

Taxonomic review of the genus *Aesalus* (Coleoptera: Lucanidae) in the Himalayas

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Abstract. The genus *Aesalus* F., 1801 of the family Lucanidae in the Himalayas is reviewed, and a new species, *A. saburoi* sp. n., is described from Central Nepal. This new species has been confused with *A. himalayicus* Kurosawa 1985, but differs from the latter mainly by a darker and broader body, and by different shapes of the intercoxal process of the prosternum and of male genitalia. The male of *A. himalayicus* sensu stricto is described for the first time and the male genitalia are illustrated. A key to the members of the genus *Aesalus* from the Himalayas is provided.

INTRODUCTION

Aesalus himalayicus was described by Kurosawa (1985) as the only member of the genus *Aesalus* F., 1801 from the Himalayas on the basis of four female specimens collected in Nepal. In 1993, one of the authors (KA) examined all of the available specimens, including the type series deposited as *A. himalayicus* in the Department of Zoology, National Science Museum, Tokyo, and found that one damaged specimen, referred to as a female in the original description of the species, is instead a male (Araya et al., 1993). Araya (1995) redescribed this specimen as the male of *A. himalayicus*. This unique male was collected from Mt. Machhapuchhale in Central Nepal (Fig. 19-1) and differs from the females (including the holotype) of *A. himalayicus* collected from Singarila Ridge in Eastern Nepal (Fig. 19-3,4) in several external characters such as coloration and body width. However, based on the available information at the time, Araya (1995) considered these differences as sexual dimorphism or geographical variation.

Recently, we were able to examine additional material of *Aesalus* from the Himalayas: Two males collected in Langtang (Central Nepal) (Fig. 19-2), and the remainder (males and females) in Sikkim (Northeast India) (Fig. 19-5). In careful comparisons of these and NSMT specimens, we found that the external characters of the male from Mt. Machhapuchhale were shared by the two males from Langtang, whereas the characters of both sexes from Sikkim were almost identical to those of the female types of *A. himalayicus* from Singarila Ridge. The genital organs of the males from Central Nepal (Mt. Machhapuchhale and Langtang) and Sikkim resemble each other, but differ in several characters such as the shape of the phallus and the length of the parameres. Therefore it is our opinion that the specimens from Sikkim represent the "true" *A. himalayicus*, while those from Central Nepal should be treated as a separate species which is described herein. We also

describe the male of *A. himalayicus* (sensu stricto), with illustrations of the male genitalia for the first time, on the basis of the specimens from Sikkim.

MATERIAL AND METHODS

A total of 13 specimens of Himalayan *Aesalus* were examined, preserved in the following collections: Muséum National d'Histoire Naturelle, Paris (MNHN); National Science Museum (Natural History), Tokyo (NSMT); Museum of Nature and Human Activities, Hyogo (MNHH); private collections of M. Tanaka (MTPC) and H.G. Bomans (HGBC).

For the morphometric analysis, 11 body measurements were taken. These are: PEL – pronotum-elytra length; BT – body thickness; HL – head length from apex to ridge behind eyes; HW – head width at widest part including eyes; PL – pronotum length; PW – pronotum width at widest part; EL – elytra length measured along the mid-line; EW – elytra width at widest part; PTL – protibia length; PTW – protibia width; CHW – head width measured between the tip of each canthus. All measurements are in mm, and all except CHW were used in Araya et al. (1993). Genital organs were treated with a weak solution of potassium hydroxide and preserved in 70% ethanol. The terminology for the description of the genital organs follows Araya et al. (1993).

