

# 山东莱阳晚侏罗世原始蠼螋化石 (昆虫纲)的发现及其意义

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## 内 容 提 要

描述了中国山东莱阳晚侏罗世的蠼螋化石 3 新种 2 新属, 分别隶属于 2 亚目 1 新科和 1 现生科。这些标本是中国已知的最古老的蠼螋化石, 具有许多原始特征, 在昆虫纲革翅目的系统发生中具有重要的意义。

**关键词** 蠼螋化石 新分类群 晚侏罗世 山东莱阳

## 一、前 言

昆虫纲(Insecta)革翅目(Dermaptera)昆虫俗称蠼螋, 在现代昆虫分类群中是一个约有 1 200 种的小目, 通常被归入 2—3 个亚目, 6—7 个科。这些昆虫大多分布在热带, 寒冷地区少见。一般习性属昼伏夜出, 杂食性居多, 肉食性种类亦常见。

蠼螋化石较为罕见。第三系主要分布于欧洲波罗的海琥珀(Baltic Amber)、德国奥埃宁根(Oeningen)、法国埃克斯昂普罗旺斯(Aix-en-Provence)、北美佛罗里蒙特(Florissant)和我国山东山旺, 计 32 种, 全部属于蠼螋亚目(Forficulina)的现生科。中生界化石发现于上侏罗统至白垩系, 分布于原苏联中亚卡拉套(Каратау)、西伯利亚库别科沃(Кубеково)、蒙古戈壁阿尔泰古尔凡埃莱尼努鲁(Гурван-Эрэний-Нуру)和我国浙江龙游, 计 17 种。其中, 5 个种被归入蠼螋亚目, 12 个种被置于中生代晚期原始的分类群始蠼螋亚目(Archidermaptera)。

本文所描述的蠼螋化石系采自山东莱阳上侏罗统莱阳组, 计 3 新种 2 新属, 分别属于 2 亚目 1 新科和 1 现生科。在此之前, 由于我国最早的蠼螋化石记录是上白垩统, 仅 1 个种, 被归入蠼螋亚目的铗螋科(Labiidae)。因此, 山东莱阳的这批标本不但在我国是迄今最古老的革翅目昆虫, 而且与原苏联中亚卡拉套所发现的标本一样, 是世界上已知的最原始的蠼螋化石, 对于我们研究这个目的起源和演化提供了宝贵的材料。

标本系本文作者在刘怀书、张生、李莲英等同志的协助下采集。化石照片由中国科学院南京地质古生物研究所照像室胡尚卿同志摄印。

• 国家自然科学基金资助项目成果之一。

## 二、分类描述

### 革翅目 *Dermaptera* Leach, 1817

#### 亚 目 检 索

1. 跗节多于 3 节; 成虫尾须丝状, 多节; 雌虫产卵器显露; 单眼发育

..... 始螞亚目 (*Archidermaptera*)

跗节 3 节; 成虫尾须不分节; 产卵器和单眼退化 ..... 2

2. 复眼发达; 上颚内缘正常, 无刚毛; 尾须骨化, 坚强光滑; 体光滑 ..... 螞螋亚目 (*Forficulina*)

复眼退化; 成虫无翅; 尾须轻微骨化; 哺乳类外寄生 ..... 3

3. 触角与体等长; 上颚不适合于咀嚼, 顶端具齿, 边缘具鬃毛; 体多毛; 复眼甚小; 外寄生于蝙蝠

..... 蝠螋亚目 (*Arixenina*)

触角较短, 其基节显长; 上颚强大, 具齿; 无复眼; 外寄生于啮齿类

..... 鼠螋亚目 (*Hemimerina*)

#### 始螞亚目 (新修订) *Archidermaptera* Bei-Bienko, 1936, emend. nov.

**特征** 中生代晚期生存的原始分类群。外部形态特征颇似现代的螞螋亚目。体小至大型; 陆地自由活动种类。单眼发育; 具发达的鞘翅和后翅; 成虫尾须柔软, 丝状, 多节; 雌虫产卵器显露; 跗节 4-4-5 或 5-5-5 节。

**讨论** 革翅目现代种类通常被划分为 3 亚目: 螞螋亚目 (*Forficulina*)、蝠螋亚目 (*Arixenina*) 和鼠螋亚目 (*Hemimerina*)。但是, 有的分类学者把鼠螋亚目视为 1 个单独的目, 称之为重舌目 (*Diploglossata*), 而把蝠螋亚目降为 1 个科, 称之为蝠螋科 (*Arixeniidae*), 归入螞螋亚目之中。本文根据国际上大多数分类学者的意见, 视革翅目现代种类划分为 3 亚目的分类系统。

始螞亚目 (*Archidermaptera*) 系原苏联学者 Бей-Биенко (1936) 根据 Martynov (1925) 所建立的始丝尾螋科 (*Protodiplatidae*) 而建立的 1 亚目。Марнынова (1962) 对这个亚目的特征曾做了修订。Вишнякова (1980) 曾引用过 *Archidermaptera* 这一学名, 其后不久, 她 (1986) 以 *Protodiplatina* 代替了 *Archidermaptera* 这个亚目名称。在此之前, 始螞亚目特征的归纳仅根据产于原苏联中亚卡拉套上侏罗统的 1 科 1 属 1 种。根据我国山东莱阳的这批新的资料, 本文建立了 1 新科, 认为应归入始螞亚目。虽然这个亚目有许多特征与其他亚目相同, 但有许多是属于中生代晚期原始的螞螋所特有的特征。因此, 本文较 Марнынова (1962) 对始螞亚目特征的归纳有较大的修订。

**分布时代** 中亚和东亚; 中生代晚期。

#### 科 检 索

体光滑无毛; 触角 17—23 节, 基节长等于或大于宽, 第 2 节不短于第 3 节; 上颚咀嚼缘具齿, 鞘翅

具纵脉; 后足基节常形, 短; 跗节 4-4-5 节 ..... 始丝尾螋科 (*Protodiplatidae*)

体具毛; 触角不少于 26 节, 基节甚短粗, 第 2 节显短于第 3 节; 上颚咀嚼缘无齿; 鞘翅无脉; 后足基

节显长; 跗节 5-5-5 节 ..... 长尾蠼螋科(Longiceriatidae)

长尾蠼螋科(新科) Longiceriatidae fam. nov.

模式属 Longiceriata gen. nov.

