ERNST HEISS & DAVID GRIMALDI

Archearadus burmensis gen. n., sp. n., a remarkable Mesozoic Aradidae in Burmese Amber (Heteroptera, Aradidae)

Abstract
An insect inclusion in Upper Cretaceous Burmese amber contained a well preserved flat bug, *Archearadus burmensis* gen. n., sp. n., which is described and figured. It is distinguished from all known genera of Aradidae by various characters that are discussed. A catalogue is given for Aradidae from Amber deposts described to date.

Kurzfassung
***Archearadus burmensis* gen. n., sp. n., eine bemerkenswerte mesozoische Aradidae aus burmesischem Bernstein (Heteroptera, Aradidae)**
Eine Insekteninkluse der Oberkreide von burmesischem Bernstein enthält eine gut erhaltene Rindenwanze: *Archearadus burmensis* gen. n., sp. n., die nachstehend beschrieben und abgebildet wird. Sie unterscheidet sich von allen Gattungen der Aradidae durch eine Kombination von Merkmalen, welche dargestellt werden. Ein Katalog aller bisher aus Bernsteininklusen beschriebenen Aradidae ist angeschlossen.

Authors
Dipl. Ing Dr. ERNST HEISS, Research Associate, Tiroler Landesmuseum, Josef-Schraffl-Strasse 2a, A-6020 Innsbruck, Austria. e-mail: e.heiss@tyrol.at
Dr. DAVID GRIMALDI, Curator, Division of Invertebrate Zoology, American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024-5192, USA. e-mail: grimaldi@amnh.org

Introduction

The oldest amber inclusions containing Aradidae known to date are from Baltic amber, which is of Eocene age (40-45 Ma) (WEITSCHAT & WICHARD 1998). That aradid fauna is relatively abundant and diverse and is represented by species belonging to four sub-families (Aneurinae, Aradinae, Calisiinae, Mezirinae) (USINGER 1941, POPOV 1978, HEISS 1997, 1998, 2000).
The first and so far only Mesozoic Aradidae described is *Aradus creticus* KORMILEV & POPOV (1986) from mid-Cretaceous rock (Cenomanian, Olskaya suite) in notheastern Siberia. That specimen is preserved as a positive impression and shows – as far as structures are discernible - characters typical for the genus *Aradus*, such as shape of head, antennae and hemelytral structures.
Now an inclusion with an Aradidae specimen from Upper Cretaceous Burmese amber has recently been found, representing a new genus and species and is described and figured as follows. It is the first record of an Aradidae in amber older than the Baltic, as Dominican amber is merely Miocene in age. Based on the study of other inclusions, there is evidence that the Burmese amber is definitely Upper Cretaceous, probably from the Turonian or Cenomanian (90-100 Ma) (GRIMALDI et al. 2002).
The unexpectedly well preserved Mesozoic specimen gives evidence that the basic groundplan of this family of worldwide recent distribution had developed by the Mesozoic. This remarkable fact should be considered in modern phylogenetic hypotheses and their interpretation.

Archearadus gen. n.

Type species *Archearadus burmensis* sp. n.

Etymology : From greek "archaios" meaning earliest, ancestral and referring to the country of origin.

Diagnosis
Distinguished from all extant genera of Aradidae including that of Baltic amber by a combination of characters which have never been observed together in one of the eight subfamilies of Aradidae
- clypeus very long
- rostrum arising far from apex, shorter than head
- long and converging postocular margins of head
- abdominal mediotergites III to VI separated by sutures, not fused to a tergal plate
- no metapleural scent gland openings discernible
- longitudinal furrow on sternum
- arrangement of abdominal glabrous spots 2 1 1
- lateral margins of dorsal external laterotergites with two lamellate expansions
- claws with distinct pulvilli

Description
Macropterous, small, less than 4 mm. Body with anteriorly attenuated thorax and wider ovate abdomen with dentate lateral margins.