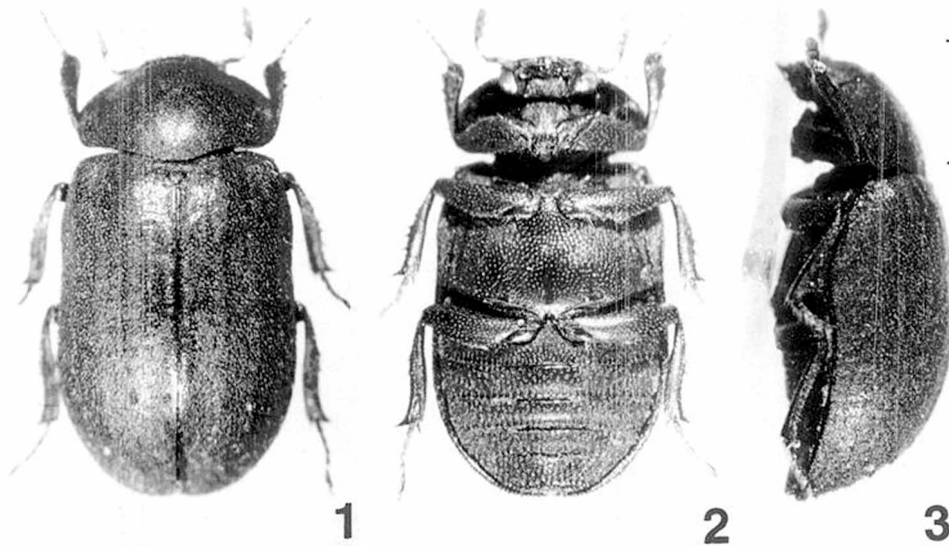
SYSTEMATICS

Aesalus saburoi Araya, Tanaka & Bartolozzi, sp. n.

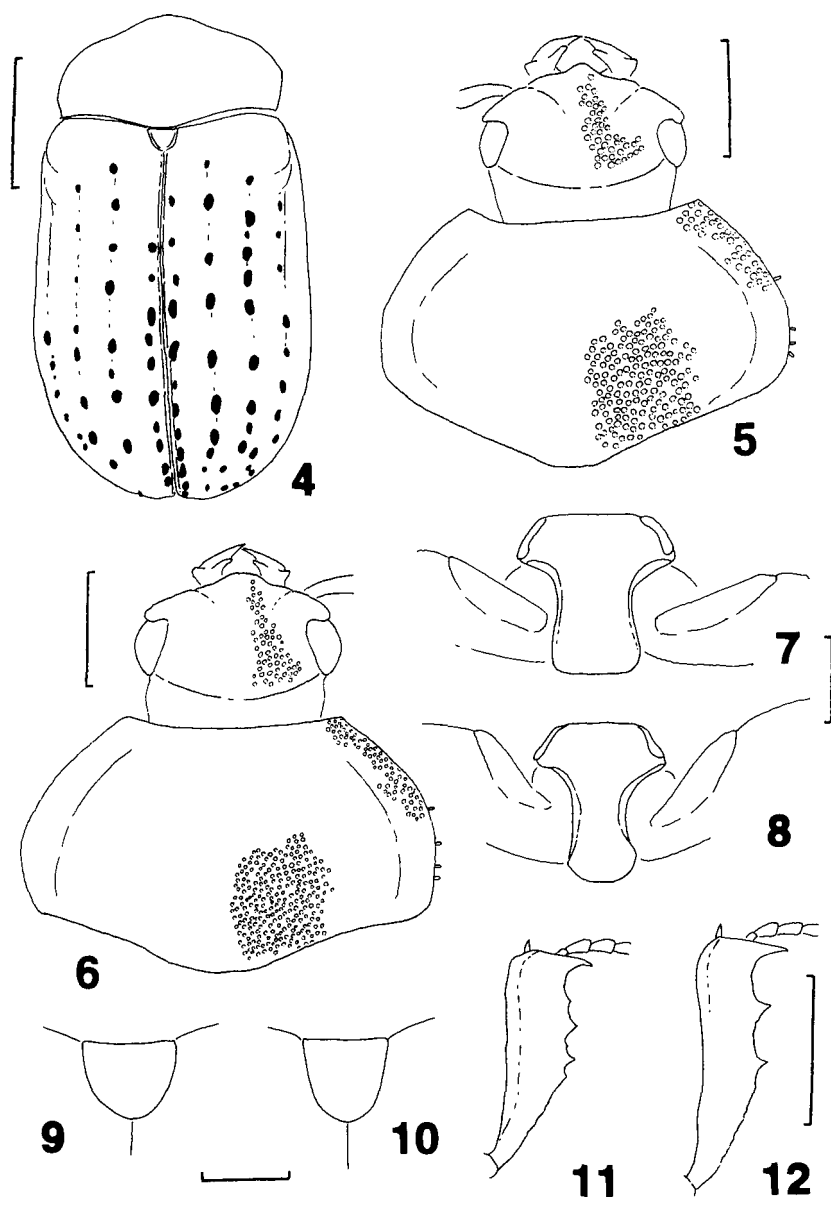
Aesalus himalayicus Kurosawa, 1985: 49 (in part); Araya, 1995: 366 (in part, Figs 12–16).