**特征** 小型蠼螋, 体具毛。触角不少于 26 节, 基节甚短粗, 宽大于长, 第 2 节显短于第 3 节; 单眼颇为发育; 复眼极大, 位于头后缘, 分为前后两部分; 上颚咀嚼缘无齿。前胸背板横阔, 宽显大于长, 前缘宽于后缘。小盾片极大, 完全暴露。鞘翅长方形, 后缘平截, 无纵脉。后翅长。前胸腹板小, 前缘弧形, 后缘中部甚狭长。中胸腹板短宽, 后缘中央未及中足基节。后胸腹板大, 横阔。足长; 前足基节大, 彼此接触; 中、后足基节彼此分别较靠近, 后足基节显长; 股节具隆堤; 跗节长, 各足一律 5 节。腹部少于 10 节, 向端部收缩; 成足尾须长, 丝状, 节数甚多, 基节甚长。

**比较** 这个新科在许多形态特征上与原苏联中亚晚侏罗世的始丝尾蠼螋科颇为相似, 其两者主要不同之处见上述科检索。

需要指出的是, 新科的触角基节甚短粗, 宽大于长; 复眼极大, 位于头后缘, 分为前后两部分; 中胸腹板短, 后缘中央未及中足基节; 后足基节显长等特征, 在已知的任何现代和绝灭的类群中都不存在, 是中国山东晚侏罗世原始蠼螋所特有的。

**分布时代** 中国山东; 晚侏罗世。

长尾蠼螋属(新属) Longiceriata gen. nov.

模式种 Longiceriata mesozoica gen. et sp. nov.

**特征** 头大, 钝三角形, 后缘平直; 触角第 3 节显长于第 4 节; 复眼长约为头长的 2/5。前胸背板后缘宽于前缘的 1/2。小盾片甚横阔, 五边形, 其前缘与前胸背板后缘等宽。鞘翅后缘宽于前缘, 肩角显著。后翅长不及腹长的 1/2。前、中足基节卵圆形, 后足基节长卵形, 约为股节长的 1/2; 各足股节、胫节和跗节彼此近等长。腹部 9 节, 各节近等长, 具明显的腹侧刺; 尾须几乎与虫体等长, 不少于 36 节, 基节甚长, 超过腹长的 1/3。

**分布时代** 山东莱阳; 晚侏罗世晚期。

种 检 索

- 头长略大于宽; 前胸背板与头等宽, 后缘为前缘宽的 3/4; 小盾片宽为长的 2.2 倍; 前足股节略宽于中足股节; 鞘翅长为宽的 2 倍 ..... 中生长尾蠼螋( Longiceriata mesozoica )
- 头宽略大于长; 前胸背板窄于头, 后缘宽为前缘宽的 2/3; 小盾片宽为长的 1.8 倍; 前足股节显粗于中足股节; 鞘翅长为宽的 1.5 倍 ..... 破长尾蠼螋( Longiceriata rumpens )

中生长尾蠼螋(新属、新种) Longiceriata mesozoica gen. et sp. nov.

(图版 I, 图 1; 插图 1)

**描述** 1 块虫体腹面保存标本; 深褐色; 登记号: L89201(正模标本)。

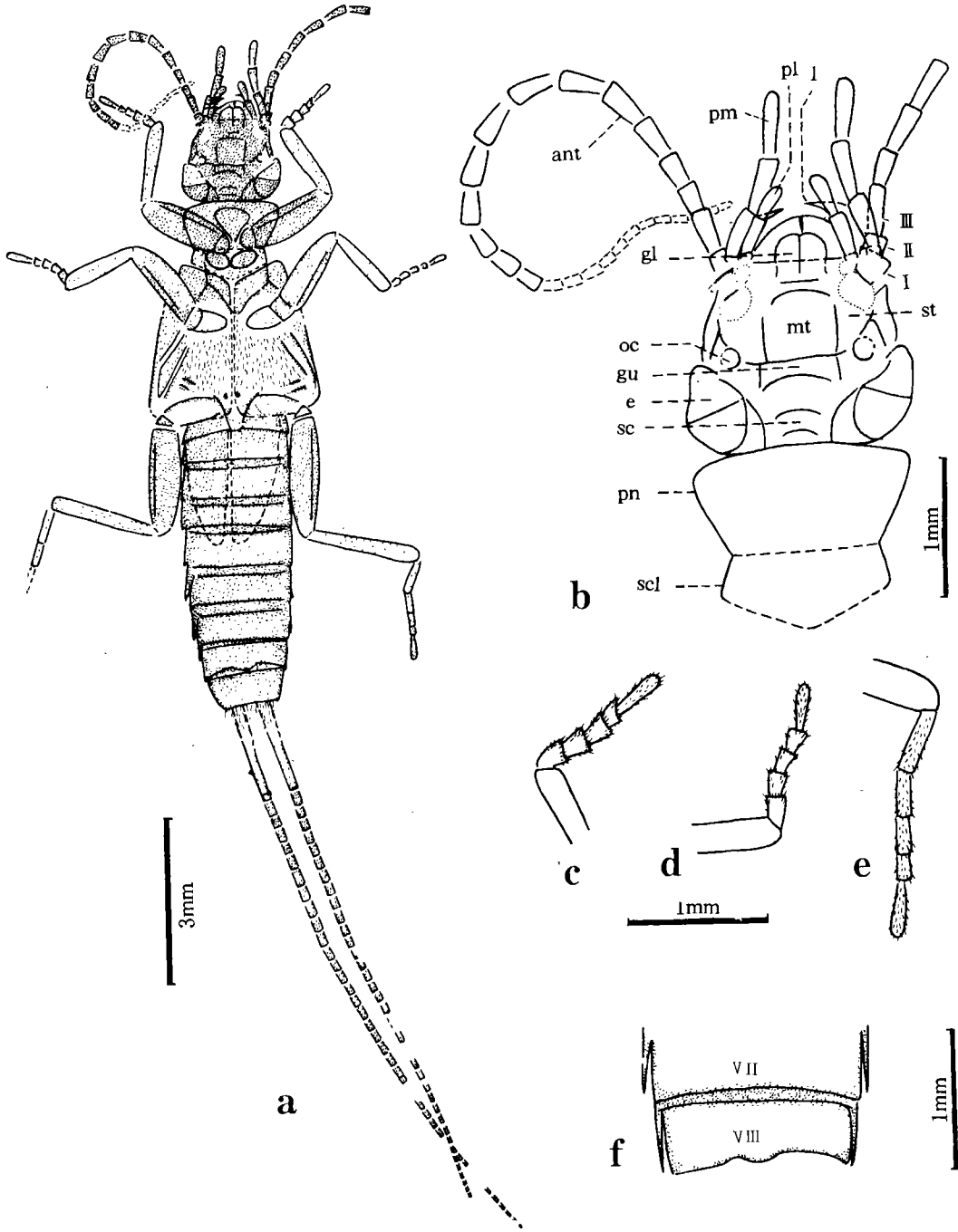


插图 1 *Longicerciata mesozoica* get. et sp. nov.

