

辽西义县组长节锯蜂科(昆虫纲, 膜翅目)昆虫化石^{*}

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中文提要 描述产自辽宁西部北票上园地区和凌源大王杖子义县组长节锯蜂科(Xyelidae)巨长节锯蜂亚科(Macroxyelinae)昆虫化石 12 种, 归于 4 族 8 属, 其中 6 新属 12 新种, 包括 *Angaridyela robusta* sp. nov., *Angaridyela exculpta* sp. nov., *Angaridyela suspecta* sp. nov., *Angaridyela endemica* sp. nov., *Lethoxyela excurva* gen. et sp. nov., *Lethoxyela vulgata* gen. et sp. nov., *Ceratoxyela decorosa* gen. et sp. nov., *Liaoxyela antiqua* gen. et sp. nov., *Heteroxyela ignota* gen. et sp. nov., *Sinoxyela viriosa* gen. et sp. nov., *Isoxyela rudis* gen. et sp. nov. 和 *Xyelites lingyuanensis* sp. nov., 并讨论其古气候特征。

关键词 昆虫纲 膜翅目 长节锯蜂科 古气候 上侏罗统 义县组 辽宁西部

XYELID SAWFLIES (INSECTA, HYMENOPTERA) FROM THE UPPER JURASSIC YIXIAN FORMATION OF WESTERN LIAONING, CHINA

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Abstract Twelve species of Xyelidae (Insecta, Hymenoptera, Symphyta) are described from the Upper Jurassic Yixian Formation of Shangyuan, Beipiao and Dawangzhangzi, Lingyuan in western Liaoning Province, China. These sawflies are assigned to 8 genera of 4 tribes within the subfamily Macroxyelinae, with 6 genera 12 species recognized as new, including *Angaridyela robusta* sp. nov., *Angaridyela exculpta* sp. nov., *Angaridyela suspecta* sp. nov., *Angaridyela endemica* sp. nov., *Lethoxyela excurva* gen. et sp. nov., *Lethoxyela vulgata* gen. et sp. nov., *Ceratoxyela decorosa* gen. et sp. nov., *Liaoxyela antiqua* gen. et sp. nov., *Heteroxyela ignota* gen. et sp. nov., *Sinoxyela viriosa* gen. et sp. nov., *Isoxyela rudis* gen. et sp. nov. and *Xyelites lingyuanensis* sp. nov. The palaeoclimate is briefly discussed here.

Key words Xyelidae, Hymenoptera, Insecta, Palaeoclimate, Upper Jurassic, Yixian Formation, western Liaoning, China

1 INTRODUCTION

The Xyelidae is a small existing family of the order Hymenoptera under the class Insecta. The earliest appearance of this family is in the Triassic of Australia and Kirghizia (Riek, 1955; Rasnitsyn, 1964, 1969) and these Triassic fossils are also the earliest represen-

tatives of Hymenoptera. The family can be divided into 4 subfamilies including more than 30 genera in the Mesozoic and only 2 subfamilies including 6 genera in the Cenozoic (Riek, 1955; Rasnitsyn, 1964, 1965, 1966, 1969, 1971, 1977, 1980; Carpenter, 1992; Ren *et al.*, 1995).

Recently, we have collected many fossil insects from the lower part of the Yixian Formation at

收稿日期: 1999-12-20
^{*} 国家自然科学基金(No. 49832020), 特殊学科点人才培养基金, 国家重点基础研究发展规划(No. G2000077700)和中国科学院古生物学与古人类学特别支持费资助项目
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Huangbanjigou Village of the Shangyuan area, Beipiao City, western Liaoning Province, China. Beipiao has become famous for its fossil localities yielding early birds, feathered dinosaurs and the earliest angiosperm, all from the lower part of the Yixian Formation. Huangbanjigou is one of these localities near Shangyuan Town, 28km southeast of Beipiao City.

The lower part of the Yixian Formation in the Shangyuan area yields abundant fossils including plants, palynomorphs, conchostracans, ostracods, shrimps, insects, bivalves, gastropods, fish, amphibians, turtles, lizards, pterosaurs, crocodiles, dinosaurs, birds and mammals (Chen *et al.*, 1998). These assemblages constitute the outstanding Jehol biota. Among them, the class Insecta is the most abundant and over 60 species referred to about 13 orders have already been described (Lin, 1976, 1978; Chen *et al.*, 1980; Ren, 1994a, b, 1997a, b, c, 1998; Ren and Guo, 1995, 1996a, b; Ren *et al.*, 1995). Actually, several hundred species of Insecta within 17 orders are known among our collections from the same horizon and area.

The Jianshangou Bed, named by Chen *et al.* in 1980 and very well developed in the Shangyuan area, is the lowest part of the Yixian Formation. This Bed can be divided into 3 parts: the lower part of coarse-clastic rock, the middle part of intermediate-basic volcanic rock and the upper part of fossil-bearing fine-clastic rock. The upper part, which is the most important component of the Jianshangou Bed, yields abundant fossils and can be subdivided into 5 sub-units. In ascending order, these are: First Horizon consisting of bivalve-bearing sandstone, Second Horizon of (lower) fossil-bearing mudstone and shale, Third Horizon of sandstone, Fourth Horizon of (upper) fossil-bearing mudstone and shale, and Fifth Horizon of turtle-bearing tuffaceous sandstone. The insects dealt with in this study were mostly collected from the Fourth Horizon.

Here we describe 12 species of xyelids, of which 11 were collected from the Jianshangou Bed at Huangbanjigou Village and only one from the Yixian Formation of Dawangzhangzi, Lingyuan.

The living xyelids are only distributed in temperate zones. A fossil biota with rich xyelids indicates a temperate climate (Rasnitsyn, 1969, 1980; Rasnit-

syn *et al.*, 1998). But some other fossils that occur together with these sawflies from the Shangyuan area indicate a warm and humid (Wang, 1995; Cai and Fan, 1999) or a dry and hot climate (Zhou, 1995). These contradictions make it clear that different microclimates existed in the Shangyuan area at the time, probably caused by topographic differences. On such grounds, and considering all other fossils and sedimentary characters, it is reasonable to assume that the palaeoenvironment comprised a large lake surrounded by hygrophilous plants, dominated by shoreline equisetals and filicales, under a warm and humid microclimate; while arboreal gymnosperms represented by ginkgoes and conifers under a temperate but arid microclimate composed forests, where these xyelids lived, on high mountains some distance from the lake shore.