Head Distinctly longer than wide, clypeus long and tapering towards apex, reaching 3/4 of antennal segment II. Antenniferous lobes distinct. Antennae long and slender, about 1.7 x as long as width of head. First segment shortest, III longest, II and IV of subequal length. Eyes protruding, subglobular. Posterior margin of head long and straight, constricted towards collar. Rostrum arising from an open atrium, not reaching posterior margin of head.
Thorax Pronotum trapezoidal, wider than long, lateral margins beset with strong long spines. Anterior margin slightly convex with a distinct collar and a spine laterad of the latter. Disk with two longitudinal carinae which are converging anteriorly.
Scutellum Triangular, longer than wide, lateral margins straight and carinate.
Hemelytra Base of corium wider than pronotum, lateral margins with smaller spines. Membrane not preserved.
Abdomen Ovate, lateral margins of dorsal external laterotergites (deltg) II to VII lamellate and expanded into two lobes of different size, which are increasing from deltg II - VII. Tergites II - VII separated by transverse sutures, a longitudinal sulcus marks the limit of deltg' s. Abdominal scent glands discernible medially on posterior border of mediotergites III, IV and V. Paratergites VIII of male expanded into bilobate lobes as deltg' s.
Venter Pro- meso- and metasternum with a shallow longitudinal furrow which extends on sternites II - VII. No metapleural scent gland openings visible. Spiracles not clearly discernible, their lateral position as generally present on the anterior lamellate expansion of deltg II and paratergites VIII is suspected to occur for deltg III - VII too.
Legs Long and slender, trochanters distinct, fused to fusiform femora. Tarsi two segmented, with long and thin claws, bearing distinct pulvilli.

Discussion
From the general habitus of this genus a close relationship to Oriental Aradinae (e.g. *Miraradus*) might be expected. However it stands apart from all genera known to date (*Aradus, Aradiolus, Miraradus, Quilnus*) by the presence of pulvilli, which are generally lacking in Aradinae. Most characters are shared by Carventinae, but the long clypeus and free, unfused mediotergites III - VI do not occur in this and other subfamilies.
The previously unseen combination of characters and the Mesozoic age, twice that of Baltic amber, may jusity a new subfamily (Archaearadinae). However, due to the uncertainty of spiracle position a tentative placement in Aradinae is proposed, unless further studies or new specimens reveal other affinities.

***Archearadus burmensis* sp. n.**
Plate 1 a

Holotype Male, in a piece of Burmese amber embedded in epoxide resin (16 x 7 x 5 mm), which stabilizes rare and friable amber pieces (NASCIMBENE & SILVERSTEIN 2000). Two labels are attached
(1) "Burmese Amber: / Heteroptera: / 1 Aradidae / Coleoptera: / 1 partial (large) / 1 complete (small) / Sternorrhyncha: / 1 male Coccoidea / 1 Araneae";
(2) "Amber: Myanmar (Burma) / Upper Cretaceous / Kachin: Tanai Village / (on Ledo Rd. 105 km NW Myitkyna) / coll. Leeward Capital Corp., 2000 / AMNH Bu - 167" It is designated as holotype and deposited in the American Museum of Natural History, New York.
The specimen is excellently preserved and visible on the dorsal and ventral sides. Although membranes of the hemelytra are lacking, the presence of a scutellum and the basal portion of the corium, as well as the dorsal abdominal structure, indicate that the specimen was macropterous.

Description
Head Longer than wide across eyes (33 / 28). Clypeus long, nose like, tapering towards subacute apex, beset with stiff erect bristles. Antenniferous lobes subrectangular, lateral margins parallel, stiff bristles projecting on anterolateral angles. Antennae thin and 1.68 x as long as width of head (47 / 28). Antennal segment I shortest and thickest, barrel shaped; II cylindrical, thinner on median 1/3; III longest, cylindrical with thinner portion on median 1/3; IV fusiform, subequal in length to III, apex pilose. Relative length of I / II / III / IV = 6 / 11 / 18 / 12. Eyes produced laterally. Postocular lateral margins long, nearly straight, strongly converging to constricted neck region. Details of surface not discernible, but seems to be granulate.
Pronotum Trapezoidal, wider than long (33 / 20). Lateral margins with about 4 larger spines anteriorly, followed posteriorly by 3 - 4 smaller spines. Anterior margin with 2 (1+1) distinct spines laterad of collar. Surface with two longitudinal carinae which narrow anteriorly.
Scutellum Longer than wide at base (23 / 14?), although somewhat displaced, its triangular shape is marked by the carinate lateral margins.
Hemelytra : Base of corium laterally expanded and rounded with about three blunt spines. Further structures are not clearly preserved.
Abdomen Of ovate outline. Lateral margins of deltg II - VII each with two lamellate expansions, the anterior one bilobate (most likely bearing the spiracles ?)with acute posterior projection, the posterior one larger, directed posterolaterally, its apex rounded. Deltg I is visible as a triangular sclerite anterior to deltg II. Paratergites VIII likewise bilobate as anterior expansion of deltg II - VII, separated from deltg VII by a deep incision. Details of pygophore not discernible. All tergites separated by transverse sutures, deltg' s (connexivum) marked by a longitudinal sulcus.