a. 虫体全貌(body), b. 头、前胸背板和小盾片(head, pronotum and scutellum), c—e. 前、中、后足跗节(tarsi of front, middle and hind legs), f. 腹部第 7, 8 节(seventh and eighth abdominal segments)  
ant. 触角, e. 复眼, gl. 中唇舌和侧唇舌, gu. 外咽片, l. 内颚叶, mt. 颊和亚颊, oc. 单眼, pl. 唇须, pm. 颚须, pn. 前胸背板, sc. 颈片, scl. 小盾片, st. 茎节;学名术语据 Chopard, 1949

头部:头长为宽的1.1倍;触角丝状,鞭节各节长柱形,向端部渐变短变窄,第15节之后脱落,仅见痕迹;单眼压痕可见圆形,近复眼前缘,几乎无色;复眼近卵形,显著凹陷(在背面观应为显著凸起),在中部被划分为前后两部分,前部黄褐色,近三角形,后部深褐色;头腹面其余特征颇近现代的蠼螋(见插图1b)。

胸部:前胸背板轮廓清晰可见前缘略向前弧状弯曲,与头后缘等宽,后缘可见压痕,平直,侧缘直,前侧角较圆润,后缘宽为前缘的3/4,最宽处为长的2倍。小盾片的形状根据压痕尚可辨认:最宽处位于后缘,其中部向后尖突,宽为长的2.2倍。鞘翅前缘、内缘和后缘压痕可以辨认:前缘斜截,内缘直,最宽处位于后缘,长为宽(单个鞘翅)的2倍。后翅压痕尚可辨认:翅较狭长,翅顶达后足股节端部,约为腹长的2/5处。前胸腹板近三角形,前缘弧形,后缘中部向后甚尖突。中胸腹板近五边形。后胸腹板浅黄褐色,密布短毛。各足股节深褐色,但端部颜色甚浅;胫节和跗节黄褐色;前足股节略粗于中足股节,与后足股节等粗,余特征如插图1a、1c—e所示。

腹部:筒状,除第1节较短外,余各节近等长,7—9节向后略收缩,腹末平截,具明显的黄色短毛;尾须(保存)长几乎与虫体等长,基节基部和中部颜色甚浅,余褐色,具短毛,第1节长为第2节长的7倍左右。

虫体长10.9mm,宽3.1mm;头长1.8mm;触角长6.0mm;前胸背板长0.8mm;小盾片长0.5mm;鞘翅长2.7mm;后翅长2.3mm;后足长6.9mm;腹长5.1mm;尾须(保存)长10.9mm。

**产地层位** 山东莱阳南李格庄村;上侏罗统莱阳组。

### 破长尾蠼(新属、新种) *Longicerciata rumpens* get. et sp. nov.

(图版1,图2;插图2)

**描述** 一块虫体背面保存标本,腹部丢失;褐色;登记号:L89202(正模标本)。

头部:宽略大于长;触角保存21节,端部丢失,基节端部粗于基部,约为第2节宽的2倍,两者近等长,余各节长柱形;上颚发育,端部略弯,尖锐,咀嚼缘平直;单眼显大,圆形,几乎无色;复眼卵形,其内缘之间距离与单个复眼的宽度近相等,上半部黄褐色,下半部褐色。

胸部:前胸背板略窄于头后缘,其前、后缘均较平直,后者为前者宽的2/3,侧缘略弧形弯曲,最宽处为长的1.9倍。小盾片后缘弧形弯曲,最宽处位于后缘,为长的1.8倍。鞘翅前缘斜截;内缘略弯曲,肩角显著,后缘内、外侧角较圆润,后缘最宽,显宽于前缘,长为宽(单个鞘翅)的1.5倍,中部颜色显浅于其余部位。后翅颜色为浅褐色,翅顶达后足股节端部。前足股节较短,显粗于中、后足股节;胫节似细长,浅黄褐色;跗节保存不佳。

虫体(保存)长6.7mm,宽2.5mm;头长1.6mm;触角(保存)长4.5mm;前胸背板长0.7mm;小盾片长0.4mm;鞘翅长2.0mm;后翅长1.6mm。

**比较** 这个新种颇似上述中生代长尾蠼,两者主要不同之处见上述种检索。

**产地层位** 山东莱阳南李格庄村;上侏罗统莱阳组。

蠼螋亚目 Forficulina Newman, 1834

大尾蠼螋科 Pygidicranidae

Verhoeff, 1902

棘蠼螋亚科 Echinosomatinae

Burr, 1910

## 属 检 索

体粗壮, 小—中型蠼螋; 头扁平, 复眼常形; 触角第 1、3 节近等长; 前胸背板前后缘近等宽, 与头等宽; 足无隆堤; 腹部短宽; 现生属 .....

..... 棘蠼螋属 (*Echinosoma*)

体匀称, 大型蠼螋; 复眼极大, 显凸; 触角第 1 节显长于第 3 节; 前胸背板后缘窄于前缘, 窄于头; 后足具隆堤; 腹部较狭长; 中生代晚期绝灭属 .....

..... 古蠼螋属 (*Archaeosoma*)

古蠼螋属(新属) *Archaeosoma* gen. nov.

模式种 *Archaeosoma serratum*

gen. et sp. nov.