2 SYSTEMATIC PALAEONTOLOGY

Order Hymenoptera Linnaeus, 1758

Suborder Symphyta Gerstaecker, 1867

Superfamily Xyeloidea Newman, 1934

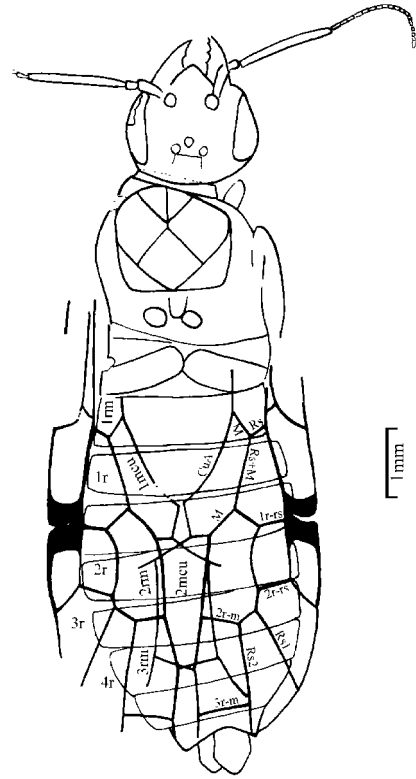
Family Xyelidae Newman, 1934

Subfamily Macroxyelinae Ashmead, 1898

Key to the known taxa of Macroxyelinae in western Liaoning

1. Forewing with pterostigma sclerotized basally only, basal section of Rs longer or slightly shorter than (but not shorter than half of) basal section of M; ovipositor with sheath short, not very wide. *Angaridyelini* Rasnitsyn, 1966 2
- Forewing with pterostigma sclerotized completely or distally only, sometimes membranous centrally ... 9
- 2(1). Forewing with pterostigma sclerotized basally and on baso-foreside, and having a shallow break. *Liaoxyela* gen. nov. *Liaoxyela antiqua* gen. et sp. nov.
- Forewing with pterostigma sclerotized basally only and having a deep break 3
- 3(2). Head with one horn-like structure before each eye; ovipositor with sheath short and small. *Ceratoxyela* gen. nov.
- *Ceratoxyela decorosa* gen. et sp. nov.
- Head without horn-like structure; ovipositor with sheath thick and short 4
- 4(3). Antennae with terminal part of flagellum as long as basal 3 segments combined; forewing with posterior branch of Sc connected to R before origin of Rs. *An-*
garidyela Rasnitsyn, 1966 5
- Antennae with terminal part of flagellum longer than

- scape, pedicel and 3rd segment combined; forewing with posterior branch of Sc connected to R just at origin of Rs. *Lethoxyela* gen. nov. 8
- 5(4). Mesoscutellum with anterior margin rounded
..... *Angridyela suspecta* sp. nov.
Mesoscutellum with anterior margin sharp 6
- 6(5). Mesonotum with scutellum larger than prescutum...
..... *Angridyela robusta* sp. nov.
Mesoscutellum distinctly small 7
- 7(6). Forewing with Sc distinctly closer to R than to C; basal section of Rs shorter than basal section of M; 1m-cu slightly shorter than section of CuA just beyond 1m-cu
..... *Angaridyela exculpta* sp. nov.
Forewing with Sc slightly closer to R than to C; basal section of Rs as long as basal section of M; 1m-cu distinctly shorter than section of CuA just beyond 1m-cu
..... *Angaridyela endemica* sp. nov.
- 8(4). Mandibles thick; eyes oval; ovipositor with sheath smaller *Lethoxyela excurva* gen. et sp. nov.
Mandibles thin; eyes kidney-shaped; ovipositor with sheath larger
..... *Lethoxyela vulgata* gen. et sp. nov.
- 9(1). Forewing with pterostigma sclerotized completely; 1m-cu longer than half of section of CuA just beyond 1m-cu. Antennae with terminal part of flagellum distinctly shorter than 3rd segment. Gigantoxyelini Rasnitsyn, 1969 *Heteroxyela* gen. nov.
..... *Heteroxyela ignota* gen. et sp. nov.
Forewing with pterostigma membranous basally 10
- 10(9). Forewing with basal section of Rs longer than half of basal section of M; ovipositor small, not thick. Ceroxyelini Rasnitsyn, 1969 11
Forewing with basal section of Rs distinctly shorter than basal section of M; ovipositor greatly thick. Xyleciini Benson, 1954
Xyelites Rasnitsyn, 1966
..... *Xyelites lingyuanensis* sp. nov.
- 11(10). Antennae with terminal part of flagellum not shorter than 3rd segment; ovipositor with sheath thin, subuliform. *Sinoxyela* gen. nov.
..... *Sinoxyela viriosa* gen. et sp. nov.
Antennae with terminal part of flagellum greatly shorter than 3rd segment; ovipositor with sheath comparatively thick, gradually becoming thin towards its end. *Isoxyela* gen. nov.
..... *Isoxyela rudis* gen. et sp. nov.



Text-fig.1 *Angaridyela robusta* sp. nov.
Female, dorsal view; LBSH98001/NIGP131979

Material A female sawfly in dorsal view with antennae, legs and wings incomplete. LBSH98001, holotype. Body length 10.7mm (excluding antennae), forewing (as preserved) 7.1mm and antennae 3.9mm.

Description Head large and oviform; labrum subtriangular; mandibles sharp and reaphook-shaped with teeth. Eyes large, nearly kidney-shaped. Ocelli small. Antennae twice longer than width of head; terminal part of flagellum 18-segmented, slightly longer than 3rd segment. Pronotum short, trapeziform. Mesonotum with prescutum small and having median suture; mesoscutellum large with anterior margin sharp. Fore femur thin and short; middle tibia thin. Forewing with costal area broad; Sc distinctly closer to R than to C, with anterior branch connected to C at level of origin of Rs and posterior connected to R just before origin of Rs; pterostigma sclerotized basally with a deep break; basal section of Rs slightly shorter than that of M; cell 1r equal to 3r in length and 1.5 times as long as 2r; cell 2r 1.6 times longer than wide; cell 2rm slightly longer than 1r; cell 3rm as long as 1r; Rs₂ straight at connection with 3rm; termination of Rs₁ distinctly closer to end of

Tribe Angaridyelini Rasnitsyn, 1966

Genus *Angaridyela* Rasnitsyn, 1966

***Angaridyela robusta* sp. nov.**

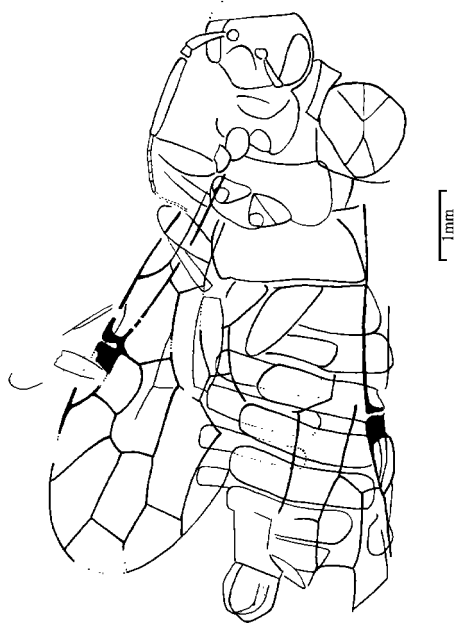
(Pl. I, fig. 1; Text-fig. 1)

Etymology From Latin ‘robustus’ — strong, robust.

Rs₂ than to pterostigma; 1m-cu slightly shorter than half of section of CuA just beyond 1m-cu; cell 1m-cu narrow, slightly longer than 2r_m; cell 2m-cu broad and equal to 1m-cu in length. Abdomen with 9 segments seen and subequal to each other in length. Ovipositor with sheath slightly longer than wide.

Comparison Only 3 species within the genus *Angaridyela* have been known, including *A. vitimica*, *A. minor* and *A. pallipes* from the Lower Cretaceous of Transbaikalia, Russia (Rasnitsyn, 1966, 1969). The new species is similar to *A. vitimica* but can be distinguished by the terminal part of flagellum consisting of 18 segments, the smaller pronotum and the larger mesoscutellum.

Locality and horizon Huangbanjigou, Shangyuan, Beipiao, western Liaoning Province; Upper Jurassic Yixian Formation.



Text-fig. 2 *Angaridyela exculpta* sp. nov.
Female, latero-ventral view;
LBSH98002/NIGP131980

Angaridyela exculpta sp. nov.

(Pl. I, fig. 5; Text-fig. 2)

Etymology From Latin 'exculptus' —sculptural, carven.

Material A female sawfly in latero-ventral view with head, legs and wings incomplete. LBSH98002, holotype. Body length 8.6mm (excluding antennae), forewing (as preserved) 6.2mm and antennae (as preserved) 3.1mm.