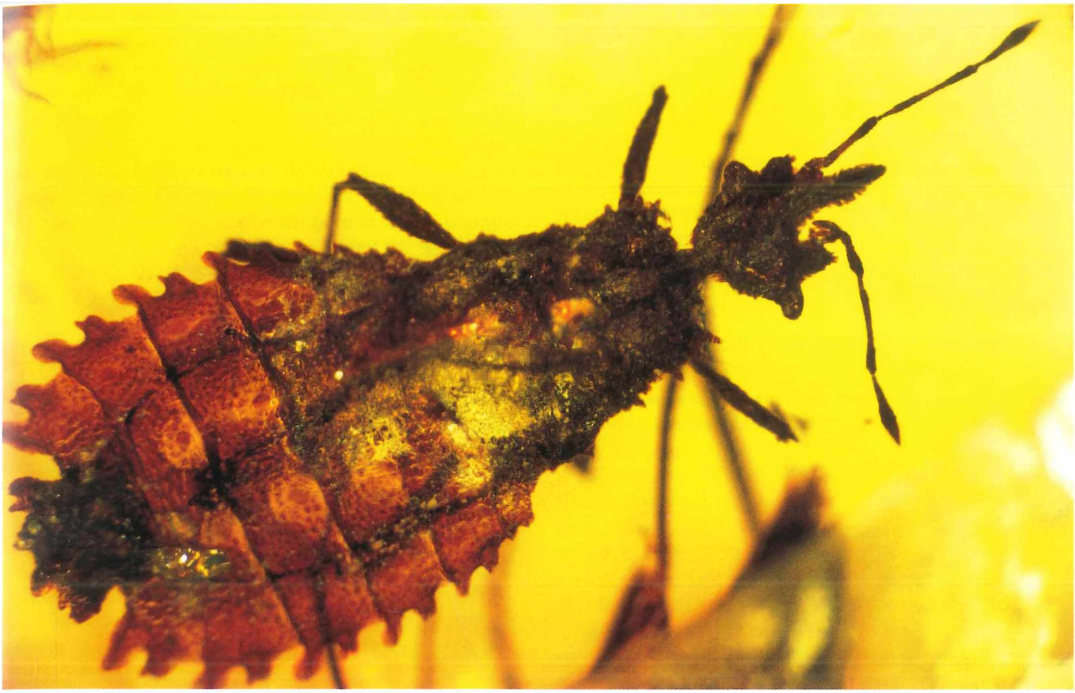

Plate 1. a) *Archearadus burmensis* gen. n., sp.. n. dorsal view.

Plate 1. b) *Archearadus burmensis* gen. n., sp.. n. ventral view.

Venter : Sternum flat with a median shallow longitudinal furrow that extends to sternite VII. Posterior margin of sternite VII slightly convex medially. Visible part of pygophore wider than long (20 / 8).
Legs Long and slender, femora fusiform and beset with short stiff bristles. Apex of tibiae with acute spines, tarsi with long claws and distinct pulvilli.
Measurements Length 3.85 mm; total length of antennae 1.17 mm; width of abdomen across lateral expansions of deltg II 1.32 mm; III 1.57 mm; IV 1.77 mm; V 1.76 mm; VI 1.57 mm; VII 1.30 mm (anterior), 1.10 mm (posterior); paratergite VIII 0.62 mm.

Catalogue of Aradidae described to date from amber and copal inclusions

Amber occurs in deposits throughout the world. They are of different origin and age, not all containing biological inclusions. Species of the flat bug family Aradidae have been described to date from Mesozoic (Burmese Amber–Upper Cretaceous), Cenozoic (Baltic Amber– Eocene/Oligocene), Dominican Amber–Oligocene/Miocene) Era deposits as well as of younger subfossil resin deposits in Madagascar, called Copal (Pleistocene).

