

# 内蒙古中生代锹甲化石 (鞘翅目: 金龟子总科: 锹甲科)\*

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**摘要** 文中记述内蒙古赤峰地区中生代锹甲化石 2 新属 4 新种。道虎沟中侏罗统的 *Juraesalus atavus* gen. et sp. nov. 是最古老的金龟总科化石。其余 3 种, *Sinaesalus longipes* gen. et sp. nov., *S. curvipes* gen. et sp. nov. 和 *S. tenuipes* gen. et sp. nov., 皆产自杨树湾子地区下白垩统义县组。这是锹甲化石在中国的首次报道, 也是斑锹亚科的最古老记录。

**关键词** 鞘翅目 锹甲科 斑锹亚科 化石 中生代 中国

## STAG BEETLES FROM THE MESOZOIC OF INNER MONGOLIA, CHINA (SCARABAEOIDEA; LUCANIDAE)

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**Abstract** Two new genera and four new species of Aesalini (Coleoptera: Scarabaeoidea; Lucanidae; Aesalinae) are described from the Mesozoic of Chifeng, Inner Mongolia. *Juraesalus atavus* gen. et sp. nov. from the Middle Jurassic of Daohugou is amongst the oldest records of Scarabaeoidea. *Sinaesalus longipes* gen. et sp. nov., *S. curvipes* gen. et sp. nov. and *S. tenuipes* gen. et sp. nov. are from the Lower Cretaceous Yixian Formation of Yangshuwanzhi. These discoveries represent not only the first fossil Lucanidae from China, but also the oldest record of subfamily Aesalinae.

**Key words** Coleoptera, Lucanidae, Aesalinae, fossils, Mesozoic, China

### 1 INTRODUCTION

The family Lucanidae (Coleoptera: Scarabae-

oidea), commonly called stag beetles, is well-known for the large and distinctive mandibles of their males. Lucanidae has long been considered one of the most primitive groups in the Scarabae-

oidea (Lawrence and Newton, 1995), and its early fossil record is a key to revealing Scarabaeoid early radiation. Aesalinae is a small subfamily of Lucanidae, comprising about 70 species in 2 or 3 tribes (Howden and Lawrence, 1974; Smith, 2006; Huang *et al.*, 2009). Until now, only one fossil species of Aesalinae had been described from the Upper Cretaceous of Kazakhstan (Nikolajev, 1993, 2007; Krell, 2007). Here, we describe five well-preserved specimens of Aesalinae from the Mesozoic of Inner Mongolia. These discoveries represent not only the first fossil Lucanidae from China, but also include the oldest record of the subfamily Aesalinae so far reported.

## 2 MATERIAL AND METHODS

All five specimens are from Ningcheng County, Chifeng City, Inner Mongolia, one (NIGPAS 152456) from the Middle Jurassic of Daohugou Village, the other four are all from the Lower Cretaceous Yixian Formation of Yangshuwanzhi Village. They are preserved as impressions on the surface of grey or yellow silty mudstone. The specimens were examined dry and under alcohol, using a Nikon SMZ1000 stereomicroscope (Nikon Corporation, Tokyo, Japan). Photographs were prepared using a digital camera (DXM1200) connected to the same microscope, and line drawings were readjusted on photographs using image-editing software (Adobe Photoshop CS). All fossils are deposited in the collections of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIGPAS).

## 3 SYSTEMATIC PALAEOLOGY

### Superfamily Scarabaeoidea Latreille, 1802

### Family Lucanidae Latreille, 1804

### Subfamily Aesalinae MacLeay, 1819

### Tribe Aesalini MacLeay, 1819

Key to genera of Mesozoic Aesalini

1. Body small (about 9.5 mm), elongate; mesofemur wide; first metatarsomere approximately as

- long as second tarsomere .....  
 ..... *Juraesalus* gen. nov.  
 Body larger (about 10–16 mm), ovoid; mesofemur slender; first metatarsomere longer than second  
 ..... 2  
 2. Eye partially divided by canthus; first mesotarsomere shorter than combined length of second and third tarsomeres ..... *Cretaesalus* Nikolajev, 1993  
 Eye without canthus; first mesotarsomere longer than combined length of second and third tarsomeres ..... *Sinaesalus* gen. nov.

