ordinal names for portions of the group. By common usage, the family Stenodictyopteridae (Dictyoneuridae of authors) and its relatives are considered to constitute the order in question. But what are the characters of this order? A few that may be listed are taken from published partial definitions or implied in published discussions. The following list is concerned only with wing characters; features of the head, thorax, and legs are equally significant, but manifestly cannot be applied to specimens consisting of wings alone, as most specimens do.

(1) Longitudinal veins much branched.
(2) MA and MP well developed.
(3) At least 3 anal veins.
(4) Mesh-like archedictyon.
(5) Veins arising independently at base of wing; but anterior and posterior limbs of dichotomous veins (M and Cu) may arise from a common stem.
(6) Veins do not cross each other or fuse together.
(7) Rs arises in proximal half of wing or about midwing.
(8) Veins curve toward posterior margin.
(9) Anal veins curve toward base of wing.
(10) CuA present, convex.
(11) CuP branched.

None of these criteria may be accepted without reserve. Tabulation from published figures and descriptions of Palaeodictyoptera indicates that in some families all reported specimens are so incomplete as to preclude use of several of these characters; other specimens that are complete fail to fulfil one or more conditions.

Just as members of a plexus of orders have an orthopteroid facies and are commonly placed together in the inclusive order Protorthoptera, so there is a palaeodictyopteran facies uniting various species into this primitive order.

In the homologizing of wing veins that is an integral part of the description of species, the concept of the order Palaeodictyoptera is in effect a "morphotype" (Zangerl, 1948, p. 355) of the primitive insect wing. The morphotype of the palaeodictyopteran wing includes the veins C, Sc, R1, Rs, MA, MP, CuA, CuP, and *n*A. Since within the order the number of branches of these veins and the number of anal veins are variable, it is fruitless to adopt a numeration for the branches; as Zangerl has shown (op. cit., p. 369), in cases where undifferentiated structures occur in different quantity among compared forms in whose mutual morphotype the quantity is unstable, each of those structures in one form is the homologue of every similar structure in the compared form. Within a smaller group, in which, for example, Rs constantly has four branches, the morphotype of that group will have that specified number of branches, and corresponding branches in compared forms may be properly considered homologous. The naming of veins in the descriptions that follow is limited to the veins that are significant for that group; where a more detailed nomenclature is employed, it is for convenience in description and is not intended to imply a detailed homology.

The Palaeodictyoptera described below pertain to two known families, one undescribed family, and two undetermined families.

Family **Spilapteridae**

It is interesting to note the occurrence of a spilapterid in this fauna. Other species of the family have been reported in Pennsylvanian rocks only from France and England; a single Permian species extends the geographic range to Kansas. Handlirsch (1925, p. 136) defines the family: "Rs more or less richly branched. Front branch of M always many-branched, as well as the hind branch. Cu often with branched anterior member. Anal veins with numerous branches. Straight cross veins more or less widely spaced.

Wings often decorated with stripes or spots." Further remarks on the family are presented below.

Mcluckiepteron, new genus

Description.—HINDWING: Subtriangular in shape, with concave anterior margin and recurved tip; greatest width near base. Narrow trichiated fringe of membrane anterior to C. C slender, accompanied in proximal half of wing by a broad, thickened, convex ridge between C and Sc. Sc and R1 very close to C. Sc extending to or nearly to apex. Rs arising very near base, running parallel to R1, converging toward it near apex, sending off a pectinate series of simple or forked branches in distal half of wing. MA arising near base from stem of MP, forked at midwing. MP putting forth a forwardly directed pectinate series of simple branches. CuA divided near base into two divided branches, their offshoots occupying the triangular space between the main branches. CuP simple, arising independently. 1A branched. Cross veins relatively few, irregularly spaced, straight, some meeting end to end between successive veins.

Genotype.—*Mcluckiepteron luciae*, new species.

Diagnosis.—*Mcluckiepteron* is allied to *Homaloneura* and *Homaloneurina* of the Commentry fauna and to *Dunbaria* of the Kansas Permian. These and perhaps *Homaloneurites* seem to constitute a compact group within the family Spilapteridae, characterized by the concave anterior margin and long Sc. The new genus differs from the others in the great development of branches in CuA, in the pectinate branching of MP, and in the possession of a precostal fringe.

Remarks.—It is appropriate to name this striking genus in honor of Mr. and Mrs. John M. McLuckie, of Coal City, Illinois, whose collection of plant and animal fossils from the strip mines of Will and Grundy counties contains many outstanding specimens, the cream of a quarter century's collecting.

Mcluckiepteron luciae, new species

Figures 4, 5

Description.—HINDWING: Length about 55 mm.; greatest width, at position of termination of 1A, 33 mm. Precostal fringe bearing about three rows of irregularly arranged macrotrichia. Auxiliary

convex coriaceous ridge between C and Sc very broad basally, narrowing evenly and thinning to nothing at midwing, where C, Sc, R1, and Rs are all bent forward, following the wing margin. Sc arising in a broadened basal concave sclerotized area about a third as wide as the convex ridge anterior to it. R1 strong, standing much higher than C, simple. Rf near base, Rs not branching again until slightly beyond midwing; Rs with five or six pectinately arranged branches, of which the first sends forth two anteriorly directed twigs. Mf slightly distad of Rf, MA arising as a concave branch from the concave stem M, but almost immediately becoming convex and as high as R1; MA forked slightly distad of the fork of Rs, the anterior branch continuing the marked elevation of the stem, but the posterior branch, less elevated, continuing its gentle curve to the margin. MP with four forwardly directed branches, the first at midwing, slightly proximad of the fork of Rs. CuA1[1] twice forked; CuA2[1] with three branches, of which the first is forked, each twig again forking, the second once forked, and the third simple. CuP distant from CuA and 1A, simple. 1A at least twice forked. Cross veins perpendicular or nearly so to longitudinal veins, tending to slant between veins of different series; sparse except between R1 and Rs. No trace of mesh-like archedictyon.

Sockets of macrotrichia are to be seen on certain veins of *M. luciae*, as follows: on the bottom surface of the main stem of Rs, but not on its branches; on the top surface of R1, though possibly lacking proximad of Rf; probably on the top surface of the basal portion of CuA. They are plentiful on the thin membranous precostal margin, on both upper and lower surfaces. Wing spots, appearing as low domes, occupy the distal radial cells.

The broadened convex base of R is split by a corrugation into two stems that come together just before Rf, the posterior member of this pair lying tangent to the heavy stem of CuA. The anal area, as in Permian ephemerids (Tillyard, 1932, p. 107), is incompletely preserved, probably being formed of a more tenuous membrane with weaker struts than the rest of the wing. 1A, with two forks, may be seen in that area, as well as part of another anal vein.

Remarks.—Tillyard (1937a, p. 85) described a megasecopteran-like genus, *Kansasia*, from the Permian of Kansas, as a spilapterid; Rohdendorf (1940, p. 108) included it in the order Archodonata. Handlirsch (1937, p. 116) posthumously proposed the family Dun-

[1] Designation adopted for convenience of reference, not to indicate a supposed homology with a similarly named vein in any other wing (see p. 19).

bariidae, which he neglected to characterize, for the single genus *Dunbaria;* his reasons for separating it from the Spilapteridae, to which Tillyard (1924, p. 203) had assigned it, are not evident. The Pennsylvanian *Mcluckiepteron* and the Permian *Dunbaria* will be treated tentatively as members of the same family, though occupying different branches; they are thus the only spilapterids known

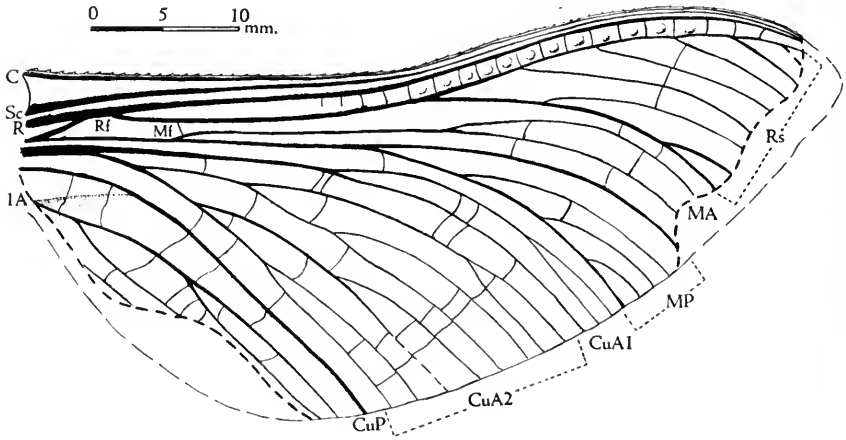

FIG. 4. *Mcluckiepteron luciae*, new species. 1A, first anal; C, costa; CuA1, CuA2, first and second forks of anterior cubitus; CuP, posterior cubitus; MA, anterior media; Mf, fork of media; MP, posterior media; R, radius; Rf, fork of radius; Rs, radial sector; Sc, subcosta.

from North America, and are, oddly enough, the oldest and the youngest representatives of an important European family. They share the character of a thickened basal part of the costal region, and both have trichia on some of the veins. Whether the other spilapterids have these characters cannot be ascertained from Handlirsch's figures and descriptions. The older genus, *Mcluckiepteron,* is more generalized than the younger, in its free CuP, its branched 1A, and its more branched MP, but it is the more specialized in several ways: (1) it lacks the mesh-like archedictyon; (2) it has developed the very unusual precostal membranous margin; (3) Rs is slightly less branched and includes a forked branch; (4) the auxiliary veins in CuA are unusually numerous; (5) Mf is situated farther toward the base; (6) it includes raised wing spots in the radial cells.

The trivial name is given in honor of Mrs. McLuckie, who discovered the holotype and recognized it as a new species of insect wing. I am grateful to Mr. and Mrs. McLuckie for the loan of the specimen from their collection.

