

Mesozoic larva in amber reveals the venom delivery system and the palaeobiology of an ancient lineage of venomous insects (Neuroptera)

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Supplementary information File S1. Data matrix for phylogenetic analysis in nexus format.

#NEXUS

[written Fri Apr 26 21:56:45 CEST 2024 by Mesquite version 3.61 (build 927)]

BEGIN TAXA;

DIMENSIONS NTAX=63;

TAXLABELS

Trachypacus_sp. Parainocellia_bicolor Raphidia_sp. Sialis_lutaria Corydalus_sp. Neohermes_sp.
Semidalis_aleyrodiformis Aleuropteryx_juniperi Nevrothrus_apatheios Osmylus_fulvicephalus Sisyra_nigra
Dilar_duelli Nallachius_sp. Podallea_sp Lomamyia_sp. Mucroberotha_vesicaria Plega_sp. Ditaxis_biseriata
Mantispa_styriaca Hemerobius_humulinus Chrysoperla_mediterranea Italochrysa_italica Ithone_sp
Polystoechotes_punctatus Psychopsis_barnardi Osmylus_norfolii Nymphes_myrmeleonoides
Nemoptera_bipennis Croce_sp. Pterocroce_capillaris Ululodes_bicolor Ascalobias_microcerus Ascalaphus_festivus
Palpares_libelluloides Dendroleon_pantherinus Distoleon_tetragrammicus Acanthaclisis_occitanica
Myrmecaelurus_trigrammus Myrmeleon_gerlindae Propsychopsis_sp. Macleodiella_electrina Cladofer_huangi
Aphthartopsychops_scutatus Acanthopsychops_triaina Nymphavus_progenitor Pronymphes_Electrocaptivus_cheni
Adelpholeon_lithophorus Diodontognathus_papillatus Burmitus_tubulifer Mesoptynx_unguiculatus
Pristinofossor_rictus Ululodes_sp.1 Neadelphus_protas Ankyloleon_caudatus Hallucinochrysa_diogenesi
Pedanoptera_arachnofila MCNA_9294 Berothidae_B Berothidae_D Berothoid_Rovno Electroxiplus_veneficus
;

END;

BEGIN CHARACTERS;

DIMENSIONS NCHAR=142;

FORMAT DATATYPE = STANDARD RESPECTCASE GAP = - MISSING = ? SYMBOLS = " 0 1 2 3 4 5 6 7";

CHARSTATELABELS

1 'Dolichaster-type setae' / absent present,
2 Head_depth / 'dorsoventral depth smaller to antero-posterior length' 'dorsoventral depth equal
to antero-posterior length',
3 Head_capsule_lenght / '<1.5 times longer than wide' '>1.5 times longer than wide',

4 'Chaetotaxy of dorsal side of head capsule, arrangement' / not_raised on_papillae
 on_cylindrical_protuberances,
 5 Chaetotaxy_of_dorsal_surface_of_head_capsule / 'sensilla mainly bristle-like'
 sensilla_mainly_dolichasters 'sensilla mainly scale-like' sensilla_mainly_curved_stout_setae
 sensilla_extremely_long_setae,
 6 Long_setae_on_head_margins / absent present,
 7 Number_of_stemmata / seven six five four three two zero,
 8 Ocular_tubercle / absent present,
 9 'Ocular tubercle (if present), size' / large small,
 10 'Ocular tubercle (if present), transversal section' / subcircular elliptical,
 11 Fringe_of_setae_on_external_margin_of_ocular_tubercle / absent present,
 12 Prominent_antennal_tubercle / absent present,
 13 Fixed_curvature_of_antenna / absent present,
 14 Length_of_antenna / about_as_long_as_mandible_or_longer 'about 2/3 of mandible length or
 slightly longer' 'at most 1/3 of mandible length',
 15 Basal_elements_of_antenna / not_fused fused,
 16 Antennomere_2 / much_shorter_than_antennomere_1 as_long_as_antennomere_1
 much_longer_than_antennomere_1,
 17 Secondary_segmentation_of_antennomere_2 / not_segmented '7< pseudosegments' '>10
 pseudosegments',
 18 Sensorium_of_antennomere_2 / absent present,
 19 Antennomeres_2_and_3 / not_fused fused,
 20 Diameter_of_antennomere_2 / subequal_to_diameter_of_antennomere_1
 slightly_smaller_than_diameter_of_antennomere_1 less_than_half_of_antennomere_1_diameter,
 21 Antennomere_3 / simple bifid,
 22 Sensilli_on_antennomere_3 / short_sensilli specialized_terminal_sensillum 'paired, spine-like
 sensilli' apical_field_of_minute_sensilli 'normal, unmodified apical seta',
 23 Articulation_of_labrum / articulated_with_anterior_clypeal_margin 'not articulated, labrum
 and clypeus fused',
 24 Prologend_labral_margin / absent present,
 25 Anterior_width_of_frontal_suture / 'wide, covering whole anterior margin of head between
 mandibles' 'narrow, covering half of anterior margin of head between mandibles',
 26 Setae_on_anterior_margin_of_labral_margin / few_localized_setae
 fringe_of_setae_on_the_whole_margin,
 27 Type_of_setae_on_anterior_margin_of_clypeolabrum / dolichasters 'bristle-like' stout_setae
 long_setae,
 28 Spiniform_processes_on_anterior_margin_of_clypeolabrum / absent present,
 29 Pseudolabral_prominence / absent present,