**特征** 大型蠼螋, 体匀称, 披短鬃和毛。头大, 钝三角形; 触角不少于 24 节, 基节粗, 长大于宽, 显长于第 3 节, 后者短于 4、5 节之和, 余各鞭节显短, 端部渐长, 各节长略大于宽; 单眼显著; 复眼极大, 位于头后缘, 显凸, 内缘脊起, 分为前后两部分。前胸背板宽显大于长, 窄于头, 后缘窄于前缘, 前后侧角圆润。小盾片隐蔽。鞘翅短, 后缘平截, 无侧隆堤。后翅窄小。足短, 后足股节具隆堤。腹部狭长, 8 节, 近端部略放宽; 腹末后缘脊起, 显著锯齿形; 尾铗坚硬, 短, 基部远离, 镰形无齿。

**比较** 据 Burr(1910)的分类, 棘蠼螋亚科仅包括 1 个现生属: 棘蠼螋属。这个属在许多具有分类学意义的形态特征方面颇似山东莱阳中生代晚期的这个新属, 有如下主要相同之处: 虫体披短鬃和毛; 头宽, 后缘平截; 触角节数较多(现生属约 30 节, 绝灭属不少于 24 节), 现生属除第 3 节较长, 4、5、6 节更短外, 其余特征与绝灭属完全一致; 前胸背板横阔, 宽显大于长, 后侧角圆润; 鞘翅发育, 后缘平截, 具毛; 具后翅; 小盾片隐蔽; 足短, 股节较粗; 腹部最后一节横阔, 较短; 臀板几乎不可见; 尾铗坚硬, 短, 基部远离, 镰形无齿等。因此, 古蠼螋属置于棘蠼螋亚科似无疑问, 且与棘蠼螋属颇为近缘。两者的主要区别特征见上述属检索。

**分布时代** 山东莱阳; 晚侏罗世晚期。

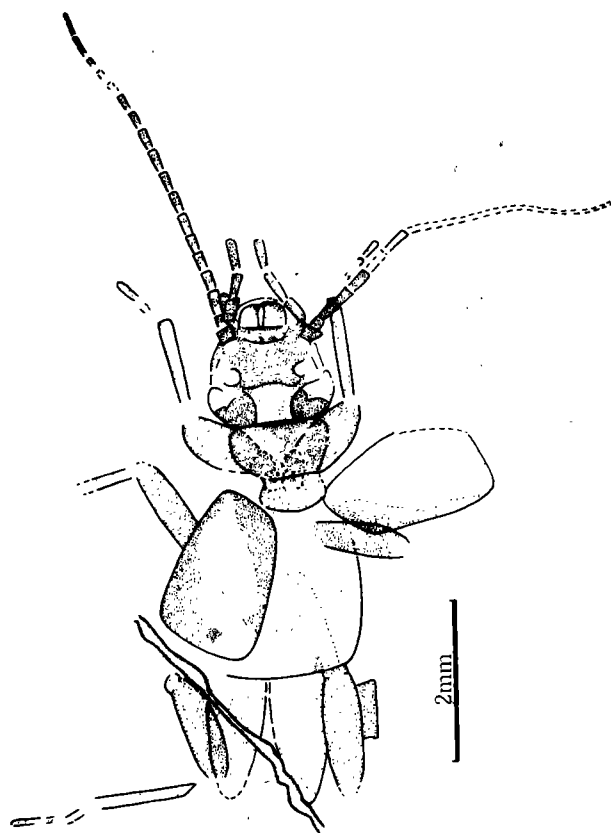


插图 2 *Longiceriata rumpens* gen. et sp. nov.

锯齿古蠼(新种) *Archaeosoma serratum* gen. et sp. nov.

(图版 I, 图 3; 插图 3)

**描述** 1 块雄性成虫背面保存标本; 褐色; 登记号: L89203 (正模标本)。

**头部:** 宽略大于长; 触角保存 24 节, 基节褐色, 余各节淡褐色, 基节长为第 3 节的 1.5—2 倍, 第 2 节甚短, 基部鞭节各节长不及宽, 端部数节长略大于宽; 上颚粗壮, 近三角形, 端部略弯, 尖锐; 单眼几乎无色, 甚近复眼前缘; 复眼前半部黄褐色, 三角形, 后半部深褐色, 整个复眼显凸, 尤以内缘为剧, 呈脊状; 头“Y”字缝细弱, 向后达前胸背板后缘。

**胸部:** 前胸背板显窄于头(包括复眼)后缘, 侧缘具明显的稀疏短鬃和长毛, 后缘略弯, 稍窄于前缘, 宽为长的 1.5 倍。小盾片完全被遮盖。鞘翅长方形, 后缘宽于前缘, 均较平直, 侧缘较直, 可见短毛, 长为宽(单个鞘翅)的 1.5 倍。后翅端部不及第 1 腹节的后缘, 约为腹节第 1 节宽度的 1/3。各足股节较粗, 基半部褐色, 端半部与胫节和跗节颜色浅, 为淡黄褐色; 前、中足股节与胫节近等长, 跗节短于胫节, 第 1、3 跗节近等长, 第 2 节甚短; 后足胫节显短于股节。

**腹部:** 自基部始渐放宽, 第 4 腹节后缘最宽, 与鞘翅后缘近等宽, 5、6、7 节分节不明显, 仅保存痕迹, 6、7 节似甚短, 腹末节显短, 后缘呈强烈锯齿形, 中央具 1 个较长的三角形尖齿; 2—5 节前部颜色甚浅, 余褐色, 第 5 节后半部至腹末黑褐色, 腹节上具长毛; 尾铗褐色, 略内弯, 中央具浅沟, 为腹长的 1/3。

虫体(包括尾铗)长 27.5mm, 宽 6.1mm; 头长 4.2mm, 触角(保存)长 10.5mm; 前胸背板长 2.4mm; 鞘翅长 4.8mm; 后翅长 1.1mm; 后足长 8.9mm; 腹长 12.7mm; 尾铗长 3.8mm。

**产地层位** 山东莱阳南李格庄村; 上侏罗统莱阳组。

## 三、讨 论

山东莱阳晚侏罗世的革翅目化石显然可以分为两种明显不同的类型: 一类属于始蠼亚目的长尾蠼科, 另一类属于蠼螋亚目的大尾蠼科。前者较后者更为原始。

东亚的长尾蠼科与中亚的始丝尾蠼科是目前世界上已知的最原始的蠼螋类群。这两个科的共同特征为各足跗节多于 3 节; 成虫具显长多节的丝状尾须; 通常具有发达的单眼; 前

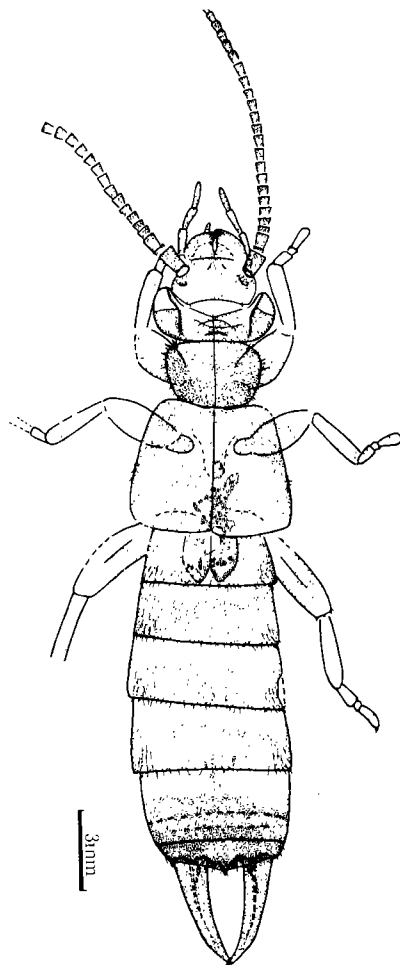


插图 3 *Archaeosoma serratum*  
gen. et sp. nov.