### Genus *Juraesalus* gen. nov.

**Type species** *Juraesalus atavus* gen. et sp. nov.; here designated.

**Type locality and horizon** Middle Jurassic; Daohugou Village, Ningcheng County, Chifeng City, Inner Mongolia, China.

**Etymology** The generic name is after the geological period “Jurassic”, and generic name *Aesalus* (the type genus of this subfamily). Gender: masculine.

**Diagnosis** Body elongate, large, about 9 mm long. Eyes without canthus. Mandibles short. Antennae non-geniculate. Winged. Mesocoxae moderately separated. Protibia with 2 or 3 large denticles on the outer margin. Meso- and metatibia with numerous denticles on the outer margin. Meso- and metatarsi nearly as long as meso- and metatibia respectively. First metatarsomere almost as long as second tarsomere. Abdomen with five visible ventrites; first four ventrites subequal in length.

**Remarks** This fossil is attributed to the tribe Aesalini because of the following characters: antennae with 3-segmented non-lamellate club, mandibles produced beyond apex of clypeus, eyes not divided by canthus, and abdomen with 5 visible sternites. Differences between this genus and others are given in the key above.

### *Juraesalus atavus* gen. et sp. nov.

(Text-figs. 1-A, 2-A)

**Etymology** Specific epithet from Latin *atavus*, meaning primitive.

**Holotype** NIGPAS 152456.

**Diagnosis** As for the genus, by monotypy.

**Description** Body length 9.5 mm. Pronotum transverse, about 1.7 times as wide as long; widest

near the base, subparallel in basal part, distinctly narrowing anteriorly; lateral margin arcuate. Elytron about 2.4 times as long as wide. Abdomen about 1.9 times as long as wide. Protibia with two large denticles on the outer margin. Meso- and metatibia with numerous denticles on the outer margin.

**Measurements** (mm) Body length 9.5 (from mandibular apex to pygidial apex); head width 2.0; pronotum width 3.5; elytron length at least 6.2, width 2.57; profemur width 0.57; protibia length at least 0.89; mesofemur width 0.8; mesotibia length 1.2, apical width 0.38; mesotarsus length 1.24; metafemur width 0.82; metatibia length 1.18, apical width 0.27; length of metatarsus 1.61; length of its tarsomeres 0.26 : 0.24 : 0.18 : 0.17 : 0.76 (with claws); length of abdominal sternites at midline (from I to V) 0.52 : 0.52 : 0.46 : 0.43 : 0.68.

### Genus *Sinaesalus* gen. nov.

**Type species** *Sinaesalus tenuipes* gen. et. sp. nov., here designated.

**Type locality and horizon** Lower Cretaceous Yixian Formation; Yangshuwanzi Village, Ningcheng County, Chifeng City, Inner Mongolia, China.

**Etymology** The genetic name is from Latin *Sino*, meaning Chinese, and generic name *Aesalus* (the type genus of this subfamily). Gender: masculine.

**Diagnosis** Body large, about 10–16 mm. Eyes without canthus. Mandibles short. Antennae non-geniculate. Scutellum about as long as wide. Winged. Mesocoxae narrowly separated. Protibia with four or five large denticles on the outer margin. Mesotarsus longer than mesotibia; metatarsus almost as long as metatibia. First mesotarsomere longer than combined length of second and third tarsomeres. First metatarsomere approximately as long as second-fourth tarsomeres combined. Abdomen with five visible ventrites; first four ventrites subequal in length.

**Included species** Three species described below.

**Remarks** The genus is attributed to Lucanidae because of its prominent mandibles and abdomen with five ventrites. It can be assigned to Aesalini in having short mandibles in both sexes, in the presence of an intercoxal process of the presternum, and narrowly separated mesocoxae.