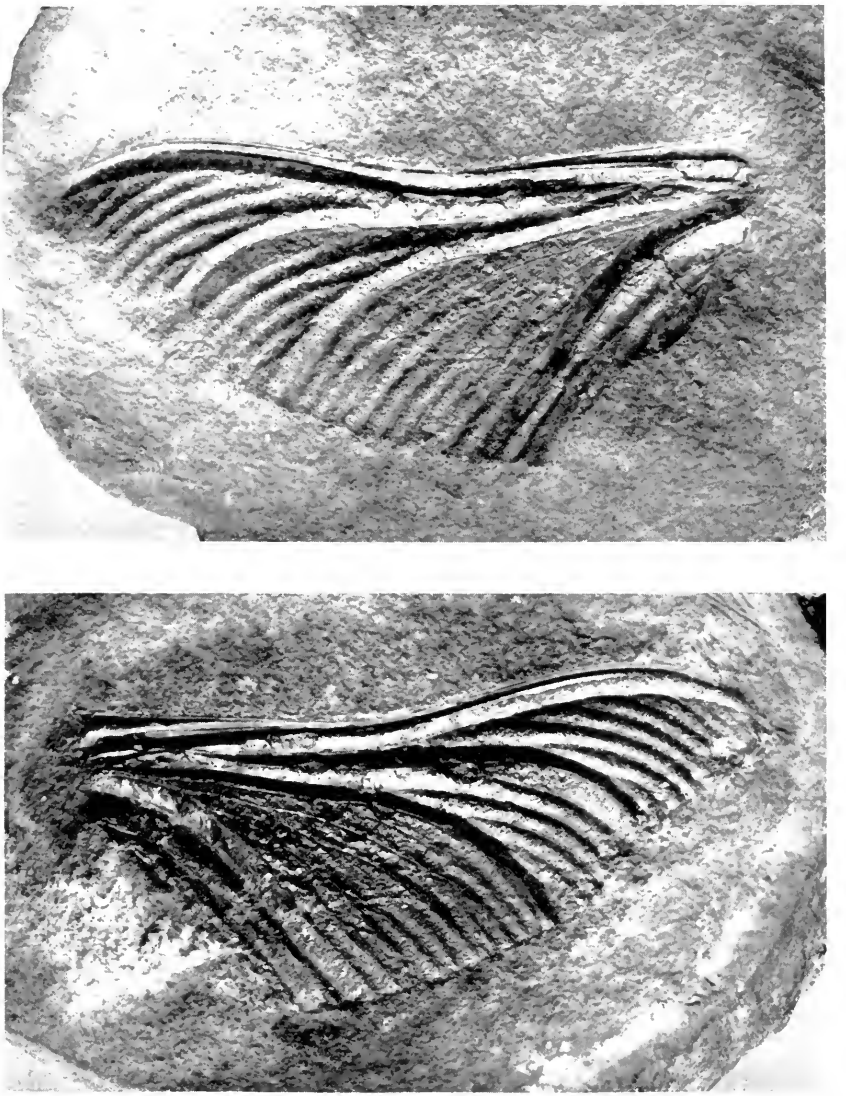

FIG. 5. *Mcluckiepteron luciae*, new species, holotype; × 1.7. McLuckie Collection.

Holotype.—Two halves of a concretion containing impressions of a hind wing; in the collection of Mr. and Mrs. John M. McLuckie. Plaster casts are preserved in the collection of Chicago Natural History Museum and in the Department of Geology, Princeton University.

Family **Syntonopteridae** Handlirsch 1911, emend. Carpenter 1938

Genus **Lithoneura** Carpenter 1938

Lithoneura Carpenter, 1938, Amer. Jour. Sci., (5), **36**, p. 446; 1943, Illinois State Mus., Sci. Pap., **3**, pt. 1, p. 13.

Two species of *Lithoneura* have been described, *L. lameerei* Carpenter 1938 (the genotype) and *L. mirifica* Carpenter 1943, both from the strip mines north of Braidwood. The first is known from both forewings and hindwings, and the second from only a hindwing. The present species, also from the strip mines near Braidwood, is known from only a forewing.

Although this species lacks full development of the two characters prescribed for the forewing in Carpenter's diagnosis of *Lithoneura* (Carpenter, 1938, p. 446), the aspect of the wing is certainly such as to admit it to the genus. Therefore, the generic diagnosis should be modified to the extent needed to include this species. True cross veins are only slightly developed in the costal area, being present in *L. carpenteri* only in the proximal quarter. The fusion of Rs and MA is incomplete, these veins being tangent rather than fused. Cross veins are as well developed in the remainder of the wing as they are in *L. mirifica*. The separation of veins normally fused is not unusual within a genus; in the family Lemmatophoridae, this character varies within species and even between right and left wings of an individual (Tillyard, 1928, p. 313; Carpenter, 1935, p. 107).

Lithoneura carpenteri, new species

Figures 6, 7

Description.—The venation of the forewing is shown in figure 6. The costa lies slightly inside the margin of the wing basally and gradually approaches it, so that it is truly marginal only in the distal quarter of the wing. The narrow precostal area slopes sharply down from C, forming a flange on the anterior edge of the wing. Sc extends nearly to the apex, probably terminating on C. Rf is far

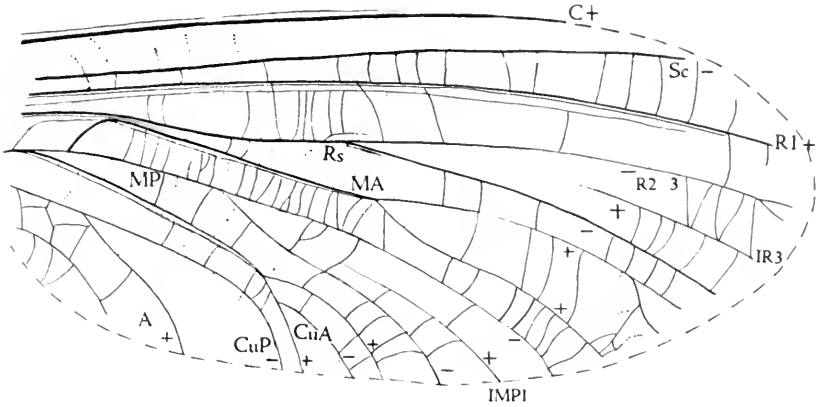

FIG. 6. *Lithoneura carpenteri*, new species; × 2.2. A, anal; C, costa; CuA, anterior cubitus; CuP, posterior cubitus; I prefixed to vein symbol, interpolated vein; MA, anterior media; MP, posterior media; MP1, first branch of posterior media; R1–3, branches of radius; Rs, radial sector; Sc, subcosta; +, elevated vein; −, depressed vein.

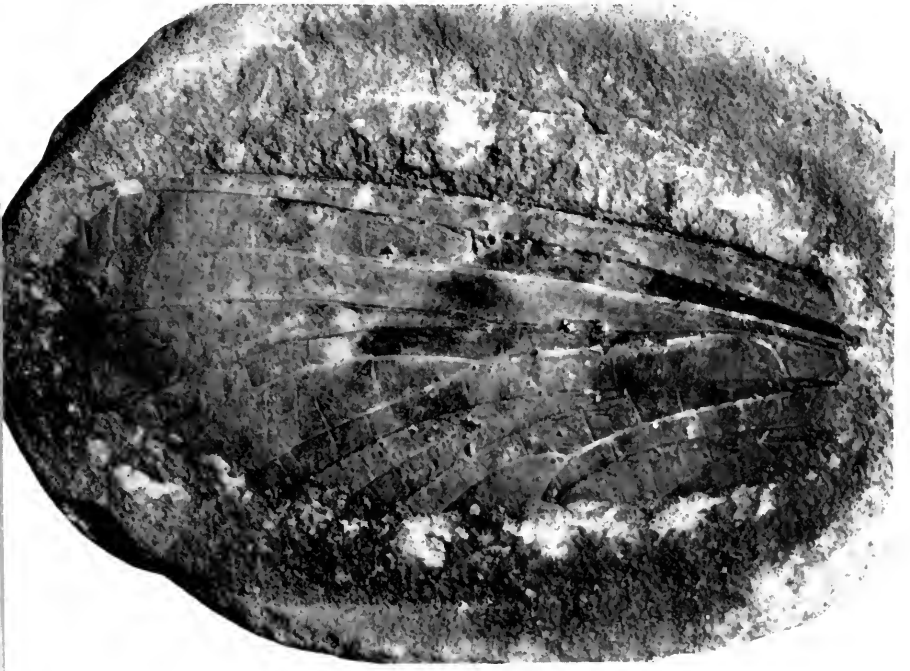

FIG. 7. *Lithoneura carpenteri*, new species; × 2.35. Walker Museum no. 45248.

toward the base; R2+3 separates from R4+5 at about midwing; R2 separates from R3 near the apex; R4+5 apparently remains undivided. Intercalary vein IR3 is present. Mf is far toward the base, but markedly apicad of Rf; MA arises in a strong arch as a convex vein from the concave stem M and touches Rs but does not fuse with it; MA bifurcates at Mf′, at about midwing, slightly apicad of Rf′; MP bifurcates about halfway between Mf and Mf′, with IMP1 originating at about midwing. CuA arises close to or from the same stem as M, and bifurcates slightly apicad of Mpf. CuP, concave, arises independently of CuA, and remains simple, as in the hindwing of *lameerei*. Anal area moderately long; anal veins simple.

In size this species is intermediate between the two previously known species, and closer to the larger, *L. mirifica*. The number of cross veins is likewise intermediate between the two other species.

Remarks.—Since this species is known from only a forewing, and *L. mirifica* from only a hindwing, the present specimen might be thought to represent the unknown forewing of the latter species. Fortunately, both wings of the genotype are known, so that a test may be made. A rectangular grid superposed on a drawing of the hindwing of *L. lameerei* undergoes a certain distortion in being transferred to a drawing of the forewing in such a way that intersections of the grid fall on homologous points in the two wings. If a similar grid transfer is attempted from the hindwing of *L. mirifica* to the forewing of *L. carpenteri*, the distortion is of a different pattern. While this test may not indicate that the wings are from different species, this is at least implied, and accordingly a new name is proposed for the species here described.

A curious feature of the wing of *L. carpenteri* is the presence of accessory ridges accompanying certain veins, and accessory furrows accompanying one of the concave veins. Near the base, two slender ridges appear between R and Rs; both continue parallel and close to R1 nearly to the apex, where the posterior one ends and the other blends with R1. Some, but not all, of the cross veins between R1 and Rs cross the posterior ridge. Short, shallow furrows are developed as a bracket around Rf′, and a single ridge parallels a portion of MA before its fork. The accessory ridges resemble those bordering the distal portions of the longitudinal veins in *Camptoneurites* and *Protembia* (Carpenter, 1950, pp. 210–217), Permian protorthopterans. Their significance is obscure, but they are probably of no more than specific or possibly individual importance.