足基节彼此甚为接近。由于现代的蠼螋各足跗节一律 3 节,因此可以肯定地说,跗节的多寡反映了革翅目在演化中的不同阶段,较多的跗节数目显然是属于原始的性状。现代的蠼螋成虫尾须通常硬化,不分节,只有个别较原始的种类,其幼虫的尾须丝状多节,如大尾蠼螋科的 *Diplatys* Serville, *Karschiella* Verhoeff 和 *Bormansia* Verhoeff 等。从这些蠼螋的个体发育的知识,可以得出肯定的结论:成虫具有丝状多节的尾须必定是一种原始的特征。单眼的退化在绝大多数现代革翅目中已成为事实,但在较原始的类群中,如大尾蠼螋的某些种类,存在着单眼,虽然有的已相当退化或仅保留痕迹。因此,单眼的发育程度似可反映蠼螋演化上的不同阶段,颇为发育的单眼的存在,应是原始蠼螋的一个重要的形态特征。在现代蠼螋中,前足基节彼此十分靠近者并不多见,如见于蠼螋科(Labiduridae)的 *Allotethus* Verhoeff 和 *Esphalmenus* Burr 等。前足基节靠近反映出前胸腹板后部显窄。这一特征在革翅目中的系统发生中是否能说明演化的规律尚值得进一步研究。

对比长尾蠼螋科和始丝尾蠼螋科,我们容易发现在中亚的这个绝灭类群中鞘翅通常具有极其明显的纵脉,同时,上颚咀嚼缘具有明显的齿状构造。由于现代蠼螋鞘翅上无任何脉序可以分辨,上颚咀嚼缘光滑无齿,因此,上述特征反映了始丝尾蠼螋科属于十分原始的蠼螋似无疑问,在这两种特征上甚至较长尾蠼螋科更为原始。但是,问题的另一方面是,东亚的这个绝灭类群跗节的模式是 5-5-5;虫体具毛,至少在后胸腹板和腹末节端部清晰可见;小盾片十分宽大,完全暴露;触角的节数更多等特征又明显有别于中亚的绝灭科。长尾蠼螋科跗节的模式无疑是革翅目中最原始的特征,甚至较始丝尾蠼螋科的 4-4-5 的模式更为原始。鉴于现代的蠼螋亚目的种类虫体光滑无毛,仅在较原始的类群中,如大尾蠼螋科的 *Pyragra* Serville, *Propyragra* Burr 和 *Echinosoma* Burr 等少数种类中虫体披毛,这一现象似也说明在某种程度上的原始性。在现代革翅目中小盾片十分宽大,完全暴露同时触角节数众多,超过 25 节者仅见于大尾蠼螋科的大尾蠼螋亚科(Pygidicraninae),这个亚科是公认的现代蠼螋中的一个较原始的类群。因此,长尾蠼螋科的这个特征亦应为原始特征。值得注意的是,在始丝尾蠼螋科存在着 *Microdiplatys* Vishniakova 这个特殊的化石绝灭属,其小盾片、前胸背板、腹部和尾须的特征与长尾蠼螋科的长尾蠼螋属颇为相似。但是,原苏联的这个属触角 19 节,第 2 节显长;鞘翅上至少可以分辨 3 条主要的纵脉与山东莱阳的长尾蠼螋属尚有明显不同。加之,它的跗节的节数尚不清楚是否为 4-4-5 式。笔者认为 *Microdiplatys* 的特征介于长尾蠼螋科和始丝尾蠼螋科之间,其科级分类位置的准确判断,尚待新的化石材料,尤其是跗节保存清楚的标本的发现。

长尾蠼螋科的如下特征是东亚这个绝灭类群所特有的:触角基节显粗且短,宽通常显大于长;复眼极大,位于头后缘,分为前后两部分,前半部的颜色总是浅于后半部分;中胸腹板显短,其后缘中央未及中足基节;后足基节甚长,约为股节长的 1/2 等。上述特征在现代革翅目种类以及山东莱阳之外的所有化石种类中都不存在。根据蠼螋外部形态学方面的知识,触角基节通常显长,长显大于宽;复眼通常位于头中部或偏前两侧,少数种类位于近后缘两侧,但绝不会占据头后缘的大部分,也未见分为前后两部分者;中胸腹板通常较长,至少后缘中央明显超过中足基节的后缘;后足基节通常很短,最长者亦远不及股节长度的 1/2。长尾蠼螋科的这些特征在革翅目的演化上是否具有意义,目前尚不明了。但是,就复眼的特征而言,被归入蠼螋亚目大尾蠼螋科中的古蠼螋属颇似长尾蠼螋属,几乎没有显著的区别。这一事实似提供了这样的结论:某些原始蠼螋所具有的特征很可能是由于所处的特定的生活环境所造成的,例如



纬度、日照、温度、气候、地理、植被等等各种因素,而并非完全反映出它们的进化程度和阶段。当然,在考虑到距今已有约一亿年之遥的中生代晚期古生态不能与现代生态等同这一事实,那么适应当时地质历史时期生活环境的古昆虫必然与昆虫的系统发生有着密切的联系。从这个意义上来讲,这些古代地方性类群所特有的形态特征在昆虫的演化上也具有十分重要的指示意义。