DESCRIPTION OF MALE. A large-sized *Aesalus*. Body (Figs 1–4) outline elliptical in dorsal view, half-elliptical in lateral view. Body opaque and dark greyish brown; dorsal surface shallowly punctated, largely covered with scale-like black bristles partly forming small clumps but without whitish-golden tomentum.

Head (Fig. 5) with a sharp projection at the anterior margin of clypeus. Eye relatively large, with distinct canthus covering about 1/3 of its external margin. Mandible with sharp apical tooth and smaller subapical tooth on dorsal side; apical tooth of left mandible not



Figs 1–3: *Aesalus saburoi* sp. n., male, holotype. 1 – dorsal view; 2 – ventral view; 3 – lateral view. Scale: 2.0 mm.



Figs 4-12: *Aesalus* spp., males. 4 - dorsal body outline with elytral ornaments; 5, 6 - head and pronotum; 7, 8 - intercoxal process of prosternum; 9, 10 - scutellum; 11, 12 - right front tibia. 4, 5, 7, 9, 11 - *A. saburoi* sp. n.; 6, 8, 10, 12 - *A. himalayicus*. Scales: 4 - 2.0 mm; 5, 6, 11, 12 - 1.0 mm; 7-10 - 0.5 mm.

forked; without mola and brushy setae. Mentum with well-defined punctures, each bearing short yellow-grey seta; some of punctures connected, forming irregular sulcus. Antenna with 10 antennomeres, geniculate between scape and pedicel; scape moderately curved, with a few long setae; pedicel subconical, about 1.5 times as long as wide; antennomere 3 slender, about three times as long as wide; antennomere 4 as long as wide; antennomere 5 transverse; antennomeres 6 and 7 very short and somewhat acutely projected laterally; antennomeres 8 to 10 forming a wholly pubescent club, weakly lamellate, antennomeres 8 and 9 transverse, antennomere 10 approximately as long as wide.

Pronotum (Fig. 5) about three-fifths as long as wide, widest near the middle; dorsal surface shallowly punctated, with short, sparsely arranged scale-like bristles not forming clumps. Scutellum (Fig. 10) about as long as wide. Elytra about 1.4 times as long as combined width, densely punctated, without striae but with sparse small black clumps of short scale-like bristles; each shoulder with a protuberance. Macropterous.

Intercoxal process of prosternum (Fig. 7) large, relatively flat, expanding anteriorly, with isodiametric and well-defined punctures, each bearing short yellow-grey hair; both anterior and posterior margin straight; posterior reaching metasternum. Metasternum with fine punctures each bearing yellow-grey hair. Metepisternum with shallow sulcus for receiving middle leg. Mesocoxae separated. Intercoxal process of hind legs forming sharp regular triangle produced anteriorly. Abdomen about five-sixths as long as wide; five abdominal sterna visible, each with isodiametric to elongate foveae bearing minute setae.

Protibia (Fig. 11) relatively shorter and widened in distal portion, with fine punctures bearing minute setae; outer margin with several denticles; a large denticle at distal end curved and hook-shaped. Profemur with punctures bearing minute setae. Middle and hind legs with fine punctures bearing semierect pilosity; meso- and metatibia with small denticles on outer margin, with one large denticle at outer distal end, and one sharp spine at inner distal end.

Variation in external morphology. Morphometric data and standard ratios in external morphology are summarized and compared with *A. himalayicus* in Tables 1 and 2.

TABLE 1. Morphometric characters (in mm) (ranges, followed by mean in parentheses) of *Aesalus himalayicus* and *A. saburoi* sp. n. See Material and methods for abbreviations.