Intercalary veins, characteristic of syntonopterids, are present in *L. carpenteri* in Rs and MP. The convex vein IR3 is joined to the concave R2+3 by a short, weak, concave cross vein. IMP1 appears to originate without connection with MP1.

Holotype.—Two halves of a concretion containing impressions of the dorsal and ventral surfaces of the wing. Collected in 1938 by Dr. Heinz A. Lowenstam. University of Chicago, Walker Museum, nos. 45248A and 45248B.

Length of preserved portion of wing, 56 mm.; probable original length, 60 mm. or slightly more.

NEW FAMILY, UNNAMED

Palaeodictyopteran wings with broad costal area narrowing distally; Sc, R1, Rs and MA parallel and running nearly straight to apex of wing; Rs little divided, forking distally; stem of M curved backward basally so that Cu and A arise from it; CuP branched; complete irregular archedictyon.

The single remarkable wing representing this family has several characteristics normally present in wings of the order Protorthoptera. Each of these, however, occurs also in one or more genera of Palaeodictyoptera, though their occurrence together is unique in the order. Characters that ally the wing to the Palaeodictyoptera are: the backward curving of MP, Cu, and A; the irregular archedictyon; the three anal veins; the branched CuP. Each of these characters may be found in wings of other orders, but their coincidence can only require an assignment to the Palaeodictyoptera. Since there is at present only a single specimen displaying this group of characters, a formal name is not proposed for the family.

Turnbullia, new genus

Description.—Wing medium-sized, about 2½ times as long as wide, greatest width in distal half. C marginal, with heavy hairs or spines on its anterior edge in the basal part of the wing. Costal area broadest in basal part of wing, occupied by irregular archedictyon and oblique veinlets. Sc, R, and M arising independently, arched at base, running nearly parallel up to Mf, MA then continuing parallel to Rs. Rf at about midwing; Mf in distal half of wing. MA simple, curving only slightly toward posterior margin. MP sending off branches toward apex of wing. Cu arising near base from stem of M; CuA simple, arising near origin of Cu; CuP

with its posteriorly directed branches occupying half of the posterior border of the wing. Anal veins arising from stem of M, arching to posterior margin.

Genotype.—*Turnbullia priscillae*, new species.

Remarks.—The genus carries the name of Mr. and Mrs. William D. Turnbull, the former Assistant Curator of Fossil Mammals, Chicago Natural History Museum, who have added greatly to the Museum's fossil collections through preparing and caring for the specimens, as well as through collecting. The specimen of the genotype was found by Mrs. Turnbull on one of their collecting excursions.

Turnbullia priscillae, new species

Figures 8, 9

Description.—Wing, as preserved, 59 mm. long, 25 mm. wide, probably about 63 mm. long in life. Costal veinlets more regular in narrow apical portion of costal area than basally. Rs branching near apex of wing into R2+3 and R4+5; a second forking separates R4 from R5 very close to the apex. MA arising as a neutral vein from the compound stem M somewhat distad of Rf; MP continuing the direction of the stem and sending off a pectinate series of three branches toward the posterior slope of the apical margin. CuA weakly convex. CuP with a pectinate series of four branches curving toward the posterior margin. 1A forked, weakly concave, arising from the stem of M somewhat basad of the origin of Cu.

Remarks.—Convexity is of little assistance in homologizing the veins of this species. R1 is strongly convex, as is to be expected, but the vein designated MA is neutral rather than convex. An alternative interpretation is that MA is lacking and that the vein following Rs is a branch of MP; that would bring the wing closer to the Protorthoptera, to which several other characters seem to draw it. This relation would be further strengthened by regarding the vein designated CuP1 as CuA, with branches arising from both sides of its stem. The vein here called 1A would then have to be understood as CuP, a simple concave vein, as in the Protorthoptera, with 1A branching from it. These changes in interpretation, plus the broad costal area, the straight course of the anterior veins, and the fusion of other veins onto the base of M, would constitute a strong argument for placing this wing among the Protorthoptera. However, the stems here called Cu and 1A are probably not far removed from a condition

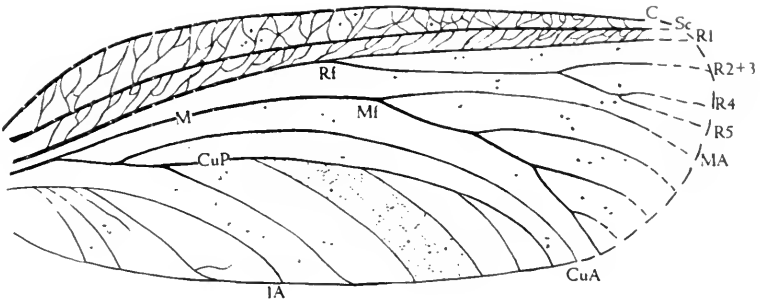

FIG. 8. *Turnbullia priscillae*, new species; × 1.6. 1A, first anal; C, costa; CuA, anterior cubitus; CuP, posterior cubitus; M, media; MA, anterior media; Mf, fork of media; R1–5, branches of radius; Rf, fork of radius; Sc, subcosta. Weight of lines indicates relative strength of veins.

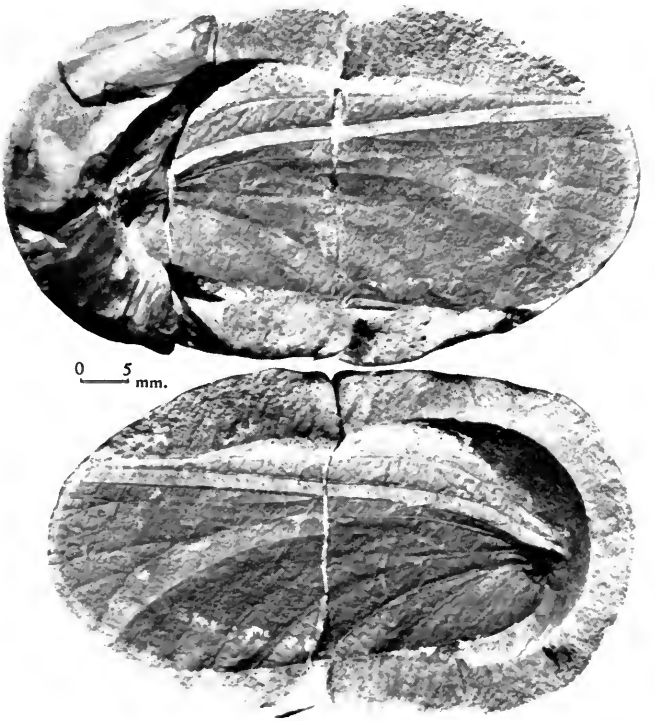

FIG. 9. *Turnbullia priscillae*, new species, holotype; CNHM no. PE149. The lower half of the concretion, illuminated from below, appears in reversed relief.

of primitive independence, having been captured by a posterior migration of the stem of M. The anterior branch of Cu, the only convex vein in the cubital neighborhood, can logically represent the normally convex CuA, while the other branches, neutral, must be the fundamentally concave CuP and its ramifications. The distinctness of MA and MP is scarcely indicated by the relief of the veins, but while the branches here labeled MP lie slightly below the level of the wing membrane and are thus weakly concave the anterior branch, though actually neutral in relief, lies higher and may therefore be understood as representing the fundamentally convex MA.

The very slight degree of branching of Rs is rare; it occurs in *Fabrecia* Meunier and *Stenoneura* Brongniart among the Protorthoptera, and in *Macroptera* Laurentiaux among the Palaeodictyoptera. Laurentiaux (1949b, p. 219) has justly called the retarded branching of Rs a primitive character.

The major veins and branches retain marks of trichia, indicated as dots in figure 8. Trichia are present also in the membrane within the mesh of the archedictyon, having the same size as those on the veins. Tillyard (1918, pp. 631–634) has shown that macrotrichia occur only on true veins and veinlets, and not on the wing membrane or on cross veins. In *Turnbullia*, the trichial bases on the membrane are as large as those on the veins, and must certainly be regarded as macrotrichia. If Tillyard's rule admits no exception,[1] *Turnbullia* has an aphantoneuric archedictyon represented by the trichial bases, plus a new secondarily developed complete archedictyon. Such a hypothesis falls almost of its own weight; the macrotrichia of *Turnbullia* must have developed originally on the wing membrane itself.

The posterior border of the wing is delimited by a fairly strong marginal vein for which there is no accepted term in the nomenclature of veins. It may represent an anal vein that blends apically with C, or it may be C itself. The wings of modern Mecoptera have such a marginal vein. The posterior margin of the wing is rippled by an up-arching of the membrane (and the marginal vein) between the relatively depressed branches of CuP.

The trivial name is proposed in honor of Mrs. Turnbull, who found the type specimen and presented it to the Museum.

[1] Macrotrichia have been reported on cross veins, as by Martynov (1938a, p. 203); they also occur on cross veins in the modern Planipennia, for example, in *Chrysopa*.

Holotype.—Two halves of a concretion bearing the paired impressions of the wing. CNHM no. PE149. From the strip-mining area near Coal City (Coordinates d9.0, *F*4.1 on the map, fig. 3, this volume, no. 1); collected April 26, 1953.

FAMILY UNDETERMINED

UNDETERMINED INSECT NO. 1

Figures 10, 11

A nearly complete body of an insect, lacking wings, but with parts of four legs. Metathorax and mesothorax about equal in size, abdominal segments at least nine in number, slightly diminishing in size posteriorly. Prothorax and head probably present, but characters obscure. On two of the abdominal segments there are lateral flaps such as are present on the abdomen of *Teneopteron, Stenodictya,* and many other primitive insects. Length, as preserved, 29½ mm.

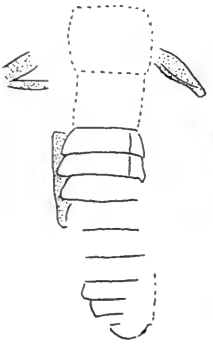

FIG. 10. Drawing of undetermined insect no. 1.