与山东中生代晚期的革翅目化石一样,哈萨克卡拉套地区在中生代晚期同时存在着两大不同类型的蠼螋种类。一类是属于始蠼螋亚目的始丝尾蠼螋科,另一类是被归入蠼螋亚目的3个化石绝灭属:*Semenoviola* Martynov, *Semenovioloides* Vishniakova 和 *Turanoderma* Vishniakova。Вишнякова(1980)把它们置于大尾蠼螋科,建立了1个新亚科:*Semenoviolinae*。可见,根据这3属的如下特征:鞘翅上具明显的纵脉;雌性成虫具有甚长的产卵器;触角第2节显长,几乎与基节和第3节等长;上颚咀嚼缘具齿等,与同一产地同一时代的始丝尾蠼螋科的科征颇为一致,应视为典型的原始性状。因此,这批标本归入大尾蠼螋科实在勉强,至少应建立单独的一个科。而且,这个科的特征介于始蠼螋亚目和蠼螋亚目之间,若归入后者,也是毫无疑问的这个亚目中的最原始的一个类群。

综上所述,我们可以得出以下结论:中生代晚期中亚的始丝尾蠼螋科和东亚的长尾蠼螋科是与现代的蠼螋亚目各科有显著区别的原始蠼螋,归入始蠼螋亚目是毫无疑问的。鉴于这两个化石绝灭科彼此又有许多明显不同之处,每个科都具有强烈的原始特性,因此,在革翅目的演化中大体处于发展的同一阶段。从而,推断含有这两类化石的地层沉积时代大体处于同一地质历史时期也是较为合理的。由于中亚卡拉套含昆虫的页岩为上侏罗统已无疑问,那么山东莱阳所产长尾蠼螋科化石的莱阳组也应为上侏罗统。晚侏罗世是革翅目昆虫演化上的一个重要的历史时期,既存在着明显原始的类群,也有一些较为进化的真正的蠼螋亚目种类的生存。最古老的革翅目分子很可能在中生代早期就已存在。

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## DISCOVERY OF PRIMITIVE FOSSIL EARWIGS (INSECTA) FROM LATE JURASSIC OF LAIYANG, SHANDONG AND ITS SIGNIFICANCE

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**Key words** fossil earwigs, new taxa, Late Jurassic, Laiyang, Shandong

### Summary

The order Dermaptera are usually divided into 6 or 7 families within 2 or 3 suborders, containing about 1 200 species. Among them, 32 species assigned to the suborder Forficulina are found from the Tertiary of such localities as the Baltic Amber, Oeningen, Aix-en-Provence, Florissant and Shanwang in Europe, North America and East Asia; while 17 species are discovered from the Upper Jurassic and Cretaceous of Russia, Mongolia and China, including 12 species assigned to the suborder Archidermaptera and 5 species placed in the Forficulina.

This study deals with 3 new species and 2 new genera recently recovered from the Upper Jurassic of Laiyang on Shandong Peninsular, China, which belong separately to the new family Longicerciatidae of Archidermaptera, and the modern family Pygidicranidae of Forficulina. All the type specimens described here are now preserved in the Shandong Provincial

Museum, Jinan.

## 1. SYSTEMATIC DESCRIPTION

### Oder Dermaptera Leach, 1817

#### Key to suborders

1. Tarsi more than 3-segmented; cerci filiform, multiarticulate when adult; ovipositor much prominent; ocelli usually well-developed ..... Archidermaptera
- Tarsi 3-segmented; cerci unsegmented when adult; ovipositor and ocelli greatly reduced or absent ..... 2
2. Eyes well-developed; mandibles normal, without bristles; cerci heavily sclerotized, without pubescence; body shining ..... Forficulina
- Eyes reduced; body apterous; cerci weakly sclerotized; living as ectoparasites on mammals ..... 3
3. Antennae as long as body; mandibles unfit for chewing, toothed at tips and fringed with bristles along the margin; body strongly pubescent; eyes present, but much reduced in size; living as ectoparasites on bats ..... Arixenina
- Antennae shorter, with basal segment greatly elongated; mandibles strong, dentate; eyes entirely wanting; living as ectoparasites on rodents ..... Hemimerina

#### Suborder Archidermaptera Bei-Bienko, 1936. emend. nov.

**Diagnosis** A Primitive group of Dermaptera living only in Late Mesozoic, closely similar to Forficulina in morphological characteristics. Body small or large in size, free-living. Ocelli, elytra and wings well-developed. Cerci soft, filiform and multiarticulate when adult. Ovipositor much prominent. Front and middle tarsi 4 or 5-segmented; hind tarsi 5-segmented.

**Comparison** The Archidermaptera (=Protodiplatina) were erected by Bei-Bienko (1936) based on the isolated impression of a body from Upper Jurassic of Karatau in Kazakhstan, Russia. Later, Martynova (1962) revised the characters of this suborder. Based on the new findings collected from the upper Jurassic Laiyang Formation in Shandong, China, an emendable diagnosis of Archidermaptera is suggested here, which differs sharply from that given by the Russian authority.

The Archidermaptera are easily distinguished from other suborders within the series of Dermaptera, as indicated in the key to suborders mentioned above.

**Distribution** Middle and East Asia; Late Mesozoic.

#### Key to families

Body shining, without pubescence; antennae bearing 17—23 segments, with basal segment as long as, or distinctly longer than wide, and second segment not shorter than the third; mandibles dentate; elytra with longitudinal veins; coxae of hind legs normal, short; front and middle tarsi 4-segmented, while hind tarsi 5-segmented

..... Protodiplatidae  
 Body clothed with pubescence; antennae not less than 26-segmented, with basal segment rather short and stout,  
 and second segment shorter than the third; mandibles undentate; elytra without veins; coxae of hind legs obvi-  
 ously elongated; tarsi 5-segmented ..... Longicericiatidae

### Family Longicericiatidae fam. nov.

**Type genus** *Longicericiata* gen. nov.

**Diagnosis** Body small-sized, clothed with pubescence. Antennae not less than 26-segmented, with basal segment rather short, wider than long, and second segment clearly shorter than the third. Ocelli well-developed. Eyes rather large in size, lying in hind margin of head and divided into two parts. Mandibles undentate. Pronotum transverse, wider barely than long, with front margin wider than hind margin. Scutellum extraordinarily large and entirely exposed. Elytra oblong, with hind margin obtuse, without longitudinal veins. Prosternum small; front margin arched upward; median of hind margin rather narrow and extended backward. Mesosternum short and wide; hind margin unreaching coxae of middle legs. Metasternum large, transverse. Legs long, with front coxae large and touching each other, middle and hind coxae separately close to each other, the latter being obviously elongated. Abdomen less than 10-segmented, gradually narrowed terminally. Cerci elongated, filiform and multiarticulate, with basal segment rather long.