Description Head medium-sized. Eyes large, nearly kidney-shaped. Antennae with terminal part of flagellum ill-preserved and preserved part nearly as long as 3rd segment. Pronotum short; prosternum small. Mesonotum with prescutum medium-sized and having median suture; mesoscutellum small with anterior margin sharp. Foreleg with coxa small and oval; trochanter small; femur short and slightly thick; tibia thin, elongate. Midleg with coxa a little larger than fore coxa, triangular; femur as long as fore femur but a little thicker; tibia thin, elongate. Hindleg with coxa large and subtriangular. Forewing with costal area broad; Sc distinctly closer to R than to C, with anterior branch slightly beyond level of origin of Rs and posterior connected to R just before origin of Rs; pterostigma sclerotized basally with a deep break; basal section of Rs slightly shorter than that of M; cell 1r equal to 3r in length and 1.8 times as long as 2r; cell 2r 1.5 times longer than wide; cell 2r_m slightly longer than 1r; cell 3r_m as long as cell 1r; Rs₂ curved at connection with 3r_m; termination of Rs₁ slightly closer to end of Rs₂ than to pterostigma; 1m-cu about two-thirds of section of CuA just beyond 1m-cu; cell 1m-cu narrow, slightly longer than 2r_m; cell 2m-cu broad and slightly longer than 1m-cu. Hindwing ill-preserved; cell r with termination rounded. Abdomen with 9 segments seen; terminal segment short. Ovipositor with sheath thick and short, slightly longer than wide.

Comparison This species can be distinguished from the known ones from Transbaikalia by its forewings with Sc distinctly closer to R than to C, crossvein 1m-cu two-thirds of section of CuA just beyond 1m-cu; from *A. robusta* sp. nov. by its smaller mesoscutellum and its forewings with crossvein 1m-cu two-thirds of section of CuA just beyond 1m-cu and Rs₂ curved at connection with crossvein 3r_m.

Locality and horizon As above.

Angaridyela suspecta sp. nov.

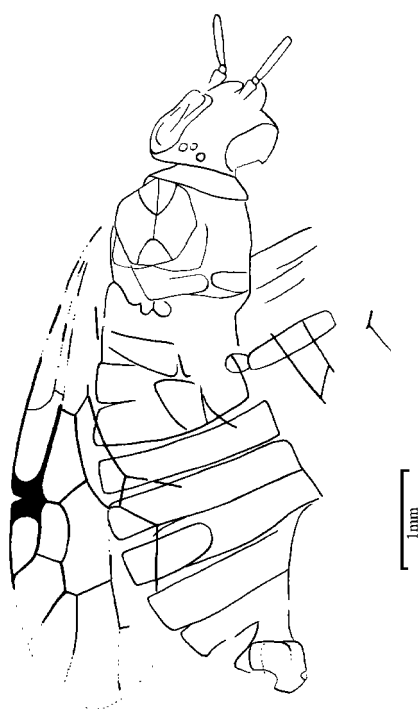
(Pl. I, fig. 6; Text-fig. 3)

Etymology From Latin 'suspectus' —dubious.

Material A female sawfly in latero-dorsal view with antennae, legs, wings and abdomen incomplete. LBSH98003, holotype. Body length 6.5mm (ex-

cluding antennae), forewing (as preserved) 4.7mm and antennae (as preserved) 1.2mm.

Description Head large, subtriangular. Eyes large, oval. Ocelli small. Antennae with 3rd segment twice as long as scape; terminal part of flagellum with only 3 segments preserved. Pronotum broad, trapeziform. Mesonotum with prescutum small and having median suture; mesoscutellum, as large as prescutum, with anterior margin rounded. Foreleg with femur and tibia thin. Midleg with trochanter small and oval; femur as thick as fore femur. Hindleg with coxa large and subtriangular. Forewing with costal area broad; Sc distinctly closer to R than to C, with anterior branch connected to C slightly beyond level of origin of Rs and posterior connected to R just before origin of Rs; pterostigma sclerotized basally with a deep break; basal section of Rs slightly shorter than that of M; cell 1r 1.6 times as long as 2r; cell 2r twice longer than wide; cell 2rm slightly longer than 1r; 1m-cu about one-fourth of section of CuA just beyond 1m-cu; cell 1mcu narrow and as long as 2rm; cell 2mcu broad and slightly longer than 1mcu. Abdomen with 9 segments seen and subequal to each other in length. Ovipositor with sheath thick and short, slightly longer than wide.



Text-fig. 3 *Angaridyela suspecta* sp. nov.
Female, latero-dorsal view;
LBSH98003/NIGP131981

Comparison Differs from *A. robustus* in its broad and subtriangular head, and broad pronotum; from *A. exculpta* in its mesoscutellum with anterior margin rounded and its forewings with 1m-cu very short; from *A. vitimica* in its forewings with Sc distinctly closer to R than to C and pronotum with anterior margin straight; from *A. minor* and *A. pallipes* in its forewings with posterior branch of Sc short, cell 2r narrow and elongate.

Locality and horizon As above.

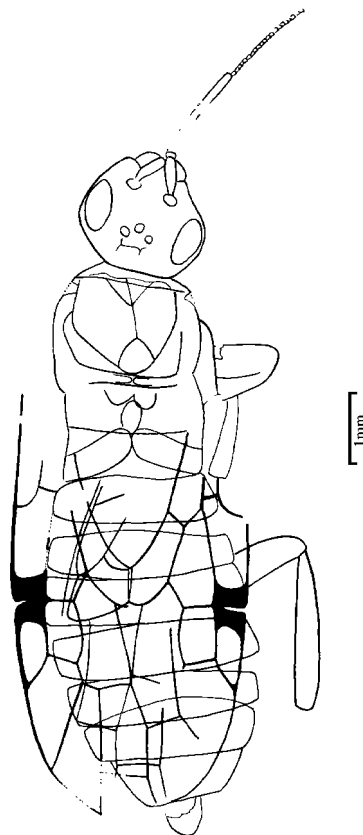
Angaridyela endemica sp. nov.

(Pl. I, fig. 4; Text-fig. 4)

Etymology From Latin 'endemicus'—aboriginal.

Material A female sawfly in dorsal view with antennae, legs and wings incomplete. LBSH98004, holotype. Body length 9.7mm (excluding antennae), forewing (as preserved) 6.2mm and antennae (as preserved) 3.4mm.

Description Head large, subovate. Mandibles short. Eyes small, ovoid. Ocelli small. Antennae with 3rd segment 2.5 times longer than scape; termi-



Text-fig. 4 *Angaridyela endemica* sp. nov.
Female, dorsal view; LBSH98004/NIGP131982

nal part of flagellum with 21 segments preserved, nearly as long as 3rd segment. Pronotum broad but short. Mesonotum with prescutum small and having median suture; mesoscutellum small with anterior margin sharp. Foreleg with femur thick; tibia thin. Midleg with tibia thin. Hindleg with femur thick; tibia thinner than femur, elongate. Forewing with costal area broad; Sc slightly closer to R than to C, with anterior branch connected to C just beyond level of origin of Rs and posterior connected to R just before origin of Rs; pterostigma sclerotized basally with a deep break; basal section of Rs as long as that of M; cell $1r$ 1.7 times longer than $2r$; cell $2r$ 1.5 times longer than wide; cell $2rm$ slightly longer than $1r$; termination of Rs_1 slightly closer to end of Rs_2 than to pterostigma; $1m-cu$ one-third of section of CuA just beyond $1m-cu$; cell $1m-cu$ narrow and slightly shorter than $2rm$; cell $2m-cu$ broad and slightly longer than $1m-cu$. Abdomen with 8 segments distinguished and subequal to each other in length. Ovipositor with sheath thick, nearly as long as wide.

Comparison This species is different from all other species within *Angaridyela* in the broad and short pronotum with posterior margin greatly wider than anterior, and the forewing with basal section of Rs as long as that of M.