FIG. 11. Undetermined insect no. 1; × 1.48. CNHM no. PE3285. The impression of parts of body and legs of insect among plant fragments.

Figured specimen.—CNHM no. PE3285, two halves of a concretion containing abundant macerated plant debris and the paired impressions of the insect body. Jackson farm, about midway between Braidwood and Wilmington. (Coordinates h5.5, *J*7.2, on the map, fig. 3, this volume, no. 1.) Collected, 1952, by E. S. Richardson, Jr.

UNDETERMINED INSECT NO. 2

Figures 12, 13

A fragment of a wing, about 20 mm. in length; not sufficiently complete for description. The fine, close cross veins in subparallel arrangement give the delicate membrane the appearance of being wrinkled.

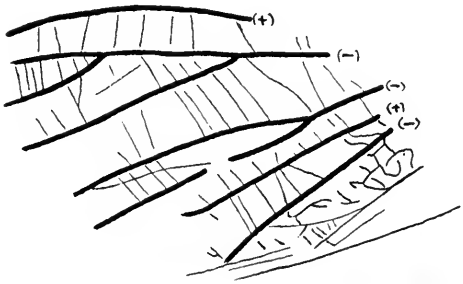

FIG. 12. Drawing of undetermined insect no. 2; × 3.5. +, elevated vein; −, depressed vein.

FIG. 13. Undetermined insect no. 2; × 1.56. CNHM no. PE146. The counterpart specimens, illuminated from below, appear in reversed relief.

Figured specimen.—CNHM no. PE146, two halves of a nodule bearing paired impressions of the wing. Collected by George Langford in strip mine spoil heap. (Coordinates e7.2, *I*0.0 on the map, fig. 3, this volume, no. 1.)

Order **PROTORTHOPTERA**

Handlirsch (1937, pp. 63–65) has divided the Protorthoptera into four suborders, plus an unassigned array of families and genera. Since this division is soon to be superseded by Professor Carpenter's promised revision, no attempt will be made here to place the following species in suborders or to break up the unwieldy order Protorthoptera. The first two genera that follow are included in the family Cacurgidae, and should therefore go in Handlirsch's suborder Cacurgoidea, though his definition of the suborder is not entirely appropriate.

Family **Cacurgidae** Handlirsch 1911, emend. Pruvost 1930

Discussions of the family are to be found in Laurentiaux (1949a, p. 55) and works there cited. In this family, Handlirsch included the following genera in 1922: *Cacurgus* Handlirsch 1911 (Mazon Creek); *Spilomastax* Handlirsch 1911 (Mazon Creek); *Palaeomastax* Handlirsch 1904 (Westphalian of Belgium); *Archaeologus* Handlirsch 1906 (Mazon Creek); *Archimastax* Handlirsch 1906 (Pottsville of Arkansas); *Cacurgellus* Pruvost 1919 (Westphalian of France). He properly excluded *Oryctomastax* Pruvost 1919 and *Archaeacridites* Meunier (included by Pruvost in 1919). To the above genera, Pruvost added (1930) *Omalia* Van Beneden and Coemans 1867,[1] including as synonyms *Palaeomastax* Handlirsch and *Coselia* Bolton 1922 (Westphalian, Belgium and England). Carpenter (1943b) added *Heterologus* Carpenter 1943 (Braidwood strip mines). It is now proposed to add two more genera, *Nacekomia* and *Anthrakoris*.

Nacekomia, new genus

Description.—Cacurgids with narrow forewing with pectinately many-branched MP; simple R1 joined to C in distal third of wing by forking veinlets; Rs twice dichotomously divided; lower branch (CuP1) of cubito-medial Y-vein very long, leaving a broad space between CuP1 and CuP2; cross veins in medial field very strong; four strong anal veins.

Diagnosis.—*Nacekomia*, like the other genera of the family, differs from *Cacurgus* in its strong and relatively straight and distant cross veins, with only a tendency to develop the polygonal network

[1] Scudder (1885, p. 331), having seen the original figure of *Omalia macroptera*, remarked that "its curious venation is plainly impossible."

seen in the latter genus. It differs from *Cacurgus* also in its simple R, its classically dichotomous Rs, and its greatly branched pectinate MP. In a comparison of the two genera, the media of *Nacekomia* may be said to take the place of the cubitus of *Cacurgus* in the structural scheme of the wing, as does the radial sector in *Heterologus*. *Cacurgus* and *Nacekomia* are similar in possessing a large area in the cubital field unsupported by a major vein, due in part to the far basal position of Cuf with respect to Mf. *Spilomastax*, *Archimastax*, and *Archaeologus* are insufficiently known, but are similar to *Nacekomia* in the relation of Cu to M. *Cacurgellus* seems to have a simple, strongly concave CuP (which Pruvost regarded as an anal). *Heterologus* and *Nacekomia* both have R2 fused distally with R1, and have also a nearly straight anterior margin, but *Heterologus* lacks the area of confused venation in the cubital field. *Omalia*, similar in this respect, differs greatly in the branching and relations of R1 and M. Nygmata (wing spots) are absent. *Nacekomia* is the only genus of the family known to have a strongly sclerotized area at the base of the wing. The forewing of *Archaeologus* apparently had proportions similar to those of *Nacekomia*, but had the cubital fork close to the medial fork, as in other cacurgids.

Remarks.—A "barbarous name," as contemplated in Recommendation *j* of the International Rules of Zoological Nomenclature, being a Latinization of the Russian word for "insect."

Genotype.—*Nacekomia rossae*, new species.

Nacekomia rossae, new species

Figures 14, 15

Description.—Forewing more than three times as long as wide, greatest width in distal half of wing. Humeral area strongly convex, sclerotized, with convex margin; anterior margin of wing broadly emarginate in proximal part, broadly convex in distal part. C marginal, strong. Sc terminating on C at about one-third the distance from the apex. R1 and CuA the only strongly convex veins in the wing. Cross veins strong, numerous, nearly perpendicular to branches of longitudinal veins.

Holotype.—CNHM no. PE791, one half of a concretion bearing the impression of the under surface of the wing. Length of wing, as preserved, 43 mm.; width in distal half, 12 mm. The apex of the wing evidently continued for at least a millimeter beyond the edge of the concretion, which had been slightly reduced in size by weath-

ering before splitting open naturally. Collected in 1948 by Miss Lillian Ross, Associate in Insects, Chicago Natural History Museum, and presented by her to the Museum. (From the strip-mine area.)

Remarks.—The humeral area, devoid of costal veinlets, is smooth and strongly convex, evidently sclerotized. An elevated or depressed, smoothly rounded area, indicated by a pattern of dots in the drawing

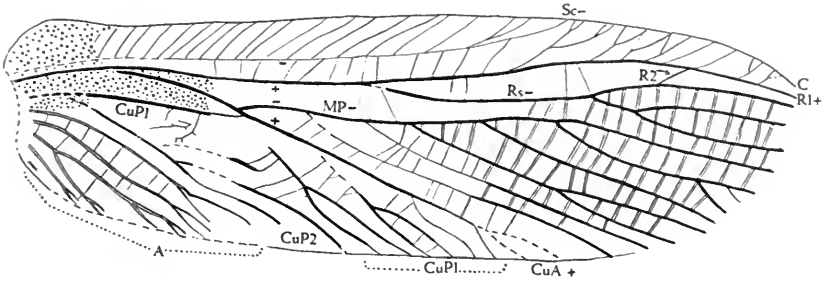

FIG. 14. *Nacekomia rossae*, new species; × 2.5. A, anal; C, costa; CuA, anterior cubitus; CuP1, CuP2, first and second forks of posterior cubitus; MP, posterior media; R1–2, branches of radius; Rs, radial sector; Sc, subcosta. +, elevated vein; –, depressed vein. Weight of lines indicates relative strength of veins. Dotted area, sclerotized.

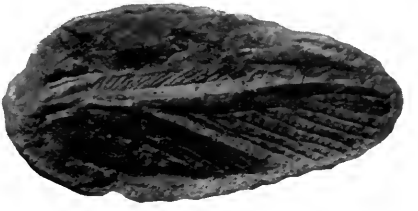

FIG. 15. *Nacekomia rossae*, new species, holotype; × 1.13. CNHM no. PE791.

(fig. 14), continues this basal horny portion to the edge of the anal field and also distally as a projection covering the bases of the pre-anal, post-costal veins. The rest of the wing membrane was very thin, the texture of the specimen showing a minute wrinkling. The strong cross veins of the medial field bear transverse striae, about 50 per millimeter. The under surface of Sc is marked by small irregular diagonal impressed lines possibly representing prostrate trichia.

The homologies of the veins have been determined with the help of the argument used by Carpenter in his valuable discussion of the veins of *Caloneura dawsoni* (Carpenter, 1943a, p. 69); since the only vein in medial position is concave, it must be MP; MA, as in *Caloneura* and very many other orthopteroids, must be lacking. The

horny base of the wing is convex over the stem of M and Cu, and may represent the missing MA. However, being a specialized structure, it probably does not represent a primitive topography. CuP branches into two concave stems very near the base, within the heavily sclerotized area, CuP1 then running parallel to the anterior longitudinal veins to its junction with CuA; CuP2 parallels the course of the anal veins, and the wide gap between these two branches of CuP is occupied by irregular veins of indefinite homology. The unusual strength of the cross veins in the medial field makes a comparison with the caloneurodeans tempting, but the structure of Cu precludes placing *Nacekomia* in that order. The presence of only two prominent convex veins, R1 and CuA, is common in most insect orders (Imms, 1934, p. 39).

Anthrakoris, new genus

Description.—Anterior margin of forewing rounded, posterior margin nearly straight. Costal area broad, occupied by branching veinlets with cross veins. Sc terminating about one-fourth of the wing length from the apex. Rs arising slightly basad of midwing, with few branches. MA absent; MP arising close to or coalesced with R at base, with many branches. CuA and CuP coalesced at base. CuA forked, CuP simple, nearly straight. Two unbranched anal veins. Cross veins not plentiful; mesh-like archedictyon present in basal half.

Genotype.—*Anthrakoris aetherius,* new species.