Family Aradidae BRULLÉ, 1836

Subfamily Aneurinae DOUGLAS & SCOTT, 1865

Aneurus (subg.?) *ancestralis* HEISS, 1997: 111, fig.1, tab. 1(Baltic Amber)

Holotype male, coll. E.HEISS, Innsbruck, Austria, He-An-1
Allotype female descr. HEISS 2001a: 15, fig. 2, 5, Photo 2, coll. E. HEISS, He-An-2

Aneurus (Aneurodes) groehni HEISS, 2001a: 16, fig. 3, 6 (Baltic Amber)

Holotype male, coll. C. GROEHN, Hamburg, Germany (later deposited in coll. Geolog.-Paläontol. Institute, University of Hamburg), No. 2259

Aneurus (Neaneurosoma) kotashevichi HEISS, 2001a: 13, fig. 1,4 (Baltic Amber)

Holotype female, coll. E. HEISS, Innsbruck, Austria, He-An-3

Subfamily Aradinae BRULLÉ, 1836

Aradus assimilis GERMAR & BERENDT, 1856: 22, Pl. II, fig. 12 (Baltic Amber)

Holotype of unknown sex lost, not located in coll. BERENDT, Museum für Naturkunde, Berlin, Germany

Aradus consimilis GERMAR & BERENDT, 1856: 23, Pl.. II, fig. 13 (Baltic Amber)

Holotype by monotypy (des. HEISS 1998: 256) female, coll. BERENDT, Museum für Naturkunde,Berlin, Germany, Inv.Nr. MBJ 1882

Aradus frater POPOV, 1978: 137, fig. 1,2 (Baltic Amber)

Holotype female, coll. Museum of the Earth, Polish Academy of Sciences, Warsaw, Poland,No. 5624

Aradus frateroides HEISS, 1998: 259, fig. 5, Pl.II, fig. 2,3 (Baltic Amber)

Holotype female, coll. E. HEISS, Innbsbruck, Austria, He-Ar-1 (formerly HE II)

Aradus madagascariensis BERVOETS 1909: 280, fig. 1, 2 (Madagascan Copal)

Holotype (not designated) male, coll. F. MEUNIER, Mus. Hist. Nat., Paris, France (not located)

Aradus popovi HEISS, 1998: 260, fig. 6, Pl. II, fig. 4 (Baltic Amber)

Holotype female, coll. Y. POPOV, Palaeontol. Inst., Academy of Sciences, Moscow, Russia

Aradus superstes GERMAR & BERENDT, 1856: fig. 1, Pl. I, fig. 1, 2 (Baltic Amber)

Holotype by monotypy (des. HEISS 1998: 253) male, coll. BERENDT, Museum für Naturkunde,Berlin, Germany, Inv.Nr. MBJ 1883

Archearadus burmenis HEISS & GRIMALDI, 2001: plate 1 a, b (this paper) (Burmese Amber)

Holotype male, coll. American Museum of Natural History, New York, USA

Subfamily Calisiinae STAL, 1873

Calisiopsis brodzynskyorum FROESCHNER, 1992: 33-34, fig. 4 (Dominican Amber)

Holotype female, coll. Smithsonian Institution, Washington DC, USA

Calisius balticus USINGER, 1941: 95 (Baltic Amber)

Holotype male, HAREN collection of Baltic amber insects, Museum of Comparative Zoology,Harvard University, Cambridge, MA, USA, No. 4634 (not located) Redescr. and allotype female, HEISS, 2000a: 196, fig. 2, Pl. 1 a, b, coll. E. HEISS, Innsbruck, Austria, He-Ca-1

Calisius rietscheli HEISS, 2000a: 197, fig. 3, Pl. 1c (Baltic Amber)

Holotype female, coll. E. HEISS, Innsbruck, Austria, He-Ca-2

Calisius vonholti HEISS, 2000a: 199, fig. 4, Pl. 1d (Baltic Amber)

Holotype male, coll. E. HEISS, Innsbruck, Austria, He-Ca-3
Calisius weitschati HEISS, 2000a: 200, fig.1, 5 (Baltic Amber)
Holotype male, coll. J. DAMZEN, Vilnius, Lithuania, No. 616

Subfamily Mezirinae Oshanin 1908

Mezira scheveni Heiss, 2000b: 7, fig. 1, Tab. 1, photo 1, 2 (Dominican Amber)