### *Sinaesalus tenuipes* gen. et sp. nov.

(Text-figs. 1-B, C, 2-B, C)

**Etymology** Specific epithet from Latin *tenuipes*, referring to the slender tibiae of all legs.

**Holotype** NIGPAS 152457, male, an almost complete beetle with extruded genitalia.

**Allotype** NIGPAS 152458, female, an almost complete beetle with extruded genitalia.

**Diagnosis** Distinct from other members of the new genus in its somewhat smaller body and the slender tibiae of all its legs.

**Description** Body small, elongate. Pronotum transverse, about 1.9 times as wide as long; widest near the base, subparallel in basal part, distinctly narrowing anteriorly; lateral margin slightly serrate. Scutellum about as long as wide. Elytron about 2.2 times as long as width, without striae. Abdomen about 1.8 times as wide as long. Protibia with four large denticles on the outer margin. Meso- and metatibia with one denticle at outer distal apex.

**Measurements** (mm) Holotype NIGPAS 152457; body length 11.6 (including mandibles and apex of fifth ventrites); head width 2.0; pronotum width 4.9; elytron length at least 7.4, width 3.6; profemur width 0.9; protibia length 2.4; mesofemur width 0.9; mesotibia length 2.4, apical width 0.58; mesotarsus length 2.6, tarsomere lengths 0.73 : 0.29 : 0.29 : 0.36 : 1.1 (with claw); metafemur width 1.0; metatibia length 2.9, apical width 0.51; metatarsus length 2.9, apical width 0.58, tarsomere lengths 1.02 : 0.4 : 0.4 : 0.33 : 1.02 (with claws); length of abdominal sternites at midline (from I to V) 0.55 : 0.55 : 0.51 : 0.47 : 0.73.

Allotype NIGPAS 152458; body length 10.5 (including mandibles and apex of fifth ventrites); head width 2.1; pronotum width 3.9; elytron length at least 6.9, width 2.9; profemur width 0.9; protibia length 1.9; mesofemur width 0.8; mesotibia length 1.8, apical width 0.54; length of first mesotarsomere 0.76; metafemur width 0.9; metatibia length 2.7, apical width 0.6; length of all abdominal sternites combined = 2.18.

**Remarks** The similar proportion and structures of the pronotum of these two specimens suggests they belong to one species. Their slight differences probably

reflect the sexual dimorphism like that in extant Aesalini (e. g. Araya *et al.*, 1998). Therefore specimen NIGPAS 152458 is treated as the allotype of this species.

***Sinaesalus longipes* gen. et sp. nov.**

(Text-figs. 1-D, 2-D)

**Etymology** Specific epithet from Latin *longipes*, referring to the long tibiae of all the legs.

**Holotype** NIGPAS 152459a, b, Part and Counterpart, male, an almost complete beetle.

**Diagnosis** Differs from the type species in having a somewhat larger body.

**Description** Body large, elongate. Pronotum transverse, about 1.8 times as wide as long, widest near the middle, distinctly narrowing anteriorly, lateral margin arcuate, slightly serrate. Scutellum about as long as wide. Elytron about 2.1 times as long as width, without striae. Abdomen about 1.6 times as wide as long. Protibia with four large denticles on outer margin. Mesotibia with one denticle at outer distal apex. Metatibia with several small denticles on outer margin and one large denticle at outer distal end.

**Measurements** (mm) Body length 15.0 (including mandibles and apex of pygidium); head width 2.9; median length of pronotum 3.5, width 6.3; elytron length at least 9.3, width 4.4; profemur width 1.3; protibia length 3.3; mesofemur width 1.1; mesotibia length 3.3, apical width 0.88; mesotarsus length 4.0, tarsomere lengths 1.25 : 0.44 : 0.36 : 0.36 : 1.76 (with claw); metafemur width 1.39; metatibia length 3.9, apical width 1.0; length of metatarsus 4.4, tarsomere lengths 1.32 : 0.44 : 0.36 : 0.36 : 1.69 (with claws); length of abdominal sternites at midline (from I to V) 0.88 : 0.73 : 0.73 : 0.73 : 1.1.