Remarks.—The shape of the wing in this genus is most like that of *Omalia,* among the cacurgids, a genus from which it differs in lacking the fusion of Rs with MP, and in the lesser development of cubital branches. The termination of Sc on R1 is a character shared with *Heterologus.* The venation of *Anthrakoris* is very much like that of the palaeodictyopteran *Aenigmatodes* Handlirsch 1906. The differences, however, are significant, and the resemblance is due simply to convergence.

Anthrakoris aetherius, new species

Figures 16, 17

Description.—FOREWING: Length, as preserved, 36 mm., entire length probably not over 40 mm.; width, 13 mm. Anterior margin strongly convex, greatest curvature near base; posterior margin only slightly curved, very slightly emarginate at the end of CuP; greatest

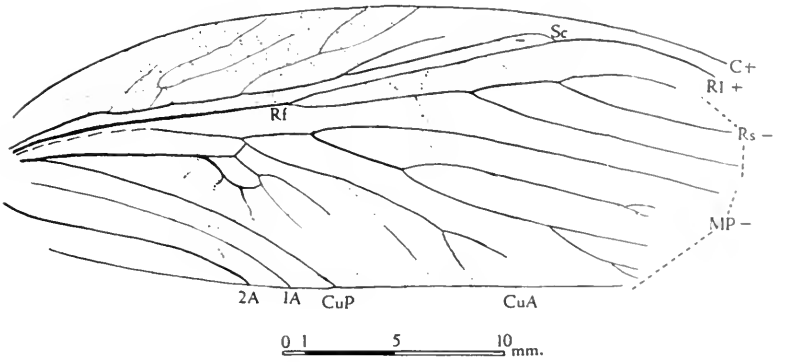

FIG. 16. *Anthrakoris aetherius*, new species. 1A, first anal; 2A, second anal; C, costa; CuA, anterior cubitus; CuP, posterior cubitus; MP, posterior media; R1, principal branch of radius; Rf, fork of radius; Rs, radial sector; Sc, subcosta; +, elevated vein; −, depressed vein. Weight of lines indicates relative strength of veins; archedictyon indicated only in part.

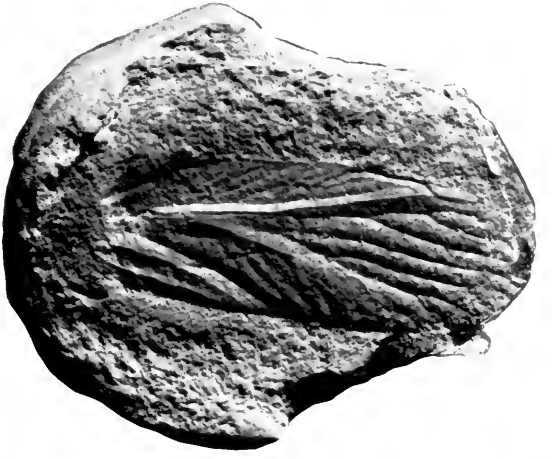

FIG. 17. *Anthrakoris aetherius*, new species, holotype; × 1.7. CNHM no. PE145.

width at about midwing. Sc close and parallel to R1, both doubly sigmoidally curved; Rs emitted shortly basad of midwing at most posterior part of curve of R. Branches of Rs and MP occupy a subtriangular area whose base is the apical margin of the wing and whose sides are defined by the prominent convex veins R1 and CuA, forming a very characteristic pattern. Besides these two convex veins, the most conspicuous vein in the wing is the deeply set

concave CuP, occupying a plical furrow. Details of the venation are apparent in the figures.

Holotype.—Two halves of a concretion bearing the impressions of the dorsal and ventral surfaces of the wing. Received at the Museum as a gift of the University of Chicago, 1951, included in the fossil plant collection of the late Professor A. C. Noé. The lithology of the specimen is of the Mazon Creek type, rather than the strip mine type. CNHM no. PE145.

Family **Blattinopsidae** Bolton 1925

Handlirsch (1937, p. 64) attempted to show that this family should properly be termed Oryctoblattinidae, the name under which he had included it in his *Fossilium Catalogus* (1922). This view, however, is apparently based on a misunderstanding of the species proposed by Scudder as genotype of *Oryctoblattina*, and Bolton's name should prevail.

Glaphyrokoris, new genus

Diagnosis.—Similar to *Glaphyrophlebia* Handlirsch 1906, but with fairly regular cross veins in place of a meshwork between the longitudinal veins, and with MP arising from the stem of R rather than independently.

Genotype.—*Glaphyrokoris mirandus,* new species.

Glaphyrokoris mirandus, new species

Figures 18, 19

Description.—FOREWING: Anterior margin strongly arched, posterior margin nearly straight. C marginal, costal space broad, occupied by many slanting veinlets arising from Sc. Sc terminating on C at about midwing. R simple, distant from Sc in basal half of wing; close to anterior margin beyond end of Sc, terminating on anterior margin. Rs arising in basal half of wing, distant from R1 in apical half, sending forth a pectinate series of four posteriorly directed branches. MA lacking; MP arising near base from stem of R, forking twice at about midwing. M5 present as a short convex vein joining MP to Cu near origin of MP. CuA strongly convex, arising independently, emitting many branches curved toward the apex of the wing. CuP simple, in deep plical furrow; posterior margin of wing not inflected at end of furrow. 1A strongly convex,

simple; 2A with three short curved branches concave toward the apex of the wing; 3A with at least one similarly curved branch.

Length, as preserved, 15½ mm.; original length probably 19 or 20 mm. Greatest width, 7½ mm. This wing is about twice the size of the forewing of *Glaphyrophlebia pusilla* Handlirsch, which it resembles in general aspect.

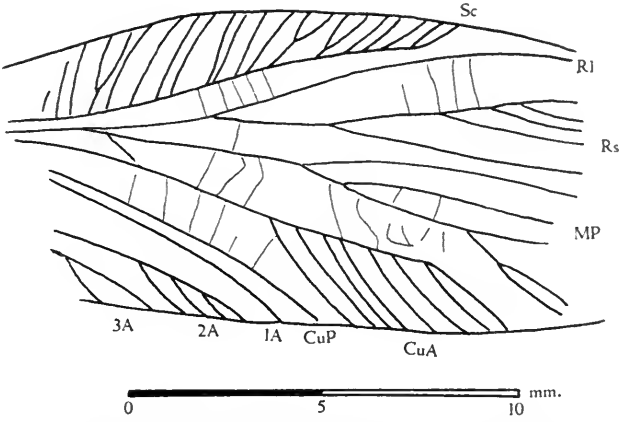

FIG. 18. *Glaphyrokoris mirandus*, new species. 1–3A, anals; CuA, anterior cubitus; CuP, posterior cubitus; MP, posterior media; R1, principal branch of radius; Rs, radial sector; Sc, subcosta.

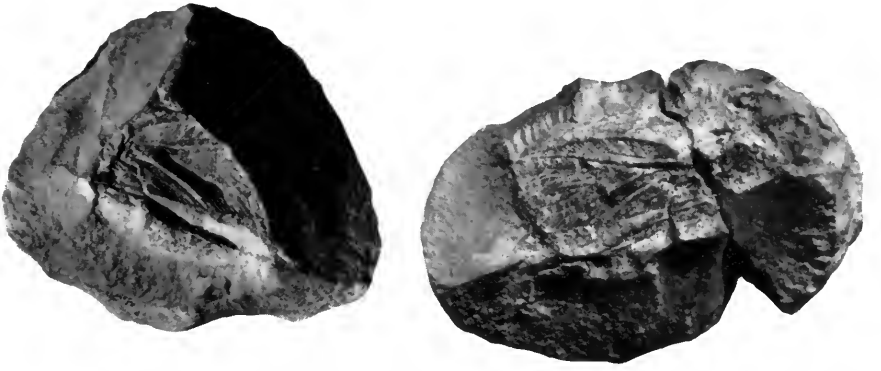

FIG. 19. *Glaphyrokoris mirandus*, new species, holotype; × 1.6. CNHM no. PE977.

Holotype.—CNHM no. PE977, two halves of a small concretion, bearing impressions of the wing. Collected in 1949 by George Langford. (Coordinates e7.2, *I*0.0 on the map, fig. 3, this volume, no. 1.)

FAMILY UNDETERMINED

UNDETERMINED INSECT NO. 3

Figures 20, 21

A large imperfectly preserved protorthopteran insect, known from only one half of a concretion that had opened by weathering. Prolonged search in the vicinity failed to reveal the missing counterpart, which should have borne the impression of the entire wings. Although the specimen may be referred to the rather indefinite order Protorthoptera, it is not assigned to a family or genus. It may very likely fall within Handlirsch's suborder Geraroidea.

Body, consisting of head, the three thoracic segments, and five of the abdominal segments, 54 mm. long, as preserved. Forewings at least 50 mm. long; wing-spread at least 108 mm. Head large, medially constricted, widest posteriorly, where it embraces the prothorax, flaring anteriorly and there terminated as though cut vertically; a raised border on the front margin, rising to a blunt spine on the center. In front of the head is a flattened impression of indefinite triangular shape, evidently representing some part of the insect, such as lies in front of the body of *Teneopteron mirabile.* Prothorax slightly longer than wide, expanding anteriorly into two lobes, and terminating at the back in a marginal ridge with a prominent blunt central dorsal protuberance. Metathorax subtrapezoidal, tapering to the rear, its greatest width greater than its length; a low central dorsal protuberance but no elevated border on the rear margin. Abdomen tapering to the rear. Two forelegs with sturdy femora.

Costa of forewing marginal; veinlets in costal area straight, slightly oblique, joined by cross veins in basal part of wing, straight or curved, oblique, forked in apical portion, as in *Anegertus.* Sc long, about parallel to C, and evidently terminating on C at some point distad of midwing. R1 simple; Rs arising at about midwing and not forked within the portion observable. Cross veins straight, oblique or perpendicular to longitudinal veins. Distal margin unknown; anterior margin only slightly bowed. Hindwings represented by only a very small fragment.

A complete specimen in the collection of Mr. Peter Enrietta, in Coal City, Illinois, may be conspecific with this insect.

Figured specimen.—CNHM no. PE2919. Collected April 30, 1952, by E. S. Richardson, Jr. (Coordinates e7.2, *I*2.0 on the map, fig. 3, this volume, no. 1.)