	<i>A. himalayicus</i> male (n = 3)	<i>A. himalayicus</i> female (n = 6)	<i>A. saburoi</i> sp. n. male (n = 3)
PEL	6.30–7.08 (6.76)	7.00–7.62 (7.30)	5.94–6.84 (6.50)
BT	2.61–3.00 (2.77)	3.06–3.30 (3.16)	2.58–3.00 (2.76)
HL	1.00–1.08 (1.04)	1.10–1.22 (1.16)	1.10–1.15 (1.12)
HW	1.46–1.60 (1.54)	1.62–1.67 (1.64)	1.51–1.64 (1.59)
PL	1.78–1.97 (1.90)	1.97–2.09 (2.02)	1.76–2.09 (1.97)
PW	3.08–3.28 (3.20)	3.32–3.41 (3.36)	3.04–3.36 (3.24)
EL	5.01–5.34 (5.21)	5.70–6.00 (5.86)	4.80–5.52 (5.24)
EW	3.60–3.78 (3.66)	3.84–4.26 (4.00)	3.42–3.90 (3.69)
FTL	1.46–1.51 (1.49)	1.62–1.69 (1.65)	1.41–1.51 (1.47)
FTW	0.29–0.33 (0.31)	0.35–0.38 (0.36)	0.32–0.36 (0.34)

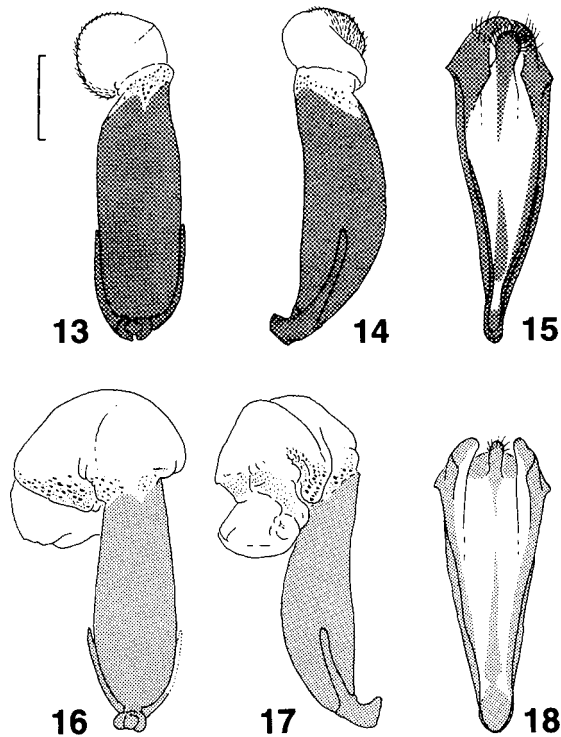
TABLE 2. Standard ratios between body measurements (ranges, followed by mean in parentheses) of *Aesalus himalayicus* and *A. saburoi* sp. n. See Material and methods for abbreviations.

	<i>A. himalayicus</i> male (n = 3)	<i>A. himalayicus</i> female (n = 6)	<i>A. saburoi</i> sp. n. male (n = 3)
EW/PEL	0.51–0.57 (0.54)	0.52–0.56 (0.55)	0.56–0.58 (0.57)
BT/PEL	0.38–0.43 (0.41)	0.42–0.44 (0.43)	0.42–0.43 (0.43)
CHW/HW*	0.90–0.92 (0.91)	0.80–0.90 (0.84)	0.95–0.98 (0.97)
FTW/FTL	0.20–0.22 (0.21)	0.21–0.22 (0.22)	0.22–0.24 (0.23)

*Significantly different between males and females of *A. himalayicus* (Mann-Whitney's U-test, $p < 0.05$)

MALE GENITALIA. Aedeagus (Figs 13–14) well sclerotized, dark-brown, with very short basal piece fused to both parameres and phallus; phallus banana-shaped, narrowing distally, distal part asymmetrical, with a notch in the middle of ventral side; paired struts absent; paramere slender, about 0.38–0.42 times as long as phallus and closely appressed to it. Internal sac well developed, with a few large globes, with dense minute hairs on dorsal side. Abdominal segment 9 (Fig. 15) with setae on ventral side; hairy, sclerotized part in the middle relatively large, widened in distal portion.

FEMALE. Unknown.



Figs 13–18: Male genital organs of *Aesalus* spp. 13, 16 – aedeagus, ventral view; 14, 17 – ditto, lateral view; 15, 18 – ninth abdominal segment. 13–15 – *A. saburoi* sp. n.; 16–18 – *A. himalayicus*. Scale: 13–18 – 0.5 mm.