30 Frontoclypeal_region / without_abrupt_change_in_profile with_abrupt_change_in_profile,
 31 Lateral_remnant_of_frontoclypeal_sulcus / present absent,
 32 'Scales-like texture on antenna and maxilla' / absent present,
 33 Position_of_maxillary_base / 'protracted, maxillary groove absent' 'slightly retracted,
 maxillary groove as long as one third of ventral head capsule' 'strongly retracted, maxillary groove at least as
 long as half of head capsule',
 34 'Mandibulo-maxillary stylets' / absent present,
 35 'Maxillary stylet, size with respect to mandible (if modified in stykets)' / 'as large as
 mandible or larger, covering the whole ventral side of mandible' 'half the size of mandible, covering the poison
 channel only',
 36 Poison_channel / absent present,
 37 Mandible_insertion / widely_separated closely_approximated_,
 38 Process_at_base_of_mandibulomaxillary_stylet / absent present,
 39 'Mandibulomaxillary stylets, length' / 'compact, shorter than head capsule' 'elongate,
 approximately as long as head capsule' 'very elongate, over twice as long as the head capsule',
 40 'Mandibulomaxillary stylets, shape' / curved_outward straight 'thin and tubule-like'
 evenly_curved_inward_for_most_of_their_length 'converging medially and then straight, beak-shaped'
 straight_and_curved_inward_at_tip,
 41 Mandibulomaxillary_stylet_apex / thin stout,
 42 Upward_bending_of_mandibulomaxillary_stylets / 'not bent, i.e. straight' bent_upward,
 43 Trycondilic_articulation_of_mandible / absent present,
 44 Mandibular_teeth / absent present,
 45 'Apical blade of mandible (if teeth are present)' / shorter_than_tooth_bearing_portion
 'longer than tooth bearing-portion',
 46 Mandibular_teeth_number / one two three seven,
 47 'Distance between teeth (if three or more)' / equidistant median_and_apical_teeth_closer,
 48 'Dimensions of apical tooth (if three or more)' / smaller_than_median_tooth
 larger_than_median_tooth median_and_apical_teeth_subequal_in_size,
 49 Pseudoteeth / absent present,
 50 Fringe_of_very_long_setae_on_lateral_side_of_the_mandible / absent present,
 51 Width_of_proximal_elements_of_maxilla / as_broad_as_base_of_maxilla narrow,
 52 Maxillary_palp / absent present,
 53 Longitudinal_sulcus_at_base_of_maxillary_element / absent present,
 54 Galea / present absent,
 55 'Postmentum, longitudinal division' / 'subdivided, with membranous parts' 'subdivided,
 completely sclerotized' not_divided,
 56 Internal_process_of_prementum / absent present,
 57 Median_anterior_process_of_prelabium / absent present,