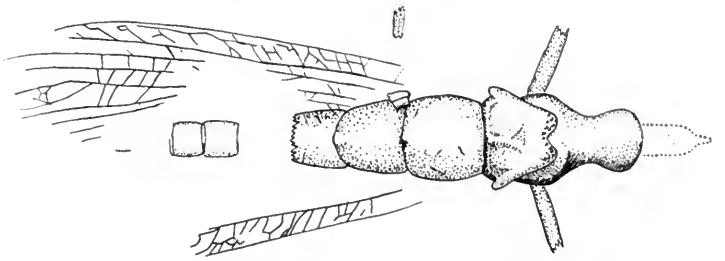

FIG. 20. Drawing of undetermined insect no. 3, partially restored; × 1.3.

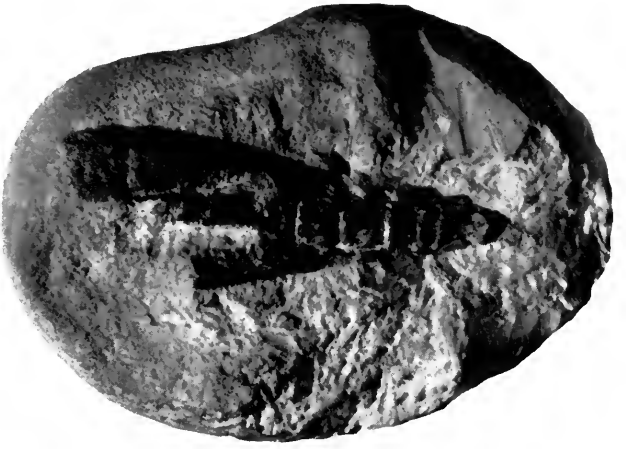

FIG. 21. Undetermined insect no. 3; × 0.86. CNHM no. PE2919.

Order CALONEURODEA

For a discussion of the order, here reported in its earliest known occurrence, see remarks below.

Genopterygidae, new family

This family is proposed for two monotypic genera, *Genopteryx* Scudder 1885 and *Rossites*, new genus. *Genopteryx* clearly has the two characters regarded by Carpenter (1943a) as prescribing inclusion in the order Caloneurodea: the heavy cross veins and the close straight parallel CuA and CuP. *Rossites* has delicate cross veins and its CuA deviates from strict parallelism with CuP, yet the venation is nearly identical with that of *Genopteryx constricta*. Except for the importance to be assumed in the later development

of the Caloneurodea by the heavy cross veins, these two insects might quite properly be included in one genus.

Family characters are: Rs much divided; MP and CuA arising from Rs; CuP arising from 1A; 2A arising from 1A.

The two genera of the Genopterygidae are the oldest members of the order known at present, and in their similarities and differences point to the manner of origin of an order in its first breaking away from an ancestral stock. In the variation within the group of the Protorthoptera-Protoblattoidea, a combination of characters was attained much like those of *Rossites*. Further variation added, in the case of *Genopteryx*, a single new character, the heavy cross veins, at the same time affirming and emphasizing the parallelism of CuA and CuP. At this point, the difference between *Genopteryx* and *Rossites* could well be considered specific rather than generic. But some selective advantage appears to have been bestowed upon *Genopteryx* and its descendants along with the adoption of the heavy cross veins. *Rossites* passed out of the picture at the end of one of the innumerable *culs-de-sac* of evolution, while the seed of *Genopteryx* spread in various directions, forming a well-defined group properly to be regarded as an order. Within the limits imposed by the two ordinal characters, which remained remarkably constant through the Pennsylvanian and the Permian, the number of possible variations is not large, though greater than was achieved in the presently known genera of the order. The general trends may be seen in comparing the wing patterns of the caloneurodean genera now recognized: the termination of Sc on C migrates basad, as in the Homoptera; the number of branches of Rs is reduced; the number of anal veins is reduced and the wings become subpetiolate; Rf moves apicad; the origins of CuA and MP vary from one stem to another, probably in adjustment to the narrowing of the wing and to the change in position of Rf. These changes proceed at different rates in several different lines, and on the basis of the few known genera, a number of hypothetical phylogenetic trees may be drawn to express this. Since, however, any one of those trees seems as valid as any other, none is represented here.

Scudder (1885) included *Genopteryx* in his "Neuropteroid Palaeodictyoptera," family Homothetidae, from which Handlirsch removed it to his family Geraridae, in the Protorthoptera. Martynov (1938b, p. 99) transferred the Geraridae to the order Paraplecoptera, which Carpenter (1943a, p. 75) regards as a doubtful unit. Since the disposition of these entities will no doubt be in-

cluded in Professor Carpenter's revision of the Protorthoptera, they will not be further discussed here.

Genus **Genopteryx** Scudder 1885

Genopteryx Scudder, 1885, Mem. Boston Soc. Nat. Hist., **3**, p. 327.

Scudder's definition of the genus is repeated here, the names of the veins according to the current nomenclature being introduced

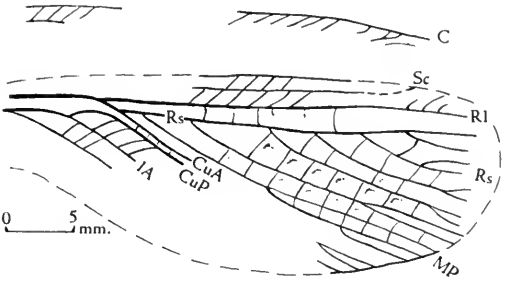

FIG. 22. *Genopteryx constricta* Scudder. 1A, first anal; C, costa; CuA, anterior cubitus; CuP, posterior cubitus; MP, posterior media; R1, principal branch of radius; Rs, radial sector; Sc, subcosta. Drawing by Laura Sparks from holotype, USNM no. 38148.

in brackets, together with a mention of the convexity, as determined by examination of the type specimen of *Genopteryx constricta* Scudder (fig. 22), seen through the courtesy of Dr. G. Arthur Cooper, United States National Museum.

Wings obovate, with more or less arched costa [C, convex] and somewhat produced apex; mediastinal vein [Sc, concave] of variable length, the scapular [R1, convex] extending to or nearly to the tip, connected to the veins on either side of it by transverse or oblique cross veins; externomedian vein [M; actually Rs, concave, plus MP, concave, plus CuA, convex] very important, commencing to branch considerably before the middle of the wing and by several longitudinally oblique mostly forked veins, closely connected by feebler cross veins, feeding the apex of the wing; internomedian vein [Cu; actually CuP, concave, and the anals] also important with several similar veins [the anals?], the outermost of which [CuP] runs in close proximity to the basal externomedian branch [CuA] from its very origin, so that at first sight both externomedian and internomedian branches appear to spring from a common vein.

The genus apparently includes the single species *Genopteryx constricta* Scudder 1885. Scudder originally included also *Gryllacris lithracantha* Goldenberg, but Handlirsch in 1906 properly removed it to another genus.

Rossites, new genus

This genus is proposed for the reception of a single species closely related to *Genopteryx constricta* but differing in lacking strongly developed cross veins.

The genus is named in honor of Dr. Herbert H. Ross, of the Illinois Natural History Survey, to whom I am indebted for several helpful conversations; and his son, Mr. Charles A. Ross, who collected a specimen of the genotype.

Genotype.—Rossites inopinus, new species.

Rossites inopinus, new species

Figures 23–25

Description.—WING: Costal area of average width, occupied by veinlets increasing in obliquity toward the apex of the wing. Sc terminating on C in apical half of wing. Base of R1 very close to base of Sc, but R1 diverging from Sc near base so that costal and subcostal areas are of about the same width. Rs arising very near base of wing; Rs with 5 or 6 pectinately arranged oblique branches occupying the apical portion of the wing. MP arising from Rs, forked. CuA, strongly convex, arising from stem of Rs, continuing the curvature of that stem until it nearly touches CuP, at which point it is angulated and thence continues more distant from CuP, about straight, to the posterior margin; simple or forked. CuP arising independently of CuA, strongly concave, nearly straight, simple or forked. 1A arising from stem of CuP; 2A (or a branch of 1A?) arising near base from the same stem.

Holotype.—Two halves of a concretion containing impressions of the right wing. Collected in 1949 by George Langford. The apical portion of the wing is missing; the remaining portion is 28 mm. in length. CNHM no. PE981. (Coordinates e7.2, *I*0.0 on map, fig. 3, this volume, no. 1.)

Paratype.—One half of a concretion bearing the impression of the dorsal surface of a right wing. Collected by Charles A. Ross and presented by him to the Museum. CNHM no. PE3304. (Coordinates approximately e7.2, *J*1.0 on map, fig. 3, this volume, no. 1.)

The paratype differs from the holotype in being about 1⅓ times as large, in lacking a faint fork on 1A, and in that CuA is forked and CuP not.

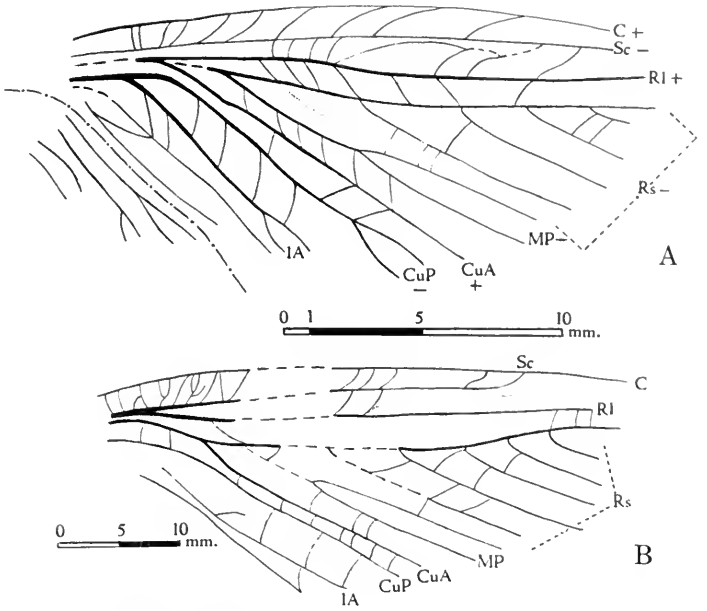

FIG. 23. *Rossites inopinus*, new species; *A* drawn from holotype, *B* from paratype. 1A, first anal; C, costa; CuA, anterior cubitus; CuP, posterior cubitus; MP, posterior media; R1, principal branch of radius; Rs, radial sector; Sc, subcosta; +, elevated vein; −, depressed vein. The dot-and-dash line in *A* indicates a break in the wing membrane, whereby the anal area may not be in correct relation to the rest of the wing.