***Sinaesalus curvipes* gen. et sp. nov.**

(Text-figs. 1-E, 2-E)

**Etymology** Specific epithet from Latin *curvipes*, referring the incurvate tibiae of all legs.

**Holotype** NIGPAS 152460, Part and Counterpart, male, a beetle lacking most portions of its tarsomeres.

**Diagnosis** Distinguished from all other species of the genus by its large body, incurved tibiae of all the

legs (male), pronotum widest near its basal part and gradually narrowing anteriorly, and protibia with five large denticles on the outer margin.

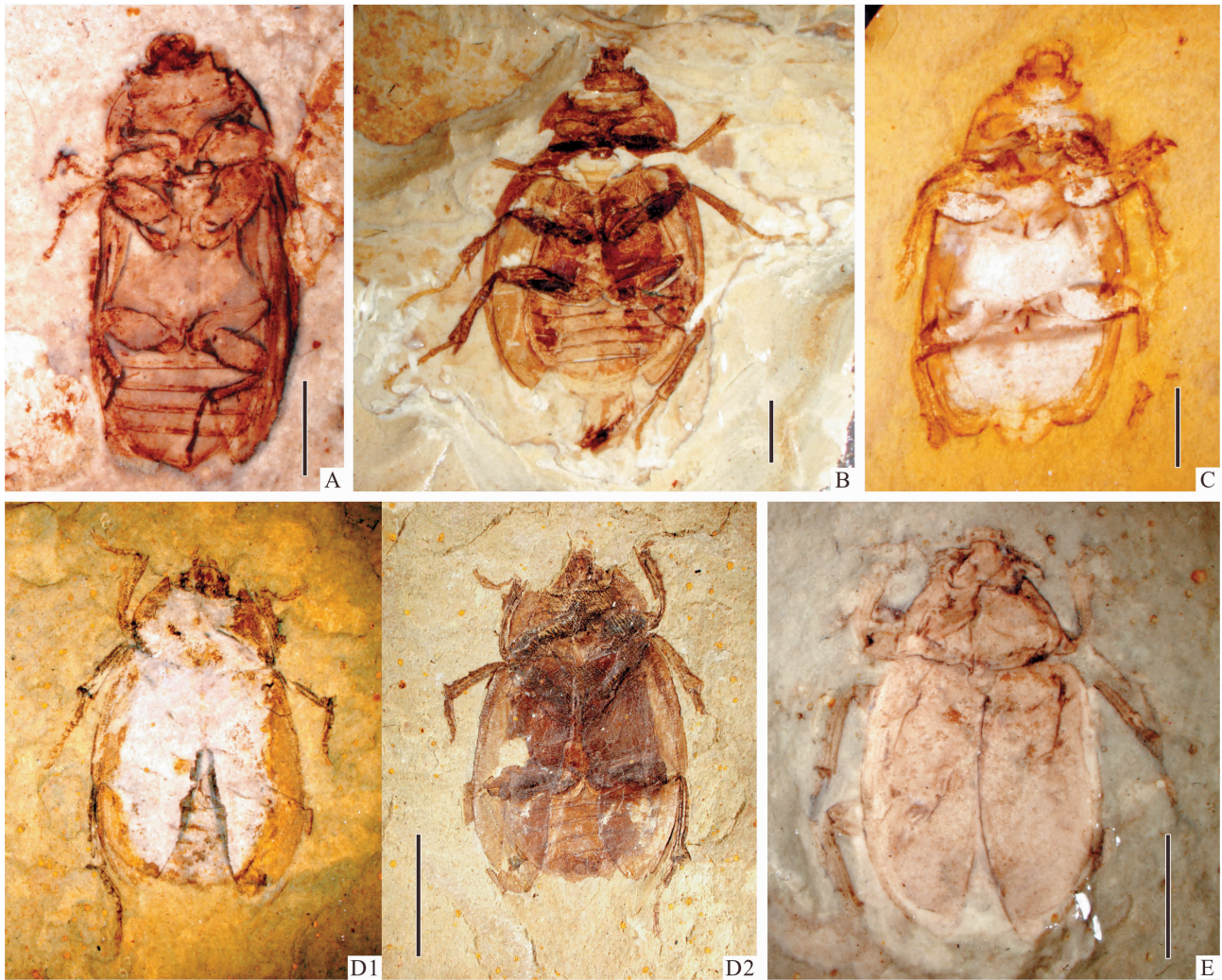
**Description** Body large, elongate, elliptical in dorsal view. Pronotum transverse, about twice as wide as long, widest near the base and gradually narrowing anteriorly, lateral margin slightly serrate. Scutellum about as long as wide. Elytron about 2.3 times as long as width, without striae. Abdomen about 1.7 times as wide as long. Protibia bent to the inside in the distal apex, with five large denticles on outer margin. Mesotibia with small denticles on outer margin and with one large denticle at outer distal apex.