Locality and horizon As above.

Genus *Lethoxyela* gen. nov.

Etymology From Greek 'lethe'—oblivion and generic name *Xyela*.

Type species *Lethoxyela excurva* gen. et sp. nov.

Diagnosis Antennae with terminal part of flagellum distinctly longer than basal 3 segments combined. Forewing with pterostigma sclerotized basally and membranous distally; costal area swollen before origin of Rs; posterior branch of Sc joining R just at origin of Rs; basal section of Rs slightly shorter than that of M; $1m-cu$ slightly shorter than (but longer than half of) section of CuA just beyond $1m-cu$; termination of Rs_1 closer to end of Rs_2 than to pterostigma. Ovipositor short with sheath slightly longer than wide.

Comparison The new genus can be clearly placed into the tribe Angaridylini in the forewing

with pterostigma sclerotized basally, basal section of Rs slightly shorter than that of M and crossvein $1m-cu$ shorter than section of CuA just beyond $1m-cu$, and in the short ovipositor. It may be compared most closely with *Angaridyela* Rasnitsyn but is distinguished by the antennae with terminal part of flagellum longer than the basal 3 segments combined and the forewing with posterior branch of Sc meeting R just at origin of Rs.

Ren *et al.* (1995) erected a new species, *Liaodoxyela chengdeensis*, based on a forewing from Chengde, Hebei Province of China and placed it into Xyelinae. However, the pterostigma has a deep break and vein C is thickened and combined with R before the break indicating a classification in the Macroxyelinae. By reference to other characters, it should be placed into Angaridylini and might be further referred to this genus.

Distribution Liaoning, China; Late Jurassic.

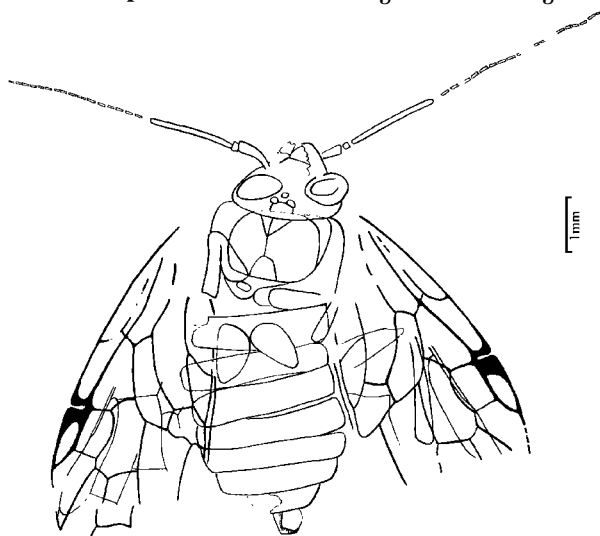
Lethoxyela excurva gen. et sp. nov.

(Pl. I, fig. 2; Text-fig. 5)

Etymology From Latin 'excurvus'—ex-curved.

Material Two female sawflies in dorsal view, part and counterpart, with antennae, legs and wings incomplete. LBSH98005a, b, holotype. Body length 7.1 mm (excluding antennae), forewing (as preserved) 6.5 mm and antennae (as preserved) 5.7 mm.

Description Head large, subtriangular.



Text-fig. 5 *Lethoxyela excurva* gen. et sp. nov.
Female, dorsal view; LBSH98005a/NIGP131983a

Mandibles stout with small teeth; labrum tongue-shaped. Eyes large and ovoid. Ocelli small. Antennae elongate with preserved part 3 times longer than width of head; terminal part of flagellum with 17 segments preserved and more than twice longer than 3rd segment. Mesonotum with prescutum small and having median suture; mesoscutellum small with anterior margin rounded. Midleg with coxa comparatively small, subtriangular; femur short, slightly thick; tibia slightly thinner and longer than femur. Hindleg with coxa large, subtriangular; femur comparatively thick; tibia thin and elongate, becoming gradually thick towards its end. Forewing with costal area broad; Sc distinctly closer to R than to C, with anterior branch connected to C beyond level of origin of Rs and posterior connected to R just at origin of Rs; pterostigma sclerotized basally with a deep break; basal section of Rs slightly shorter than that of M; cell 1r as long as 3r and 1.7 times longer than 2r; cell 2r 1.5 times longer than wide; cell 2rm slightly longer than 1r; Rs₂ slightly curved at connection with 3r-m; termination of Rs₁ slightly closer to end of Rs₂ than to pterostigma; cell 1m-cu strongly curved and slightly longer than 2rm; cell 2m-cu broad; 1m-cu slightly shorter than section of CuA just beyond 1m-cu. Hindwing ill-preserved; cell r with end rounded; cell 2rm+3rm connected with m-cu. Abdomen with 7 segments distinguished and subequal to each other in length. Ovipositor with sheath slightly longer than wide.

Locality and horizon As above.

***Lethoxyela vulgata* gen. et sp. nov.**

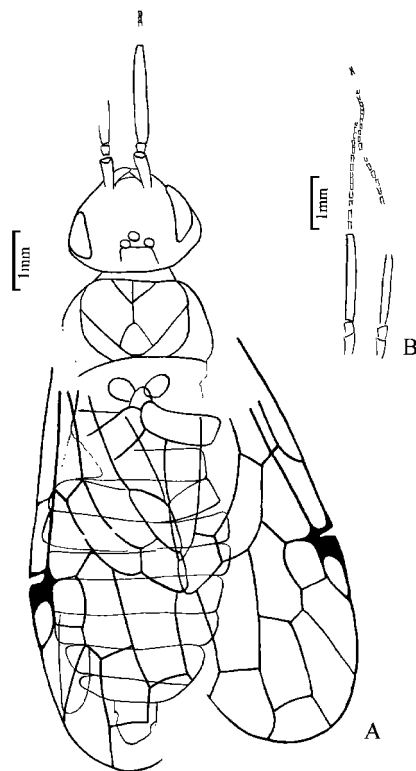
(Pl. II, fig. 1; Text-fig. 6)

Etymology From Latin 'vulgatus' — ordinary, vulgar.

Material Two female sawflies in dorsal view, part and counterpart, with antennae, legs and wings incomplete. LBSH98006a, b, holotype. Body length 9.8 mm (excluding antennae), forewing (as preserved) 7.2 mm and antennae (as preserved) 5.1 mm.

Description Head large, subovate. Mandibles thin; labrum with anterior margin straight. Eyes medium-sized and kidney-shaped. Ocelli small. Antennae elongate with preserved part 2.5 times longer than width of head; terminal part of flagellum with at

least 20 segments preserved and about twice longer than 3rd segment. Pronotum short, nearly trapeziform. Mesonotum with prescutum small and having median suture; mesoscutellum small with anterior margin rounded. Forewing (characters according to the right forewing in specimen LBSH98006a as the left one has a folded costal area) with costal area broad; Sc slightly closer to R than to C, with anterior branch connected to C a little beyond level of origin of Rs and posterior connected to R just at origin of Rs; pterostigma sclerotized basally with a deep break; basal section of Rs two-thirds of that of M in length; cell 1r nearly as long as 3r and twice longer than 2r; cell 2r 1.5 times longer than wide; cell 2rm slightly longer than 1r; cell 3rm as long as 1r; Rs₂ slightly curved at connection with 3r-m; termination of Rs₁ slightly closer to end of Rs₂ than to pterostigma; cell 1m-cu strongly curved and slightly longer than 2rm; cell 2m-cu broad and as long as 1m-cu; 1m-cu slightly shorter than section of CuA just beyond 1m-cu. Abdomen with 9 segments seen and subequal to each other in length. Ovipositor with sheath nearly as long as wide.