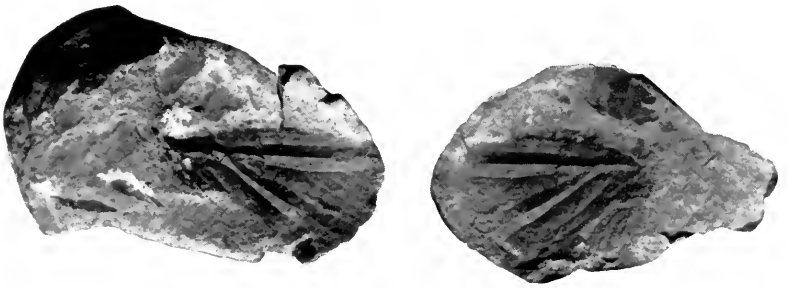

FIG. 24. *Rossites inopinus*, new species, holotype; × 1. CNHM no. PE981. Associated markings in concretion are indeterminate plant debris.

FIG. 25. *Rossites inopinus*, new species, paratype; × 1.1. CNHM no. PE3304. An impression of upper surface of wing, veins appearing in reverse relief.

ORDER UNCERTAIN

The following new family is based on a species that Carpenter (1943b, p. 17) called "probably the most remarkable insect which has been found in the Mazon Creek nodules." In ordinal position it probably lies closest to the Blattaria in wing venation, but, lacking the characteristic modification of the blattarian prothorax, it cannot be included within that order. It bears a superficial resemblance to *Idelia* M. D. Zalessky, from the Russian Permian (order Protorthoptera), but is more specialized in several respects; hence it cannot lie in that lineage. It can not be considered ancestral to the Permian order Protelytroptera, another order in which the forewings are heavily sclerotized, as its venation is already too highly specialized. In shape, relative size, and generalities of venation, the wings resemble those of the modern Tettigoniidae (Orthoptera).

Teneopteridae, new family

Medium-sized neopterous insects with slender tegminous forewings, the principal longitudinal veins grouped in a band on or near the midline, many veinlets occupying the costal area, the anal area set off by a plical furrow; legs robust, homonomous; abdomen no longer than thorax.

Genus **Teneopteron** Carpenter 1943

Teneopteron Carpenter, 1943, Illinois State Mus., Sci. Pap., **3**, pt. 1, p. 17.

The genus was defined only by comparison with *Megagnathites* (Bolton) Handlirsch, to which, however, it is not related. Characters of generic importance are probably the following, combined with the family characters suggested above: Prothorax with elevated rachis in anterior half, rachis expanding anteriorly, divided by median groove; a pair of low tubercles on posterior half of prothorax. Mesothorax shorter than other thoracic segments. Forewings more than three times as long as wide, sclerotized, nearly flat antero-posteriorly, with convex humeral area; principal longitudinal veins arising at base in two deep grooves, the posterior groove arching backward as a plical furrow; Sc terminating on C in distal third of wing.

Genotype.—Teneopteron mirabile Carpenter 1943 (by original designation).

Teneopteron mirabile Carpenter 1943

Figures 26–30

Teneopteron mirabile Carpenter, 1943, Illinois State Mus., Sci. Pap., 3, pt. 1, pp. 17–20.

This species was founded on a single specimen, no. 14887 in the Illinois State Museum. In describing it, Carpenter, misled by the extraordinary venation, thought that the forewings had been overturned, and accordingly interchanged anterior and posterior in his description. The second specimen, no. PE967 in Chicago Natural History Museum, is somewhat better preserved than the type, and clearly shows the position of the wings. Thus, the species may now be more fully described. The following description and discussion are based on the two specimens, which are interpreted as conspecific in spite of certain apparent differences. Even though the specimens should in the future be considered distinct species, they are so closely related that the orientation of the wings of the original specimen can no longer be in doubt.

Forewings.—The forewings are thick and sclerotized, nearly flat transversely, with a convex humeral area. Longitudinally, they are bowed upward. The anal area, probably of thinner membrane, is bent at the plical furrow out of line with the rest of the wing surface. Apparently it is the same sort of anal area as appears in the forewings of modern Tettigoniidae, and the manner of folding the wings was probably similar, with the small anal area folded down over the mesothorax.

The veins of the forewing arise in two furrows at about the middle of the base. Homologies of the veins, indicated in the accompanying drawings (fig. 26), are tentative, as the veins stand in very low relief and many can be seen only with special lighting. What veins may be expected in the order are, of course, not known. The humeral area is clear of veinlets, and is succeeded by the costal area, occupied by many curved veinlets arising from Sc. The anterior edge of the wing just beyond the humeral area is emarginate and minutely serrated. Sc apparently curves into the costal margin at about two-thirds the length of the wing. Beyond its termination, veinlets from R1 continue the pattern of branches reaching the anterior margin. The longitudinal vein denoted as Rs sends off branches to the posterior margin in its distal half. As far back toward the base of the wing as it can be separately distinguished, it is independent of R. The veins already mentioned arise in the anterior of the two grooves at the base of the wing; two succeeding

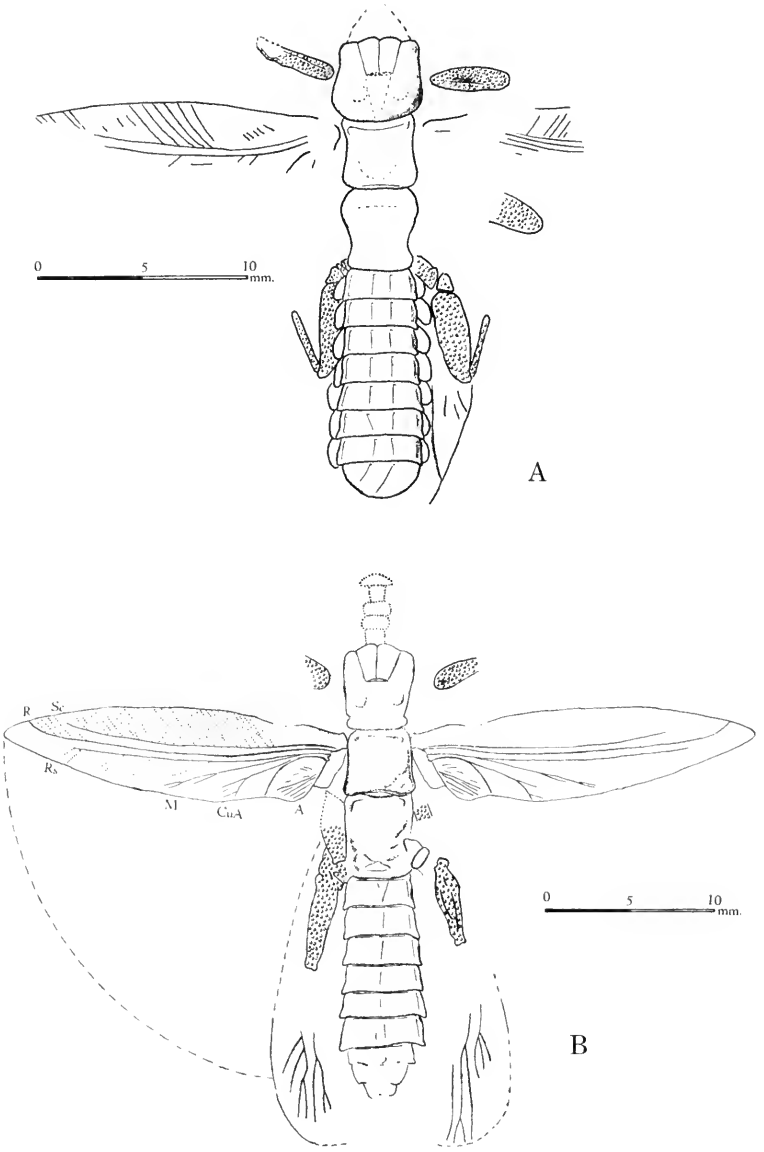

FIG. 26. *Teneopteron mirabile* Carpenter. *A*, drawn from holotype, slightly restored. *B*, drawn from plesiotype, slightly restored. A, anal; CuA, anterior cubitus; M, media; R, radius; Rs, radial sector; Sc, subcosta.

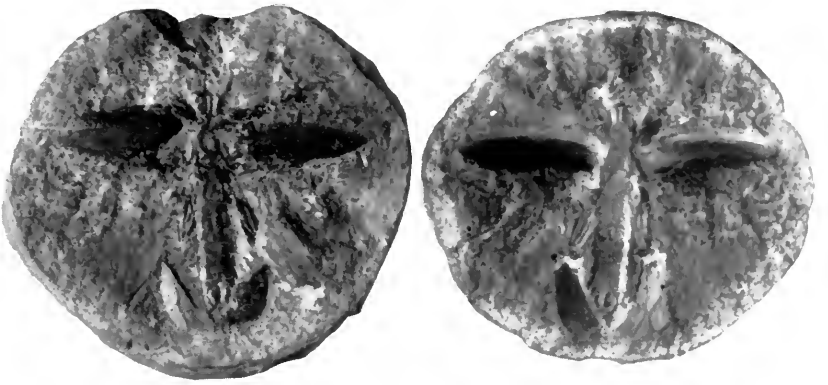

FIG. 27. *Teneopteron mirabile* Carpenter, plesiotype; × 1. CNHM no. PE967, consisting of counterpart impressions.