58 Premental_element / 'similar, in shape and size, to palpimeres'
 strongly_developed_and_ventrally_flattened,
 59 'Labial palpus, length' / 'about 2/3 of mandible or slightly longer' 'at most 1/3 of mandible'
 ' reduced absent,
 60 Median_separation_of_mental_elements / adjacent widely_separated,
 61 Labial_palpi / close_at_base separated_by_a_ligula separated,
 62 'Labial palp, shape' / not_swollen swollen,
 63 Sensory_area_on_distal_labial_palpomere / absent present,
 64 Number_of_labial_palpomeres / five_or_more four three two,
 65 Sensory_pit_of_distal_palpomere / absent_present,
 66 'Labial palpus, annulations' / absent present,
 67 Gular_region / long_sclerite_covering_most_of_head_capsule sclerite_fused_to_head_capsule
 'short, longer than wide sclerite' small_anterior_triangular_sclerite 'stripe-like' posteriorly_membranous
 entirely_membranous,
 68 Hypostomal_bridge / absent_present,
 69 Shape_of_tentorium / 'H-shaped' 'X-shaped',
 70 Tentorial_bridge_in_1st_instar / present absent,
 71 Posterior_tentorial_pits / central_region close_to_hind_margin
 in_anterior_third_of_head_capsule,
 72 Position_of_anterior_tentorial_pits / within_anterior_third_of_head_capsule
 posterad_of_anterior_third_of_head_capsule,
 73 Position_of_posterior_tentorial_pits_with_respect_to_subgenal_ridge / in_contact 'posterior
 tentorial pits not in contact with subgenal ridge, ventro-lateral to it',
 74 Dorsal_depression_on_dorsal_side_of_head_capsule / absent present,
 75 Depth_of_dorsal_depression_of_the_head_capsule / shallow deep very_deep,
 76 Temple_region / present absent,
 77 Posterior_prominence_of_temples / smooth quadrate 'lobe-like',
 78 Lateral_sutures / absent present _ absent present,
 79 'Head-thorax articulation' / roughly_coplanar shifted_dorsally,
 80 Occipital_area / 'not heart-shaped' 'heart-shaped (cordate)',
 81 Neck_region / present absent,
 82 'Neck region (if present), size' / elongated short,
 83 Cervix / absent present,
 84 Cervical_sclerite_and_lateral_apodemal_tendon / absent present,
 85 'Cervix, sclerotization' / largely_membranous entirely_sclerotized,
 86 Median_dorsal_cervical_apodeme / absent present,
 87 Postcephalic_body_shape / elongate_campodeiform ovoid scarabeiform,
 88 Proportion_of_head_and_postcephalic_body_in_later_instar / head_normally_sized head_reduced,

89 'Dorso-ventral flattening of postcephalic body' / 'body not flattened dorso-ventrally,
 relatively thick' 'body distinctly compressed dorso-ventrally',
 90 'Mesonotum, tuft of hair-like setae' / absent present,
 91 Mesothoracic_spiracle / sessile raised_on_a_conical_tubercle,
 92 Mesothoracic_setiferous_process / zero one two,
 93 'Anterior mesothoracic setiferous process (if two are present), type' / 'scolus-like'
 'tubercle-like' small_protuberance 'extremely elongated, tubular',
 94 'Posterior mesothoracic setiferous process (if two), type' / 'scolus-like' 'tubercle-like'
 small_protuberance 'extremely elongated, tubular',
 95 Metathoracic_setiferous_process / zero one two,
 96 'Anterior metathoracic setiferous process (if two), type' / 'scolus-like' 'tubercle-like'
 small_protuberance 'extremely elongated, tubular',
 97 'Posterior metathoracic setiferous process (if two), type' / 'scolus-like' 'tubercle-like'
 small_protuberance 'extremely elongated, tubular',
 98 Extremely_long_setae_on_thoracic_setiferous_processes / absent present,
 99 'Legs, shape' / relatively_short extremely_elongated,
 100 'Fringe of elongated setae on meso- and metathoracic legs' / 'absent, only short setae'
 present,
 101 Metathoracic_legs / similar_to_mesothoracic_leg more_robust_than_mesothoracic_leg,
 102 'Metathoracic legs, tarsus and tibia, articulation' / articulated fused,
 103 Spiniform_setae_on_tibiae_and_tarsi / absent present,
 104 Unguitractor_process / absent present,
 105 Empodium / absent 'trumpet-shaped' 'stick-shaped' 'filament-like',
 106 Empodium_in_later_instar_larvae / present lost,
 107 Pretarsal_claws_of_prothoracic_leg / of_similar_shape_and_size of_different_shape_and_size,
 108 'Pretarsal claws, basal dilatation' / 'simple, not dilated'
 with_a_basal_quadrangular_dilatation,
 109 'Metathoracic leg, pretarsal claws' / not_enlarged enlarged,
 110 Long_setae_inserted_in_deep_socket_on_thoracic_tergites / absent present,
 111 Setae_on_dorsal_side_of_thorax_and_abdomen / not_rising_from_sclerites
 rising_from_sclerites,
 112 'Abdominal segment 1, position of spiracle' / lateral ventral dorsal,
 113 'Abdominal segment 2, position of spiracle' / lateral ventral dorsal,
 114 'Abdominal segments 3-8, position of spiracles' / lateral ventral,
 115 Lateral_abdominal_tracheal_gill / absent present,
 116 Abdominal_setiferous_processes / absent present,
 117 'Abdominal segment 1, dorsal setiferous process' / absent present,
 118 'Abdominal segment 1, ventral setiferous process' / absent present,