Text-fig. 6 *Lethoxyela vulgata* gen. et sp. nov.
A. female, dorsal view: LBSH98006a/NIGP131984a
B. antennae: LBSH98006b/NIGP131984b

Comparison Differs from the type species in its subovate head, kidney-shaped eyes and thin mandibles.

Locality and horizon As above.

Genus *Ceratoxyela* gen. nov.

Etymology From Greek 'cerato'—horn, and generic name *Xyela*.

Type species *Ceratoxyela decorosa* gen. et sp. nov.

Diagnosis Antennae with terminal part of flagellum longer than basal 3 segments combined. One horn-like structure situated before each eye. Forewing with pterostigma greatly sclerotized basally; costal area swollen before origin of Rs; Sc branching into 2, with posterior branch joining R before origin of Rs; basal section of Rs slightly shorter than that of M; $1m-cu$ shorter than (but longer than half of) section of CuA just beyond $1m-cu$; termination of Rs_1 closer to end of Rs_2 than to pterostigma. Ovipositor with sheath small and slightly longer than wide.

Discussion This genus is referable to the tribe Angridyelini on the basis of the forewing with pterostigma sclerotized basally, basal section of Rs slightly shorter than that of M and $1m-cu$ shorter than section of CuA just beyond $1m-cu$, and the ovipositor with short sheaths. The genus differs from other genera of Angridyelini in the horn-like structure situated before each eye, and the short and small sheath of ovipositor.

Distribution Liaoning, China; Late Jurassic.

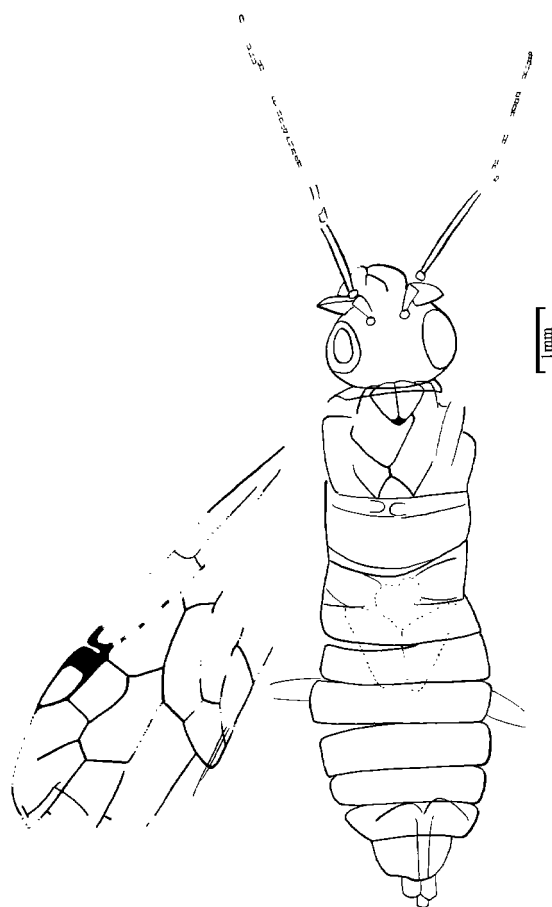
Ceratoxyela decorosa gen. et sp. nov.

(Pl. II, fig. 3; Text-fig. 7)

Etymology From Latin 'decorosus'—colorful.

Material A female sawfly in dorsal view with antennae, legs and wings incomplete. LBSH98007, holotype. Body length 10.3mm (excluding antennae), forewing (as preserved) 7.6mm and antennae (as preserved) 5.3mm.

Description Head large, subovate. Mandibles thick. Eyes large, and ovoid. One horn-like structure situated just before each eye. Antennae very long with preserved part more than twice longer than width of head; terminal part of flagellum with 17 segments preserved, slightly longer than basal 3 seg-



Text-fig. 7 *Ceratoxyela decorosa* gen. et sp. nov.
Female, dorsal view; LBSH98007/NIGP131985

ments combined. Pronotum extremely short. Mesonotum large; prescutum small with median suture sharp. Forewing with costal area broad; Sc slightly closer to R than to C, with anterior branch connected to C before level of origin of Rs and posterior connected to R before origin of Rs; pterostigma sclerotized basally with a deep break; basal section of Rs two-thirds of that of M in length; cell $1r$ 1.7 times longer than $2r$; cell $2r$ 1.5 times longer than wide; cell $2rm$ slightly longer than $1r$; termination of Rs_1 slightly closer to end of Rs_2 than to pterostigma; $1m-cu$ slightly shorter than section of CuA just beyond $1m-cu$; cell $1m-cu$ narrow and as long as $2rm$; cell $2m-cu$ broad and slightly longer than $1m-cu$. Hindwing with only several veinal sections preserved. Abdomen with 8 segments seen; terminal segment a little longer. Ovipositor thin and slightly protruding from abdominal apex; sheath short, small and slightly longer than wide.

Locality and horizon As above.

Genus *Liaoxyela* gen. nov.

Etymology From the locality, which belonged to the state Liao in the history, yielding the specimens.

Type species *Liaoxyela antiqua* gen. et sp. nov.

Diagnosis Antennae with terminal part of flagellum longer than basal 3 segments combined. Forewing with pterostigma sclerotized basally and on basoforeside, and having a shallow break; costal area swollen before origin of R_s ; Sc branching into 2 just before origin of R_s , and with posterior branch joining R just at origin of R_s ; basal section of R_s slightly shorter than that of M; $1m-cu$ slightly shorter than section of CuA just beyond $1m-cu$; termination of R_{s1} closer to end of R_{s2} than to pterostigma. Ovipositor short; sheath broad and short, and slightly longer than wide.

Comparison Similar to *Lethoxyela* gen. nov., but this genus can be distinguished by its forewing with pterostigma sclerotized basally and possessing a shallow break on basoforeside.

Distribution Liaoning, China; Late Jurassic.

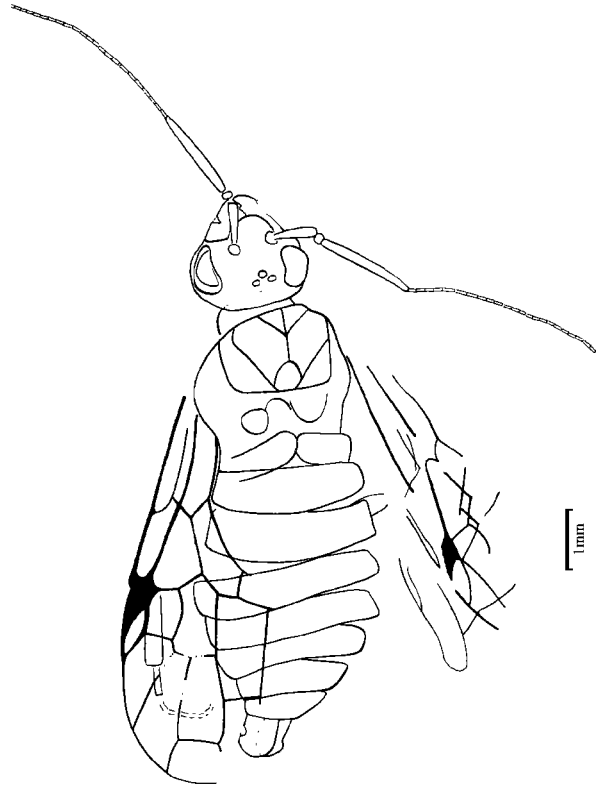
Liaoxyela antiqua gen. et sp. nov.

(Pl. II, fig. 2; Text-fig. 8)

Etymology From Latin 'antiquus'—archaic.