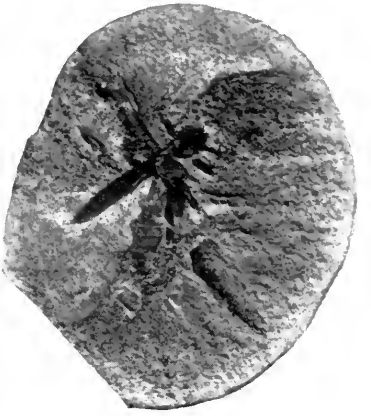

FIG. 28. *Teneopteron mirabile* Carpenter, holotype; × 1. Illinois State Museum no. 14887.

veins, designated M and CuA, arise from the other groove, which corresponds to the plical furrow, containing CuP, of the roaches. Within the anal area, behind the plical furrow, is a series of extremely fine lines radiating from a point posterior to the basal origin of the furrow and directed to the posterior margin of the wing basad of the outer end of the furrow. This is the character of the anal veins in the most primitive Blattaria, as emphasized by Tillyard (1919, p. 362; 1937b, pp. 177–178), though in the present specimen (CNHM PE967) they are unusually straight and unusually weak. The straightness is probably, then, a primitive character.

Hindwings.—The distal tips of the two hindwings are visible in the CNHM specimen. From them, little of the character of the wing can be made out. The veins all stand in relief on the ventral

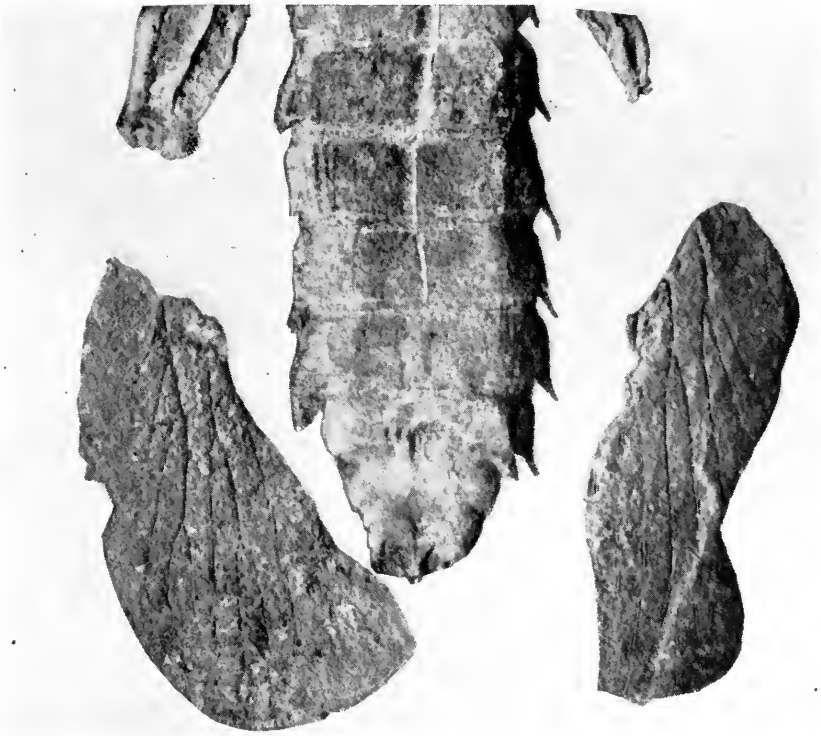

FIG. 29. *Teneopteron mirabile* Carpenter; × 6.1. Portion of plesiotype, CNHM no. PE967, showing venation of hindwings.

surface of the wing and are impressed on the dorsal surface. The membrane in this distal portion of the wing is flat, without concave and convex veins, and with no cross veins. The hindwings are somewhat longer, from base to tip, than the forewings, and, since they originate farther back on the body, it is evident that they must have projected from beneath the ends of the forewings if they were not folded when in repose. The Coleoptera and the Protelytroptera protect the long hindwings by folding the apical ends upward; the Tettigoniidae and perhaps *Teneopteron* permit the distal end of the hindwing to project beyond the end of the tegmen. The hindwing has a broad costal area occupied by slanting veinlets, in the orthopteroid fashion; the tip of the wing is broadly rounded.

Thorax.—Three segments of about equal size, the mesothorax being the shortest. Crushing and distortion have been most trouble-

FIG. 30. *Teneopteron mirabile* Carpenter; × 3.85. Detail of thoracic region and wings of plesiotype; CNHM no. PE967.

some in these segments, so that they cannot be described in detail. The prothorax has the characters described for the genus.

Abdomen.—The abdominal segments are very clearly preserved in both specimens, with the exception, in both, of the posteriormost portion. In the holotype, the one or two final segments form a smoothly rounded termination of the body, with no cerci or other appendage. Carpenter drew and described this as two clearly distinct segments, which it must surely be. Counting it as two, the number of abdominal segments is nine. In the plesiotype there is apparently a central boss on the seventh segment (it may be merely a small rosette of marcasite), followed by a medial groove in the last two segments.

The two specimens are drawn as they appear under the microscope (fig. 26), the apparent differences probably being due as much to preservation as to natural variation between the specimens. On both, the abdomen gradually widens posteriorly to the sixth segment, the last three being narrower. The segments are about flat dorsally, with angulated edges and steep pleural slopes. The edges of the terga in the holotype are set off by low ridges. In both specimens, a low ridge traverses the first seven segments longitudi-

nally; this is single in the plesiotype but double in the holotype. In the holotype it continues through the three terminal segments, but in the other it ends against the boss on the seventh segment. Carpenter regarded the portion of the tergum between the paired ridges as a separated median plate. The difference in appearance between the two specimens almost certainly does not reflect an anatomical difference, as the appearance of the under side of the abdomen may vary extremely in individual specimens of dried tettigoniids, both of these aspects and many others being among the possible configurations of wrinkles in this region.

Paired lateral abdominal processes, which Carpenter interpreted as gills signifying an aquatic larval stage, are visible on all abdominal segments of the holotype but are not visible on the other specimen; their lack is probably due to imperfect preservation.

Legs.—Parts of the femora of all six legs are visible on the CNHM specimen and four on the other. The trochanter and coxa are present on the two hind legs of the plesiotype, and on one hind leg of the other, but are so crushed or wrinkled that it is not possible to distinguish their details. A nearly complete tibia is articulated to the femur of a hind leg of the type specimen. Femora robust, those of the forelegs probably less so than the others; tibia of hind leg slender, shorter than femur.

Measurements.—Holotype: body, front of prothorax to end of abdomen, 22 mm.; thorax, 11¼ mm.; abdomen, 10¾ mm.; forewing (restored), 16 mm. Plesiotype: body, front of prothorax to end of abdomen, 27 mm.; thorax, 14 mm.; abdomen, 13 mm.; forewing, 19½ mm.

Locality.—The two specimens were found about 50 yards apart, on opposite sides of the section line road, 3 miles north of Braidwood. (Coordinates e7.0, *H*6.3 [holotype] and e7.0, *H*9.8 [plesiotype], on the map, fig. 3, this volume, no. 1.) Both were collected by Mr. George Langford.

Plesiotype.—CNHM no. PE967, two halves of a concretion bearing paired impressions of the insect.

NYMPH

Figure 31

This specimen pertains to an undetermined order. It has much the appearance of a palaeodictyopteran.

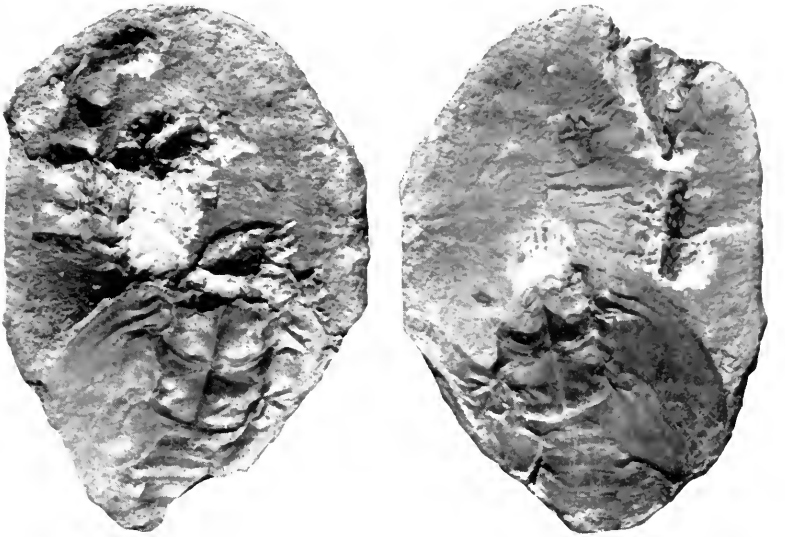

FIG. 31. Nymph; × 1.36. CNHM no. PE973. Associated material includes plant fragments and a large crustacean claw.

The mesothorax, metathorax, and parts of five abdominal segments of a rather large immature insect are preserved in a concretion, associated with two legs of a large, undetermined crustacean. The insect specimen undoubtedly represents a late instar in the larval development of a winged hemimetabolous form. The mesothorax is about square, 7½ mm. on an edge; the metathorax, with the same width, is 6½ mm. long; the abdominal segments are about 2 mm. long. A median groove in each of the thoracic segments may have been deepened by the pressure that evidently flattened the specimen, and the width of the body exaggerated, but the groove is a character of the species, since the abdominal segments, subjected to the same pressure, have no such groove.

The four large and heavy wing pads are immovably fixed to the thoracic segments, though the position of the future axillary sclerites is indicated by a modeling of the surface of the integument at the junction of the body with the wing pads. Venation is not developed but is foreshadowed by a pair of deep but indistinct furrows at the base of each pad, probably representing Sc and CuP of the adult wing.

The wing pads are laid back along the edge of the abdomen at a low angle to the body. They are initially directed outward

beyond the edge of the thorax before turning along the abdomen, and thus do not cover the body. By the time of the latest larval instars, the wing pads of modern insects have developed venation. The position of the larval wings in this fossil nearly resembles that of the super-ordinal group Opisthoptera of Lemche (1940, pp. 147–154, fig. 5, *b*), distinct from the developmental stages of plagiopterans such as the Palaeodictyoptera (op. cit., fig. 5, *a*).

The specimen resembles in a general way the supposed palaeodictyopterous larvae discussed by Carpenter (1948), who removed the five previously described specimens from that order for various reasons. The lack of venation and the fragmentary state of the specimen at hand make it impossible to assign this larva to a known order and fruitless to give it a specific name.

Figured specimen.—CNHM no. PE973, two halves of a concretion bearing matching impressions of the nymph. Collected by Mrs. Robert H. Whitfield and presented by her to the Museum. (Coordinates e7.0, *H*9.8, in the map, fig. 3, this volume, no. 1.)

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