**Comparison** This new family resembles Protodiplatidae, but may be distinguished from the latter as indicated in the key to families mentioned above.

**Distribution** Shandong, China; Late Jurassic.

### *Longicericiata* gen. nov.

**Type species** *Longicericiata mesozoica* gen. et sp. nov.

**Diagnosis** Head large, obtuse-triangular, with hind margin truncate. Antennae with the third segment longer than the fourth. Eyes about  $2/5$  as long as head. Pronotum with hind margin more than  $1/2$  as wide as front margin. Scutellum much transverse, pentagonal, with front margin as wide as hind margin of pronotum. Elytra with hind margin wider than front margin, and humeral angle prominent. Wings less than  $1/2$  as long as abdomen. Front and middle coxae oval; hind coxae elongate-oval, about  $1/2$  as long as femora. Femora, tibiae and tarsi nearly equal in length. Abdomen 9-segmented, with each segment subequal in length, and armed with lateral spines. Cerci nearly as long as body, not less than 36-segmented, with basal segment more than  $1/3$  as long as abdomen.

**Distribution** Laiyang, Shandong; late Late Jurassic.

### Key to species

Head slightly longer than wide; pronotum as wide as head, with hind margin  $3/4$  as wide as front margin; scutellum 2.2 times as wide as long; front femora a little stouter than middle femora; elytra twice as long as wide  
 ..... *Longicericiata mesozoica*

Head slightly wider than long; pronotum narrower than head, with hind margin  $2/3$  as wide as front margin; scutellum 1.8 times as wide as long; front femora distinctly stouter than middle femora; elytra 1.5 times as long as wide ..... *Longicerciata rumpens*

***Longicerciata mesozoica* gen. et sp. nov.**

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

**Description** A single specimen in ventral view. Darkish brown in color. Holotype: L89201.

Head 1.1 times as long as wide. Antennae missing beyond the 15th segment, but impression visible. Ocelli with impression circular, almost lipochromous. Eyes strongly concave (but convex in dorsal view), and divided into two parts, with upper part triangular, yellowish brown in color. Pronotum twice as wide as long, while scutellum 2.2 times as wide as long, both distinguishable in outline. Elytra twice as long as wide. Wings with impression visible, nearly  $2/5$  as long as abdomen. Legs with femora at terminal, tibiae and tarsi yellowish brown in color. Metasternum and apex of abdomen clothed with yellowish brown hairs. Cerci clothed with brown hairs, with basal segment rather light in color, about 7 times as long as the second, and more than  $1/3$  as long as abdomen. Other characters as shown in text-fig. 1.

Length: body 10.9mm (3.1mm in width); head 1.8mm; antennae 6.0mm; pronotum 0.8mm; scutellum 0.5mm; elytra 2.7mm; wings 2.3mm; hind legs 6.9mm; abdomen 5.1mm; and cerci (only preserved part) 10.9mm.

**Horizon and Locality** Nanlighezhuang Village, Laiyang; Upper Jurassic Laiyang Formation.

***Longicerciata rumpens* gen. et sp. nov.**

(Pl. I, fig. 2; text-fig. 2)

**Description** A single specimen in dorsal view, abdomen missing. Brown in color. Holotype: L89202.

Head a little wider than long. Antennae preserved with 21 basal segments. Pronotum narrower than head, with hind margin  $2/3$  as wide as front margin, and 1.9 times as wide as long. Scutellum 1.8 times as wide as long. Elytra 1.5 times as long as wide, with median parts rather light in color. Front femora distinctly stouter than middle and hind femora; tibiae thin and long, yellowish brown in color. Other characters as shown in text-fig. 2.

Length: body (only preserved part) 6.7mm (2.5mm wide); head 1.6mm; antennae (only preserved part) 4.5mm long; pronotum 0.7mm; scutellum 0.4mm; elytra 2.0mm; wings 1.6mm.

**Comparison** This new species is closely similar to *L. mesozoica* sp. nov., but can be easily differentiated from the latter by the characteristics as indicated in the key to species mentioned above.

**Horizon and Locality** Nanligezhuang Village, Laiyang; Upper Jurassic Laiyang Formation.

**Suborder Forficulina Newman, 1834**

**Family Pygidicranidae Verhoeff, 1902**

**Subfamily Echinomatinae Burr, 1910**

**Key to genera**

Body stout and small or medium-sized; head flat; eyes normal; antennae with basal segment nearly as long as the third; pronotum as wide as head, with front margin as wide as hind margin; legs not keeled; abdomen short and wide; living as an extant genus ..... *Echinoma*

Body of proportional build, large-sized; eyes rather large, strongly convex; antennae with basal segment evidently longer than the third; pronotum narrower than head, with front margin wider than hind margin; hind femora keeled; abdomen narrow and long; representing an extinct genus ..... *Archaeosoma*

***Archaeosoma* gen. nov.**

**Type species** *Archaeosoma serratum* gen. et sp. nov.

**Diagnosis** Body of proportional build, large-sized, covered with short stiff bristles and long hairs. Head large, obtuse-triangular. Antennae not less than 24-segmented, with basal segment stout, longer than wide, and obviously longer than the third, the latter being shorter than the fourth and fifth combined; remainder flagellum rather short, gradually elongated apically, and each barely longer than wide. Ocelli prominent. Eyes rather large, lying in hind margin of head, strongly convex, with inner edges carinal, divided into two parts at median. Pronotum narrower than head, wider than long, with hind margin narrower than front margin, and lateral angles rounded. Scutellum concealed. Elytra short, with no lateral keels; hind margin truncate. Wings narrow and small. Hind femora keeled. Abdomen narrow and long, 8-segmented, somewhat widened near apex; hind margin of last abdominal segment carinal, distinctly dentate-serrate. Forceps heavily sclerotized, short, with branches remote at base, falcate, armed without dentate.

**Comparison** The subfamily Echinomatinae comprise only a single modern genus *Echinoma* Serville according to Burr (1910). Although with certain of identical features, the extant genus can be separated from *Archaeosoma* gen. nov. as indicated in the key to genera mentioned above.

**Distribution** Laiyang, Shandong; late Late Jurassic.

***Archaeosoma serratum* gen. et sp. nov.**

(Pl. I, fig. 3; text-fig. 3)

**Description** An isolated specimen of adult male in dorsal view. Brown in color. Holo-

type: L89203.