Material Two female sawflies in dorsal view, part and counterpart, with legs and wings incomplete. LBSH98008a, b, holotype. Body length 9.2 mm (excluding antennae), forewing (as preserved) 6.4 mm and antennae 5.8 mm.

Description Head large and subovate. Mandibles thick with teeth. Eyes large and kidney-shaped. Antennae very long and 3 times longer than width of head; terminal part of flagellum 23-segmented and twice as long as 3rd segment. Pronotum short. Mesonotum large; prescutum small with median suture; mesoscutellum small with anterior margin obtuse. Hindleg with femur thin; tibia comparatively thin; tarsus thin and elongate with basitarsus slightly long. Forewing with costal area broad; Sc distinctly closer to R than to C with anterior branch connected to C at level of origin of $R_s + M$ and posterior connected to R just at origin of R_s ; costal area slightly swollen before origin of R_s ; pterostigma sclerotized



Text-fig. 8 *Liaoxyela antiqua* gen. et sp. nov. Female, dorsal view; LBSH98008a/NIGP131986a

basally and on basoforeside with a shallow break; basal section of R_s two-thirds of that of M in length; cell $1r$ 1.8 times longer than $2r$; cell $2r$ 1.4 times longer than wide; cell $2rm$ slightly shorter than $1r$; cell $3rm$ as long as $2rm$; termination of R_{s1} slightly closer to end of R_{s2} than to pterostigma; R_{s2} curved at connection with $3rm$; $1m-cu$ about half of section of CuA just beyond $1m-cu$ in length; cell $1mcu$ narrow and slightly longer than $2rm$; cell $2mcu$ broad and slightly longer than $1mcu$. Hindwing ill-preserved; cell r with end rounded. Abdomen with 8 segments seen; terminal segment short. Ovipositor short; sheath broad and short, slightly longer than wide.

Locality and horizon As above.

Tribe Gigantoxylini Rasnitsyn, 1969

Genus *Heteroxyela* gen. nov.

Etymology From Greek 'hetero'—difference, and generic name *Xyela*.

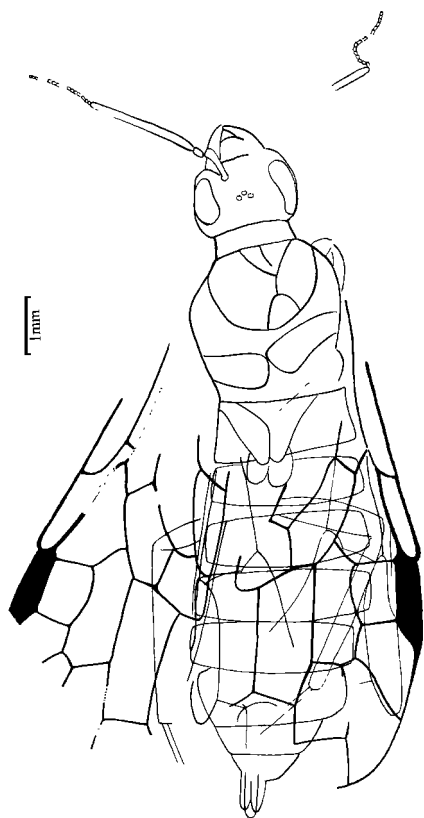
Type species *Heteroxyela ignota* gen. et sp. nov.

Diagnosis Antennae with terminal part of flagellum greatly shorter than 3rd segments (the former

about $2/3$ of the latter in length). Thorax clothed with sparse and small puncta. Forewing with pterostigma sclerotized completely; costal area swollen before origin of Rs; Sc branching into 2 with posterior branch joining R before origin of Rs; basal section of Rs as long as that of M; $1m-cu$ slightly shorter than section of CuA just beyond $1m-cu$. Ovipositor short; sheath comparatively slender and twice as long as wide.

Comparison The new genus differs from *Gigantoxyla* in the latter having antennae with terminal part of flagellum one-third of 3rd segment in length and forewings with Sc 4-branched and 1st abscissa of Rs slightly shorter than basal section of M; from *Chaetoxyla* in the latter having antennae with terminal part of flagellum half of 3rd segment in length, forewings with posterior branch of Sc joining R just at origin of Rs and 1st abscissa of Rs slightly shorter than basal section of M, and ovipositor with sheath comparatively thick.

Distribution Liaoning, China; Late Jurassic.



Text-fig. 9 *Heteroxyela ignota* gen. et sp. nov.
Female, dorsal view; LBSH98009/NIGP131987

Heteroxyela ignota gen. et sp. nov.

(Pl. II, fig. 4; Text-fig. 9)

Etymology From Latin 'ignotus'—unknown.

Material A female sawfly in dorsal view with antennae, legs and wings incomplete. LBSH98009, holotype. Body length 12.4 mm (excluding antennae), forewing (as preserved) 8.7 mm and antennae 4.0 mm.

Description Head medium-sized and subovate. Eyes large and kidney-shaped. Ocelli small. Antennae twice longer than width of head; terminal part of flagellum consisting of more than 15 segments (maybe 16) and two-thirds of 3rd segment in length. Thorax clothed with sparse and small puncta. Pronotum short, nearly trapeziform. Mesonotum with prescutum small and having median suture; mesoscutellum small with anterior margin obtuse. Foreleg with femur short; tibia thin. Hindleg with coxa large, subtriangular; trochanter medium-sized and oval; femur slightly thick; tibia thin and elongate; tarsus with only basitarsus preserved, thin and elongate. Forewing with Sc distinctly closer to R than to C; anterior branch of Sc connected to C at level of origin of $Rs+M$ and posterior connected to R a little before origin of Rs; costal area slightly swollen before origin of Rs; pterostigma sclerotized completely; basal section of Rs as long as that of M; $1r-rs$ slightly longer than $2r-rs$; cell $1r$ 1.8 times longer than $2r$ and slightly longer than $3r$; cell $2r$ 1.3 times longer than wide; cell $2rm$ slightly longer than $1r$; Rs_2 curved at connection with $3r-m$; termination of Rs_1 slightly closer to pterostigma than to end of Rs_2 ; cell $1m-cu$ greatly shorter than $2rm$; cell $2mcu$ 1.4 times longer than $1m-cu$; $1m-cu$ slightly shorter than section of CuA just beyond $1m-cu$. Hindwing ill-preserved; cell r with end rounded. Abdomen with 8 segments seen; basal 6 segments with each subequal in length; terminal 2 segments a little shorter. Ovipositor with sheath short and twice longer than wide.

Locality and horizon As above.

Tribe Ceroxyelini Rasnitsyn, 1969

Genus *Sinoxyela* gen. nov.

Etymology From Greek 'sin'—China, and generic name *Xyela*.

Type species *Sinoxyela viriosa* gen. et sp.

nov.

Diagnosis Antennae with terminal part of flagellum not shorter than 3rd segment. Forewing with pterostigma sclerotized but membranous basally; costal area swollen before origin of Rs; Sc branching into 2 before origin of Rs; basal section of Rs slightly shorter than that of M; termination of Rs₁ closer to Rs₂ than to pterostigma; 1m-cu slightly shorter than section of CuA just beyond 1m-cu; cell 1m-cu comparatively broad and slightly shorter than 2m-cu. Hindwing with 1r-m meeting Rs beyond origin of Rs. Ovipositor with sheath comparatively thin, subuliform.

Comparison The genus bears some resemblance to *Ceroxyela* but differs in its body without puncta, forewing with Sc branching into 2 before origin of Rs and cell 1m-cu broad but a little shorter than 2m-cu, and ovipositor with sheath subulate.