TYPE MATERIAL. Holotype ♂, "Rain Forest (2300–2800 m in alt.), Langtang, Central Nepal, V-VI-1990, S. Bily leg" (MNHH). Paratypes 1 ♂, "Deorali, 3000 m-Kuldi 2800 m in alt., nr. basecamp of Mt. Machhapuchhale, Central Nepal, 21-X-1981, M. Sakai leg." (NSMT); 1 ♂, same data as holotype (MTPC).

DISTRIBUTION. Known from Central Nepal (Langtang National Park and Mt. Machhapuchhale), 2,300–3,000 m in altitude.

ETYMOLOGY. The new species is dedicated to Mr. Saburo Tanaka, father of the second author.

NOTES. This new species and *A. himalayicus* share the same character states in almost all characters examined and should form a special species group (i.e. *A. himalayicus* species group) in the genus *Aesalus*. This species group is defined by characteristics such as large eyes and banana-shaped phallus with a notch on the distal part, which are shared by no other members of the tribe Aesalini and appear to be the synapomorphies of this species group, though a phylogenetic analysis would be necessary to confirm this.

Further field surveys may bridge the gap between the known localities of this species in Central Nepal.

Aesalus himalayicus Kurosawa, 1985

Aesalus himalayicus Kurosawa, 1985: 49, Fig. 1 (type locality: Eastern Nepal); Araya, 1995: 366, Figs 1–11, 17.

DIAGNOSIS OF MALE. Very similar to *A. saburoi*, but differs by the following external characters: Average size slightly larger; body more slender, surface glossy and light reddish-brown, punctures on dorsal surface smaller and deeper; eye (Fig. 6) much larger; canthus a little less developed covering about 2/7 of its external margin (about 1/3 in *A. himalayicus*); projection of anterior margin of head smaller and obtuse; pronotum widest near the posterior part; scutellum (Fig. 9) transverse (about as long as wide in *A. saburoi*); intercoxal process of prosternum (Fig. 8) relatively smaller and more slender, its posterior margin rounded (straight in *A. saburoi*); protibia (Fig. 12) relatively longer, less widened distally.

VARIATIONS IN EXTERNAL MORPHOLOGY. Morphometric data and standard ratios in external morphology are summarized in Tables 1 and 2. Females are larger on the average than males. The male canthus is a little more developed than that of the females. However, the standard ratios of most other body parts are not different between males and females. No sexual dimorphism was evident in the shape of mandible, projection on anterior margin of clypeus, and metatibia.

MALE GENITALIA. Aedeagus (Figs 16, 17) as in *A. saburoi*, but slightly less sclerotized and light yellow-brown; phallus gradually narrowing distally; parameres shorter, about 0.33 times as long as phallus (about 0.38–0.42 times in *A. saburoi*); internal sac with weakly-sclerotized part at base; hairy, sclerotized part in the middle of abdominal segment 9 (Fig. 18) relatively smaller and less widened in distal portion.

FEMALE GENITALIA. Female genitalia with visible styli; hemisternite well sclerotized, with long setae on posterior end.

TYPE MATERIAL EXAMINED. 3 ♀ (holotype and two paratypes), "Kalapokhri, 3000 m in alt., Singalila Dara, E. Nepal, 2-X-1983, Y. Nishikawa leg." (NSMT).

ADDITIONAL MATERIAL EXAMINED. 1 ♀, "Thakham, 3350 m in alt., Singarila Ridge, West Bengal, India, 4-X-1983, M. Sakai leg." (NSMT); 3 ♂, "Sikkim de Padamtsin a Lingtoug, Juillet 1901", ex coll. Chassot (MNHN); 1 ♂, ditto (HGBC); 1 ♂ "Padamtsin 5500 p., 28-29 VII." (MNHN); 1 ♂ "Sikkim Gnatong, Aout 1901", ex coll. Chassot (MNHN).

DISTRIBUTION. Known from Eastern Nepal and Northeast India (West Bengal and Sikkim), 3,000–3,350 m in altitude.

NOTES. We suppose that “Kalapokhri”, the type locality of this species, is a misspelling of “Kalpokhri” whose exact altitude is 3108 m. This is the first record of *A. himalayicus* from Sikkim. Singarila Ridge stretches along the borders of Eastern Nepal and Sikkim, and it is not surprising that *A. himalayicus* occurs in Sikkim, which includes eastern slopes of this mountain ridge.