Head slightly wider than long. Antennae with basal segment distinctly longer than the third, brown but with remainder light brown in color; flagella each wider than long basally, but longer than wide terminally. Mandibles stout, subtriangular. Ocelli almost achromatic, close to front margin of eyes. Eyes with upper half triangular, yellowish brown, and lower half darkish brown in color. Pronotum clothed with short stiff bristles and pubescence on hind and lateral margins, 1.5 times as wide as long. Elytra oblong, 1.5 times as long as wide, with hind margins wider than front margins, both straight, and covered with short hairs. Wings about  $1/3$  as long as abdomen. Femora stout, brown at basal half, but yellowish brown in color at terminal half; tibiae and tarsi yellowish brown. Abdomen with widest part lying on hind margin of the fourth segment, nearly as wide as elytra. Metamerism between the fifth, sixth and seventh segments indistinct, with the latter two appearing extraordinarily short, while last abdominal segment short, transverse, with hind margin bearing a large triangular serration just at median; second to fifth segments with upper half rather light, while remainder brown, but lower half of the fifth to apex of abdomen blackish brown in color; each abdominal segment covered with long hairs. Forceps  $1/3$  as long as abdomen, brown in color, slightly curved inward; each branch with shallow groove medially.

Length: body (including forceps) 27.5mm (6.1 in width); head 4.2mm; antennae (only preserved part) 10.5mm; pronotum 2.4mm; elytra 4.8mm; wings 1.1mm; hind legs 8.9mm; abdomen 12.7mm; forceps 3.8mm.

**Horizon and Locality** Nanlizehuang Village, Laiyang; Upper Jurassic Laiyang Formation.

## II. DISCUSSION

It is quite evident that the fossil earwigs discovered from the Upper Jurassic of Laiyang, Shandong can be included in two groups, the Archidermaptera consisting of two species, *Longicerciata mesozoic* and *L. rumpens*, and the Forficulina containing a single species, *Archaeosoma serratum*.

The East Asian Longicerciataidae and the Middle Asian Protodiplatidae are the oldest known earwigs throughout the world. They resemble the modern dermapterons in many ways, but have more than 3-segmented tarsi, and filiform, multiarticulate cerci when adult, usually well-developed ocelli and a pair of close coxae in front legs. In these characters, they have a closer affinity to each other than to any other families of earwigs, and thus also represent their primitive conditions. As compared with the Longicerciataidae, the Protodiplatidae possess distinct veins on elytra and dentate mandibles which are absent not only in the former, but also in the known extant families of Dermaptera. It is reasonable to

deduce that this Russian extinct group show more primeval features. On the other hand, however, in the Chinese extinct family the tarsi are 5-segmented; the body presents pubescence at least on metasternum and apex of abdomen; the scutellum is rather wide, large, and entirely exposed; and the antennae possess more segments, which are wanting in Protodiplatidae, indicating that Longiceriatidae also have certain of more primitive characteristics. It should be noted that the genus *Microdiplatys* Vishniakova placed in Protodiplatidae is closely similar to *Longiceriata* gen. nov. in many taxonomic aspects, such as the shape and construction of scutellum, pronotum, abdomen and cerci, but it has 19 antennal segments with the second clearly elongated, and at least 3 longitudinal veins on elytra. In addition, it is ambiguous as to the number of tarsal segments this genus possesses according to Vishniakova's description and figures (Vishniakova, 1980). For this reason, the author considers this genus as an intermediate form between Protodiplatidae and Longiceriatidae, but the accurate systematic position of this genus at familial level still remains to be proved by more details of new materials, especially the tarsal character.

There are some particular features to the Longiceriatidae, which are not provided for other fossil and living representatives of dermapterans. The basal antennal segment appears rather short and stout, usually wider than long. The eyes are situated in hind margin of head, extremely large in size, and divided into upper and lower parts. The mesosternum is distinctly short, not reaching coxae of middle legs, while the hind coxae appear to be much more elongated, and about one-half as long as femora. However, in the character of the eyes, the *Archaeosoma serratum* within the Pygidicranidae is strikingly analogous to Longiceriatidae. The author is not quite sure about whether the above-mentioned structures can reflect the stage and the level in earwig evolution; nevertheless, at least to a certain extent, they can evince the characteristics concerning the evolutionary ecology of Dermaptera in East Asia during the Late Jurassic.

Just like the Laiyang earwig assemblage, the Dermaptera found in Karatau also comprise two groups, the Archidermaptera and the Forficulina. The author has doubts about the taxonomical positions of *Semenoviola* Martynov, *Semenovioloidea* Vishniakova and *Turanoderma* Vishniakova, which Vishniakova (1980) classified in the Pygidicranidae. These three genera possess distinct longitudinal veins on elytra, very prominent ovipositor, elongated second antennal segment nearly as long as the third, and dentate mandibles which are closely similar to those of Protodiplatidae within the Archidermaptera. The author tends to believe that they could represent some other radiating line in the Late Jurassic, and thus represent a separate family Semenoviolidae which is the most primeval group within the Forficulina ever known so far.

To sum up, it is possible to reach the following conclusion: Protodiplatidae and Longiceriatidae are known primitive groups of Dermaptera from the Late Mesozoic of Middle and East Asia. Both have many different but very primeval characteristics, and therefore



they were approximately in the same stage and at the same level in earwig phylogeny. Hence, the strata yielding these fossil dermapterans should be roughly the same in geological age. As the sediments in Karatau have been regarded as of the Late Jurassic, the Laiyang Formation is of Late Jurassic rather than Early Cretaceous, and it is an important geological age in the evolution of earwigs, due to the coexistence of two major groups, the primitive Archidermaptera and the more advanced Forficulina. The Dermaptera might have originated in the Early Mesozoic time.

## 图版说明

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### 图版 I

1. *Longicerciata mesozoica* gen. et sp. nov.

虫体腹面保存,×9.7, Holotype, 登记号:L89201, 山东莱阳南李格庄村, 上侏罗统莱阳组。

2. *Longicerciata rumpens* gen. et sp. nov.

虫体背面保存,×9.3, Holotype, 登记号:L89202, 山东莱阳南李格庄村, 上侏罗统莱阳组。

3. *Archaeosoma serratum* gen. et sp. nov.

虫体背面保存,×2.5, Holotype, 登记号:L89203, 山东莱阳南李格庄村, 上侏罗统莱阳组。