Distribution Liaoning, China; Late Jurassic

***Sinoxyela viriosa* gen. et sp. nov.**

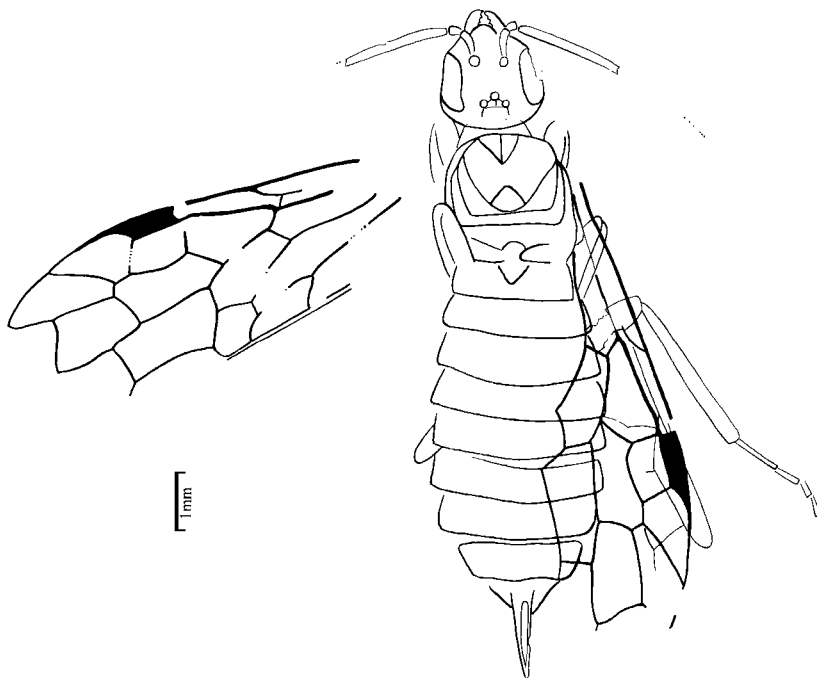
(Pl. I, fig. 3; Text-fig. 10)

Etymology From Latin 'viriosus'—strong, robust.

Material A female sawfly in dorsal view with antennae, legs and wings incomplete. LBSH98010, holotype. Body length 10.3mm (excluding antennae and ovipositor), forewing (as preserved) 7.6mm,

antennae 4.5mm and ovipositor sheath 1.2mm.

Description Head large and subovate. Mandibles medium-sized and reaphook-shaped with small teeth. Eyes large and elongate-ovoid. Ocelli small. Antennae incomplete; terminal part of flagellum extremely thin with only part preserved and not shorter than 3rd segment. Pronotum short. Mesonotum broad; prescutum small with median suture; mesoscutellum small with anterior margin obtuse. Foreleg with femur a little thick; tibia thin. Midleg with femur and tibia thin. Hindleg with femur comparatively thick; tibia thin and elongate; tarsus with 4 segments preserved; basitarsus longest; second tarsomere half of basitarsus in length; third distinctly shorter than second; fourth slightly shorter than second. Forewing with Sc slightly closer to R than to C; anterior branch of Sc connected to C at level of origin of Rs+M and posterior connected to R just before origin of Rs; costal area slightly swollen before origin of Rs; pterostigma sclerotized but membranous basally; basal section of Rs slightly shorter than that of M; cell 1r as long as 3r and 1.4 times longer than 2r; cell 2r 1.6 times longer than wide; cell 2rm slightly longer than 1r; cell 3rm nearly trapeziform and as long as 1r; Rs₂ slightly curved at connection with 3rm; termination of Rs₁ slightly closer to end of Rs₂ than to pterostigma; cell 1m-cu slightly shorter than



Text-fig. 10 *Sinoxyela viriosa* gen. et sp. nov.

Female, dorsal view; LBSH98010/NIGP131988

2_{rm} and as long as 1_r; cell 2_{mcu} as long as 2_{rm}; 1_{m-cu} slightly shorter than section of CuA just beyond 1_{m-cu}. Hindwing ill-preserved; cell r with end rounded; 1_{r-m} meeting Rs a little beyond origin of Rs; vestige 2_{r-m} present; 3_{r-m} complete. Abdomen with 9 segments seen and subequal to each other in length. Ovipositor comparatively thin with sheath subuliform.

Locality and horizon As above.

Genus *Isoxyela* gen. nov.

Etymology From Greek 'iso'—equality, and generic name *Xyela*.

Type species *Isoxyela rudis* gen. et sp. nov.

Diagnosis Antennae with terminal part of flagellum greatly shorter than 3_{rd} segment. Forewing with pterostigma sclerotized but membranous basally; costal area slightly swollen before origin of Rs; Sc branching into 2 slightly before origin of Rs; basal section of Rs slightly shorter than that of M; termination of Rs₁ slightly closer to end of Rs₂ than to pterostigma; cell 1_{mcu} comparatively broad and shorter than 2_{mcu}; 1_{m-cu} slightly shorter than section of CuA just beyond 1_{m-cu}. Hindwing with 1_{r-m} meeting Rs beyond origin of Rs. Ovipositor with sheath comparatively thick, gradually becoming thin towards its end and greatly longer than wide.

Comparison Similar to *Sinoxyela*, but the genus can be distinguished by the ovipositor with the sheath thicker and the antennae with the terminal part of flagellum shorter than the 3_{rd} segment.

Distribution Liaoning, China; Late Jurassic.

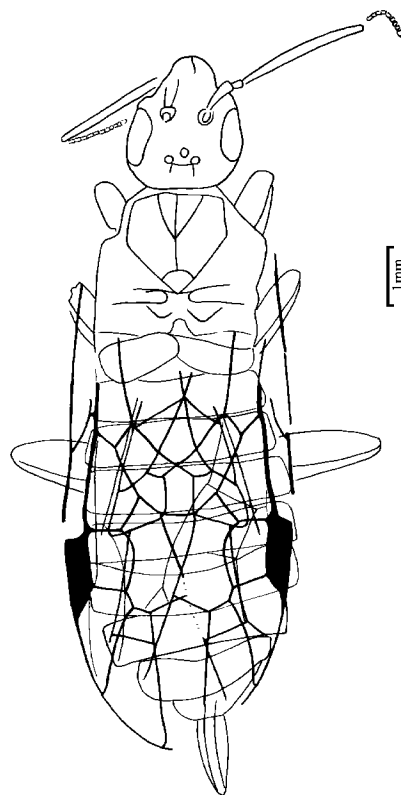
Isoxyela rudis gen. et sp. nov.

(Pl. II, fig. 5; Text-fig. 11)

Etymology From Latin 'rudis'—wild, rude.

Material A female sawfly in dorsal view with antennae, legs and wings incomplete. LBSH98011, holotype. Body length 11.2mm (excluding antennae and ovipositor), forewing (as preserved) 8.1mm, antennae 4.2mm and ovipositor 1.4mm.