Holotype male, coll. E. Heiss, Innsbruck, Austria, He-Dom-1

Mezira succinica Usinger, 1941: 98, fig. 1a, 1b (Baltic Amber)

Holotype male, Haren collection of baltic insects, Museum of Comparative Zoology, Harvard University,Cambridge, MA., USA, No. 4635 (not located)

Species Inquirendae

„Larva Aradii" Germar & Berendt, 1856: 23, Tab. III, fig. 17 (Baltic Amber)

Specimen redesr. Heiss 1998: 257, fig.3, Tab. I, fig.3, coll. coll. Berendt, Museum für Naturkunde, Berlin, Germany, Inv.Nr. MBJ 1885

Calisius sp. (nr. *balticus*) Heiss, 1998: 201 (Baltic Amber)

Specimen male, coll. E. Heiss, Innsbruck, Austria

Acknowledgments
We thank Paul C. Nasimbene AMNH for the careful preparation of the precious amber piece and Tam Nguyen for the excellent photographs of the inclusion.

References

Bervoets, R. (1909) Un Aradidae nouveau du copal récent de Madagascar (Hem. Aradiae). – Bull. Soc. Ent. France, **16**: 280-281; Paris.

Froeschner, R. C. (1992) The Flat Bug genus *Calisiopsis* Champion: A Review with descriptions of Three New Species, Including One from Dominican Republic Amber (Heteroptera: Aradidae). – Proc. Biol. Soc. Washington, **105**: 32-39; Washington.

Germar, E. F. & Berendt, G. C. (1856) Die im Bernstein befindlichen Hemipteren und Orthopteren der Vorwelt. – In: Berendt, G. C.: Die im Bernstein befindlichen organischen Reste der Vorwelt, **2**: 1-40, Tafel 1-4; Berlin.

Grimaldi, D., Engel, M. S. & Nascimbene, P. C. (2002): Fossiliferous Cretaceus amber from Burma (Myanmar): Its rediscovery, biotic diversity, and paleontological significance. – American Museum Novitates 3361: 71 S.; New York (in print).

Heiss, E. (1997) Erstnachweis einer Aneurinae aus dem Baltischen Bernstein: *Aneurus ancestralis* n. sp. (Heteroptera, Aradidae). – Carolinea, **55**: 111-113; Karlsruhe.

Heiss, E. (1998) Revision der Familie Aradidae des Baltischen Bernsteins I. Bisher beschriebene Taxa der Gattung *Aradus* und zwei neue Arten (Insecta, Heteroptera). – Mitteilungen des Geologisch-Paläontologischen Instituts der Universität Hamburg, **81**: 251-268; Hamburg.

Heiss, E. (2000a) Revision der Familie Aradidae des Baltischen Bernsteins II. Drei neue *Calisius*-Arten (Insecta, Heteroptera). – Carolinea, **58**: 195-201; Karlsruhe.

Heiss, E. (2000b) First Record of a Mezirinae Flat Bug from Dominican Amber: *Mezira scheveni* n.sp. (Heteroptera, Aradidae). – Entomol. Nachrichtenblatt. **7**: 6-10; Wien

Heiss, E. (2001a) Revision der Familie Aradidae des Baltischen Bernsteins III. Zwei neue *Aneurus*-Arten (Insecta, Heteroptera). – Entomol. Nachrichtenblatt, **8**: 12-18; Wien.

Kormilev, N. A. & Popov, Y A. (1986) The first find of a Mesozoic aradid bug fossil in North-east Siberia (Hemiptera: Aradidae). -– Journal of Natural History, **20**: 279-282; London.

Nascimbene, P. & Silverstein, H. (2000) The preparation of fragile Cretaceous ambers for conservation and study of organismal inclusions. – In Grimaldi, D. (ed.): Studies on fossils in amber, with particular reference to the Cretaceous of New Jersey: 93-102; Leiden (Backhuys Publishers).

Popov, Y A. (1978) New species of Aradidae (Hemiptera) from the Baltic Amber. – Prace Muzeum Ziemi, **29**: 137-140; Praha.

Usinger, R. L. (1941) Two New Species of Aradidae from Baltic Amber (Hemiptera). – Psyche, **48**: 95-100; Cambridge, Massachusets.

Weitschat, W. & Wichard, W. (1998) Atlas der Pflanzen und Tiere im Baltischen Bernstein. 256 S.; München (Verlag F. Pfeil).