**Measurements** (mm) Body length 16.1 (including mandibles and apex of pygidium); head width 3.0; median length of pronotum 3.3, width 6.6; elytron length at least 11.3, width 4.9; profemur width 1.3; protibia length 3.5; mesofemur width 1.3; mesotibia length 3.9, apical width 1.0; metafemur width 1.8; metatibia length 4.0, apical width 0.9; length of abdominal sternites at midline (from I to V) 0.9 : 0.8 : 0.9 : 0.8 : 0.9.

#### 4 DISCUSSION

*Juraesalus atavus* gen. et sp. nov. from the Middle Jurassic of Daohugou is one of the oldest records of Scarabaeoidea (see a summary in Nikolajev, 2007). The fossil indicates that diversification of the Scarabaeoidea had already taken place at least by the Middle Jurassic, earlier than previously thought (Krell, 2006). Based on a phylogenetic hypothesis of extant Aesalini, Araya (2004) suggested that the tribe was composed of two major lineages: one northern and one southern, each of which consists of two or three major clades. The Cretaceous Aesalini exhibit some ancestral (plesiomorphic) characters and are distinctly different from both of these Recent lineages (Table I). Thus, these Cretaceous fossils should be considered as a stem group.

Extant Lucanidae are usually associated with decaying wood and logs in coniferous and deciduous forest habitats (Ratcliffe, 2002). Considering the rarity of Angiosperms during Jurassic and