Description Head large and subovate. Eyes large and elongate-ovoid. Ocelli small. Antennae with terminal part of flagellum 11-segmented and half of 3_{rd} segment in length. Pronotum extremely short. Mesonotum broad; prescutum small with median su-

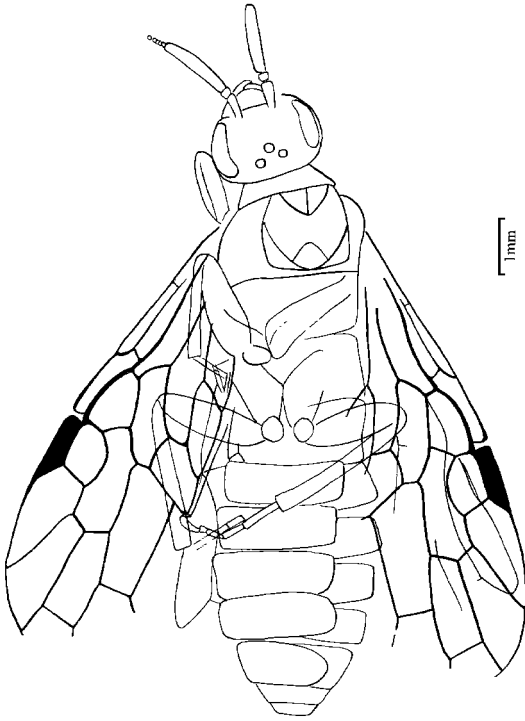


Text-fig. 11 *Isoxyela rudis* gen. et sp. nov.
Female, dorsal view; LBSH98011/NIGP131989

ture; mesoscutellum extremely small with anterior margin obtuse. Foreleg with femur a little thick; tibia thin. Midleg with femur slightly thinner than fore femur; tibia thin. Hindleg with femur slightly thicker than fore femur and long; tibia thin and elongate. Forewing with Sc distinctly closer to R than to C; anterior branch of Sc connected to C at level of origin of Rs+M and posterior connected to R a little before origin of Rs; costal area slightly swollen before origin of Rs; pterostigma sclerotized but membranous basally; basal section of Rs slightly shorter than that of M; cell 1_r 1.5 times longer than 2_r and slightly shorter than 3_r; 1_{r-rs} slightly shorter than 2_{r-rs}; cell 2_r 1.3 times longer than wide; cell 2_{rm} slightly longer than 1_r; cell 3_{rm} nearly trapeziform and slightly longer than 1_r; Rs₂ straight at connection with 3_{r-m}; termination of Rs₁ slightly closer to end of Rs₂ than to pterostigma; cell 1_{mcu} slightly shorter than 2_{rm} but slightly longer than 1_r; cell 2_{mcu} slightly longer than 2_{rm}; 1_{m-cu} slightly shorter than section of CuA just beyond 1_{m-cu}. Hindwing ill-preserved; 1_{r-m} meeting Rs a little beyond origin of Rs; 1_{r-m} complete; vestige 2_{r-m} present. Abdomen with 9 segments seen; basal 8 segments equal to each other

in length and ninth shorter. Ovipositor with sheath comparatively thick, gradually becoming thin towards its apex and 3 times longer than wide.

Locality and horizon As above.



Text-fig. 12 *Xyelites lingyuanensis* sp. nov.
Male, dorsal view; LLD98001b/NIGP131990b

Tribe Xyeleciini Benson, 1954

Genus *Xyelites* Rasnitsyn, 1966

Xyelites lingyuanensis sp. nov.

(Pl. II, fig. 6; Text-fig. 12)

Etymology Named after Lingyuan, the locality yielding the type specimens.

Material Two male sawflies in dorsal view, part and counterpart, with antennae, legs and wings incomplete. LLD98001a, b, holotype. Body length 10.8 mm (excluding antennae), forewing (as preserved) 7.7 mm and antennae (as preserved) 2.3 mm.

Description Head large and transversely ovate. Labrium broadly tongue-shaped. Mandibles falciform with small teeth. Eyes large and kidney-shaped. Ocelli small. Antennae with 3rd segment long, two-thirds of width of head in length and 3 times as long as scape; terminal part of flagellum with only 5 segments preserved, each one thin and small. Pronotum short and nearly trapeziform. Mesonotum broad; prescutum small with median suture; mesoscutellum small with anterior margin obtuse. Foreleg with fe-

mur thin; tibia thin. Midleg with trochanter small, oval; femur thick; tibia thin and as long as femur; tarsus thin and elongate with basitarsus longest, second tarsomere half of basitarsus in length and third slightly longer than second. Hindleg with coxa large, subtriangular; trochanter small and ovate; femur slightly thinner than mid femur; tibia thin and elongate; tarsus thin, slightly shorter than tibia with basitarsus longest, second tarsomere distinctly shorter than basitarsus, third slightly shorter than 2nd, fourth shortest, 5th slightly longer than 2nd with 2 short claws apically. Forewing with C thickened near pterostigma; Sc slightly closer to C than to R and branching into 2 a little before origin of Rs with Sc1 connected to C at level of origin of Rs and Sc2 connected to R a little before origin of Rs; Sc1 issuing a short branch near base of wing and ending in C; costal area distinctly swollen before origin of Rs; pterostigma sclerotized; basal section of Rs very short and about one-fourth of basal section of M in length; 2r-rs nearly twice longer than 1r-rs; cell 2r slightly shorter than 1r and half of cell 3r in length; Rs2 slightly curved at connection with 3r-m; termination of Rs1 greatly closer to end of Rs2 than to pterostigma; cell 2rm twice as long as 2r and slightly longer than 3rm; 1m-cu very short and about one-third of section of CuA just beyond 1m-cu in length; cell 1m-cu as long as but slightly narrower than 3rm; 2m-cu meeting cell 3rm midway; cell 2m-cu obliquely trapeziform, slightly longer than 2rm. Hindwing ill-preserved; cell r with end rounded. Abdomen with 9 segments seen; terminal 2 segments distinctly shorter.

Comparison Differs from the type species in its forewing with basal section of Rs a little longer, Rs2 curved at connection with 3r-m and 2m-cu meeting cell 3rm midway.

Locality and horizon Dawangzhangzi, Lingyuan, western Liaoning Province; Upper Jurassic Yixian Formation.

3 ACKNOWLEDGEMENTS

We are grateful to Profs. Chen Pei-ji, Zhang Wentang, Lin Qi-bin, Wu Shun-qing, Cao Meizhen (Nanjing Institute of Geology and Palaeontology

gy, Chinese Academy of Sciences), Zhang Yong-lu and Liu Guan-bang (Department of Earth Sciences, Nanjing University) for their comments on the manuscript. We are indebted to Prof. Kenneth G. McKenzie (Charles Sturt University, Australia) for revising part of the manuscript. Thanks also go to Mr. Chen Zhou-qing for photographic work. This program is supported by NSFC and CAS.

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EXPLANATION OF PLATES

All specimens illustrated in plates are housed at Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Specimens with catalogue-numbers 131979—131989 were collected from the Jiangshangou Bed of the Upper Jurassic Yixian Formation of Huangbanjigou Village, Shangyuan, Beipiao and the specimen with catalogue-number 131990 was from the Upper Jurassic Yixian Formation of Dawangzhangzi, Lingyuan.

Plate I

- 1. *Angaridyela robusta* sp. nov.
Female, ×10.0, holotype, NIGP131979.
- 2. *Lethoxyela excurva* gen. et sp. nov.
Female, ×6.1, holotype, NIGP131983a.
- 3. *Sinoxyela viriosa* gen. et sp. nov.
Female, ×6.0, holotype, NIGP131988.
- 4. *Angaridyela endemica* sp. nov.
Female, ×8.5, holotype, NIGP131982.
- 5. *Angaridyela exculpta* sp. nov.
Female, ×8.1, holotype, NIGP131980.
- 6. *Angaridyela suspecta* sp. nov.
Female, ×10.5, holotype, NIGP131981.

Plate II

- 1. *Lethoxyela vulgata* gen. et sp. nov.
Female, ×6.0, holotype, NIGP131984a.
- 2. *Liaoxyela antiqua* gen. et sp. nov.
Female, ×6.1, holotype, NIGP131986a.
- 3. *Ceratoxyela decorosa* gen. et sp. nov.
Female, ×6.1, holotype, NIGP131985.
- 4. *Heteroxyela ignota* gen. et sp. nov.
Female, ×6.2, holotype, NIGP131987.
- 5. *Isoxyela rudis* gen. et sp. nov.
Female, ×6.0, holotype, NIGP131989.
- 6. *Xyelites lingyuanensis* sp. nov.
Male, ×6.0, holotype, NIGP131990a.