In the previous study (Araya, 1995), the shape of the projection on the anterior margin of clypeus was reported as being sexually dimorphic. However, the present study reveals that this does not represent a sexual difference in *A. himalayicus*, but an interspecific difference between *A. himalayicus* and the new species.

Key to the species of the genus *Aesalus* known from the Himalayas

- 1 Body opaque, dark greyish brown; pronotum widest near the middle; scutellum about as long as wide; posterior margin of intercoxal process of prosternum straight *A. saburoi* sp. n.
- 2 Body glossy and light reddish-brown; pronotum widest near the posterior part; scutellum transverse; posterior margin of intercoxal process of prosternum rounded *A. himalayicus* Kurosawa

DISCUSSION

SYSTEMATIC POSITION OF *A. HIMALAYICUS* SPECIES GROUP. Lucanid beetles of the tribe Aesalini are known from both the Old and New World. In the Old World, some 15 species belonging to two genera have been described from the Palearctic (Europe, Caucasus and Japan) and Oriental (Himalayas, Southern China, Taiwan and Southeast Asia) regions (Benesh, 1960; Krikken, 1975; Inahara & Ratti, 1981; Kurosawa, 1985; Araya, 1993, 1995; Araya et al., 1993, 1995a, b). The Himalayas, which harbor the *A. himalayicus* species group, are latitudinally located on the borders of the Oriental and Palearctic regions, and longitudinally located on the middle of the known distributional range of the Old World Aesalini. This suggests that the *A. himalayicus* species group may occupy an important position for the understanding of the evolutionary history of the Old World Aesalini.

In the original description of *A. himalayicus*, Kurosawa (1985) considered that the discovery of this species bridges the two isolated distributional ranges of the genus *Aesalus* (East Asia and Europe) in the Palearctic region. He proposed the “true *Aesalus*” group, which consisted of the Palearctic and Taiwanese members of the genus *Aesalus* at the time, and assigned *A. himalayicus* to this group. However, he considered that *A. timidus* Krikken, 1974 from Sumatra may represent a different genus. The latter argument was accepted by Zelenka, who erected a new genus *Echinoaesalus* Zelenka, 1993 (with *E. jaechi* from Sulawesi as its type species) and placed all Southeast Asian *Aesalus*, including *A. timidus*, in this genus (Zelenka, 1993, 1994).

The *A. himalayicus* species group superficially resembles the Palearctic *Aesalus* [*A. scarabaeoides* (Panzer, 1794), *A. asiaticus* Lewis, 1883, *A. ulanowskii* Ganglbauer, 1886] because of its elongated body. However, the *A. himalayicus* species group exclusively shares the following important characters with the Southeast Asian *Echinoaesalus*: Mandible showing no sexual dimorphism (showing a distinct sexual dimorphism in the Palearctic *Aesalus*); antennomere 3 slender and long, not transverse (short and transverse in Palearctic *Aesalus*); antennal club wholly pubescent (partly pubescent in Palearctic