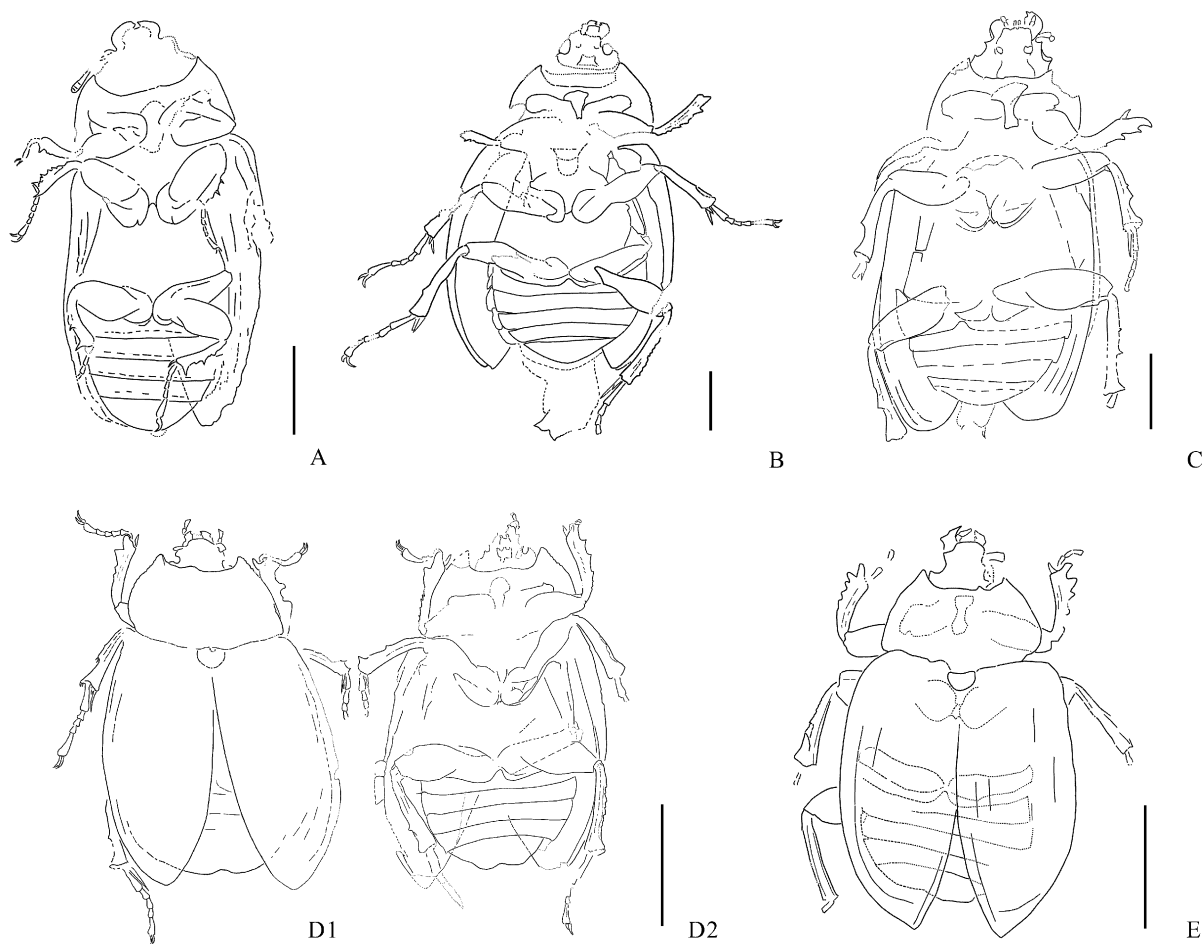


Text-figure 1 Photographs of the five specimens

A. *Juraesalus atavus* gen. et sp. nov., holotype NIGPAS 152456; B. *Sinaesalus tenuipes* gen. et sp. nov., holotype NIGPAS 152457; C. *Sinaesalus tenuipes* gen. et sp. nov., allotype NIGPAS 152458; D. *Sinaesalus longipes* gen. et sp. nov., holotype NIGPAS 152459a, b, Part (D1) and Counterpart (D2); E. *Sinaesalus curvipes* gen. et sp. nov., holotype NIGPAS 152460, Part. Scale bar 2 mm in A—C, 5 mm in D, E.

**Table I Differences between Cretaceous and Recent Aesalini**

Cretaceous Aesalini	Recent Aesalini
Body large (about 10—16 mm)	Body smaller (about 4—8 mm)
Antennae non-geniculate	Antennae partially geniculate
Scape shorter than next six segments combined	Scape as long as next six segments combined
Meso- and metatarsi almost as long as meso- and metatibia respectively	Meso- and metatarsi shorter than meso- and metatibia respectively
First mesotarsomere longer than (or as long as) second and third tarsomeres combined	First mesotarsomere shorter than combined length of second and third tarsomeres
First metatarsomere approximately as long as second-fourth tarsomeres combined	First metatarsomere shorter than combined length of second and third tarsomeres
Second to fourth abdominal ventrites are subequal in length	Second abdominal ventrite longer than third or fourth



Text-figure 2 Line drawings of the five specimens

A. *Juraesalus atavus* gen. et sp. nov., holotype NIGPAS 152456; B. *Sinaesalus tenuipes* gen. et sp. nov., holotype NIGPAS 152457; C. *Sinaesalus tenuipes* gen. et sp. nov., allotype NIGPAS 152458; D. *Sinaesalus longipes* gen. et sp. nov., holotype NIGPAS 152459a, b, Part (D1) and Counterpart (D2); E. *Sinaesalus curvipes* gen. et sp. nov., holotype NIGPAS 152460, Part. Scale bar 2 mm in A—C, 5 mm in D, E.

Early Cretaceous times, the early Lucanidae most probably fed on decaying coniferous wood.

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