119 'Abdominal segment 1, relative position of dorsal and ventral setiferous processes ' /
 not_coplanar coplanar,
 120 'Abdominal segment 2, dorsal setiferous process ' / absent present,
 121 'Abdominal segment 2, ventral setiferous process' / absent present,
 122 'Abdominal segment 2, relative position of dorsal and ventral setiferous processes ' /
 not_coplanar coplanar,
 123 'Abdominal segments 3-7, ventral setiferous processes ' / absent present,
 124 'Abdominal segments 3-7, relative position of dorsal and ventral setiferous processes' /
 not_coplanar coplanar,
 125 'Abdominal segment 1, position of dorsal setiferous process' / lateral dorsal,
 126 'Abdominal segments 1-7, type of dorsal setiferous processes' / 'scolus-like'
 'tubercle-like',
 127 'First abdominal segments 1-2, type of ventral setiferous processes' / 'scolus-like '
 'tubercle-like',
 128 Extremely_long_setae_on_abdominal_setiferous_processes / absent present,
 129 'Abdominal segment 8, setiferous processes' / absent present,
 130 'Abdominal segment 8, dorsal setiferous process ' / absent present,
 131 'Abdominal segment 8, ventral setiferous process ' / absent present,
 132 'Abdominal segment 8, odontoid processes' / absent present,
 133 'Odontoid processes (if present), setae' / absent present,
 134 'Abdominal sternite 8, specialized digging setae' / absent present,
 135 'Abdominal segment 9, shape' / longer_than_wide wider_than_long,
 136 'Abdominal sternite 9, specialized digging setae on ventral surface' / absent present,
 137 Rastra_ / absent present,
 138 Secondary_segmentation_of_segment_10 / absent present,
 139 Abdominal_segment_10 / not_retractable retractable,
 140 Structures_on_abdominal_segment_10 / absent plumose_filament paired_hooked_pseudopods
 paired_retractable_structures_bearing_minute_hooks adhesive_pads 'paired prominent cup-shaped adhesive pads'
 'large, paired oval stuctures' ambulatory_rosette,
 141 Camouflaging_behaviour / absent present,
 142 Habitat / aquatic terrestrial ;

MATRIX

Trachypacus_sp.

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Parainocellia_bicolor

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Raphidia_sp.
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000-----0-000000701

Sialis_lutaria
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Corydalis_sp.
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Neohermes_sp.
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Semidalis_aleyrodiformis
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Aleuropteryx_juniperi
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Nevrorthus_apathelios
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Osmylus_fulvicephalus
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Sisyra_nigra
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Dilar_duelli
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Nallachius_sp.
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Podallea_sp
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Lomamyia_sp.
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Mucroberotha_vesicaria
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Plega_sp.
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Ditaxis_biseriata
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Mantispa_styriaca
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Hemerobius_humulinus
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Chrysoperla_mediterranea
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Italochrysa_italica
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Ithone_sp
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Polystoechotes_punctatus
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Psychopsis_barnardi
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Osmylops
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Norfolius_howensis
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Nymphes_myrmeleonoides

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Nemoptera_bipennis

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Croce_sp.

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Pterocroce_capillaris

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Ululodes_bicolor

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Ascalobyas_microcerus

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Ascalaphus_festivus

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Palpares_libelluloides

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Dendroleon_pantherinus

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Distoleon_tetragrammicus

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Acanthaclisis_occitanica

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Myrmecaelurus_trigrammus

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Myrmeleon_gerlindae

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Electrocaptivus_cheni
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Adelpholeon_lithophorus
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Burmitus_tubulifer
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Mesoptynx_unguiculatus
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Pristinofossor_rictus
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 Hallucinochrysa_diogenesi
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 Pedanoptera_arachnofila
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 MCNA_9294
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 Berothidae_B
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 Electroxipheus_veneficus
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