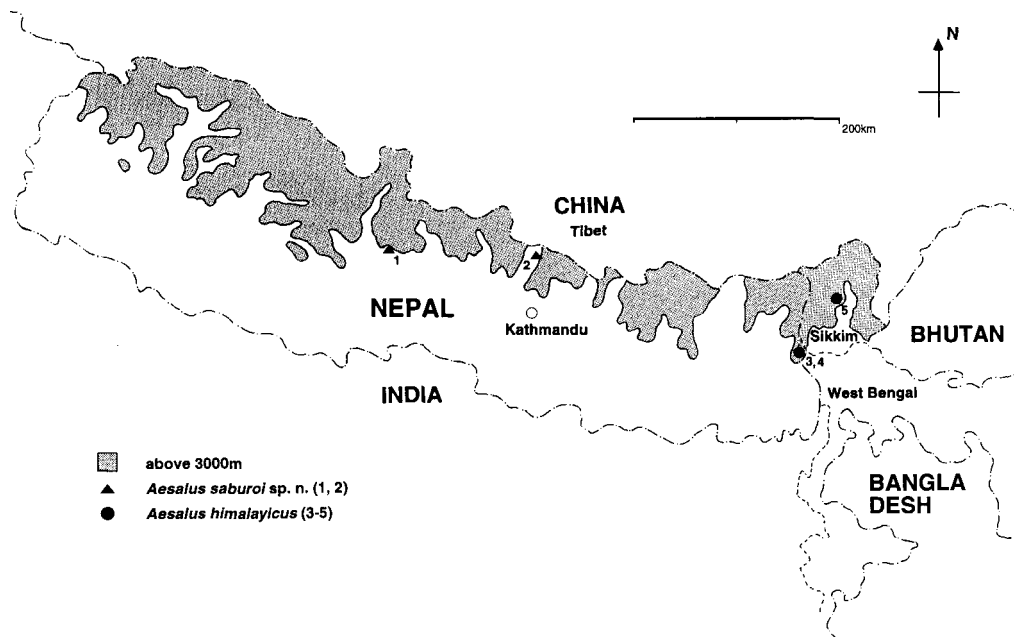


Fig. 19: Distribution of the known records of the genus *Aesalus* in the Himalayas. 1 – Basecamp of Mt. Machhapuchhale; 2 – Langtang; 3, 4 – Takham and Kalpokhari; 5 – Lingtou and its vicinities.

Aesalus); eye with distinctly developed canthus (without canthus in Palearctic *Aesalus*); intercoxal process of prosternum flat (convex in Palearctic *Aesalus*); and phallus not cylindrical or symmetrical (cylindrical and symmetrical in Palearctic *Aesalus*). Because of these numerous similarities, it is possible that the *A. himalayicus* species group plus the genus *Echinoaesalus* form a monophyletic unit, but a phylogenetic analysis of the entire tribe Aesalini would be necessary to corroborate this.

The genus *Echinoaesalus* was defined by its circular body shape (Zelenka, 1993, 1994). This character state is likely to have evolved as an adaptation against the attacks by predators such as ants, especially in tropical regions (Araya, 1995) and appears to be synapomorphic for *Echinoaesalus* (all other Aesalini have an elongated body). It is possible that the *A. himalayicus* species group, which has been isolated in the highlands of the Himalayas, represents slightly modified descendants of the speculative ancestral stock with *Echinoaesalus*. Detailed phylogenetic analyses of the tribe Aesalini, including the New World taxa, should establish the systematic position and the evolutionary history of this interesting species group. Also, such a study would contribute much to the evaluation of the currently prevailing generic classification of the tribe, in light of the phylogenetic taxonomy.

SPECIATION WITHIN *A. HIMALAYICUS* SPECIES GROUP. In the Himalayas, an unexpected high species diversity has recently been revealed for the lucanid subgenus *Pseudolucanus* Hope & Westwood, 1845 of the genus *Lucanus* Scopoli, 1763, whose habitat is similar to those of *A. himalayicus* species group, and approximately 10 allopatric species of this subgenus

have been recorded (Boucher & Huang, 1991; Boucher, 1994). Although known localities of Himalayan *Aesalus* are few, the possible distributional patterns of *A. himalayicus* and *A. saburoi* appear to correspond to those of *L. (P.) confusus* Boucher, 1994 (from Bhutan and Sikkim) and *L. (P.) atratus* Hope, 1831 (from Central Nepal), respectively. Langtang, the easternmost collection site of *A. saburoi*, is located only about 250 km north-northwest of the type locality of *A. himalayicus* (Fig. 19) on Singarila Ridge. However, the southern slope of Eastern Himalayas, including Singarila Ridge, and that of the Central Himalayas, including Langtang, are divided by several deep valleys below 1,500 m in altitude made by the Arum River and its tributaries. These valleys may have formed the barriers preventing the dispersal of Himalayan lucanids such as *Pseudolucanus* and *Aesalus*.

Alternatively, it is also possible that the speciation between *A. himalayicus* and *A. saburoi* took place as a result of habitat segregation due to the vertical vegetational zonation. Actually, all the known collection sites of *A. himalayicus* belong to the subalpine mixed conifer forest recognized above 3,000 m in altitude, while those of *A. saburoi* are limited to the upper montane broad-leaved evergreen forest or mixed conifer forest below 3,000 m sensu Chang & Chiang (1973).

Currently, both theories on speciation within the *A. himalayicus* species group are too speculative, and further investigations are needed for verifying one of them. It is also expected that future detailed faunal surveys, especially in the West Himalayas, may yield other undescribed members of the genus *Aesalus*.

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