



The psychomyiid genus *Palerasnitsynus* (Insecta, Trichoptera) in mid-Cretaceous Burmese amber

Authors: Wichard, Wilfried, Müller, Patrick, and Wang, Bo

Source: Palaeodiversity, 11(1) : 151-166

Published By: Stuttgart State Museum of Natural History

URL: <https://doi.org/10.18476/pale.11.a8>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

The psychomyiid genus *Palerasnitsynus* (Insecta, Trichoptera) in mid-Cretaceous Burmese amber

WILFRIED WICHARD, PATRICK MÜLLER & BO WANG

Abstract

The extinct caddisfly genus *Palerasnitsynus* (Psychomyiidae) is revised, based on nine new species embedded in mid-Cretaceous Burmese amber. They can be distinguished from all other extinct and extant psychomyiid genera by the absence of fork III in their fore- and hindwings and by the presence of latero-apical dark sporns at the 3rd maxillary palp segment. These species belong to the smallest Trichoptera hitherto known, with forewing lengths of 1.8–2.6 mm. Moreover, the micro-caddisflies of the genus *Palerasnitsynus* are very common and comprise almost 60 % of all caddisflies in Burmese amber. Some amber pieces contain aggregations of specimens which indicates swarming activities of the adults.

Key words: Psychomyiidae, *Palerasnitsynus*, amber caddisflies, micro-caddisflies, swarming.

1. Introduction

The psychomyiid genus *Palerasnitsynus* WICHARD, ROSS & ROSS, 2011, named after the Russian palaeontologist ALEXANDR P. RASNITSYN, was established based on the type species *Palerasnitsynus ohlhoffi* WICHARD, ROSS & ROSS, 2011 from the Cretaceous Burmese amber. In 2015 two further specimens of *Palerasnitsynus* were found in Burmese amber which has led to a re-description of *Palerasnitsynus ohlhoffi* (WICHARD & WANG 2016). During the last three years, however, many more specimens of *Palerasnitsynus* were found. Compiled by P. MÜLLER and B. WANG the amber caddisfly collection increased to about 500 specimens – single inclusions and some even aggregated in swarms (Fig. 12). Thereof almost 300 specimens belonging to the genus *Palerasnitsynus* were found in Burmese amber and necessitate the introduction of several new species within this genus.

2. Material and methods

The Burmese amber material is collected by local people in several districts of northern Myanmar, but most fossils come from the amber mine located at Noiye Bum village near Tanaing town (KANIA et al. 2015). The age provided by U-Pb dating of zircons from the volcano-clastic matrix of the amber is early Cenomanian (98.8 ± 0.6 Ma) (SHI et al. 2012).

We have examined many specimens probably belonging to the genus *Palerasnitsynus*, but most of them are poorly preserved and therefore inadequate for detailed studies and descriptions. The selected fossil specimens are embedded in small amber blocks, which have been cut out from larger amber pieces. All studied specimens represent

nearly complete adults, most of them being clearly visible in ventral and dorsal views. The male genitalia are often visible in ventral view. The hindwings are often totally or partially covered by the forewings.

Photographs were taken using a Leica stereomicroscope M 420 Apozoom in combination with a Canon EOS 60D, EOS utility software 3 and the Zerene Stacker software. All images and figures were prepared with Adobe Photoshop CS4.

Terminology (wing venation terminology generally follows HOLZENTHAL et al. 2007): I – apical fork I; II – apical fork II; III – apical fork III; IV – apical fork IV; V – apical fork V; R – radius, Rs – radius sectori, M – media, Cu1 – cubitus anterior, Cu2 – cubitus posterior, A – analis, DC – discoidal cell, MC – median cell, TC – thyridium cell.

Male genitalia: inf app = inferior appendage, cox = coxopodite, har = harpago, med pro = medio-distad process, pre app = preanal appendage (cercus), pha app = phallic apparatus, int pro = intermediate process.

3. Systematic palaeontology

Order Trichoptera KIRBY, 1815

Suborder Annulipalpia MARTYNOV, 1924

Family Psychomyiidae WALKER, 1852

Diagnosis: Adults without ocelli. Filamentous antennae at most as long as forewings; scapus slightly stronger than the following flagellomeres. Maxillary palps usually 5-segmented, 2nd segment usually longer than 1st segment and smaller or almost as long as 3rd segment, terminal segment long, annulated and flexible; labial palps 3-segmented (however, in *Paduniella* maxillary palps are 6-segmented and labial palps 4-segmented). Mesoscutum with two rounded or ovoid setal warts; mesoscutellum

originally with a separate pair of setal warts usually fused in a single setal wart. The tibial spurs 2/4/4. In forewings, veins R2 and R3 fused, fork I absent. Hindwings shorter and narrower than forewings, venation reduced.

The family Psychomyiidae is widely distributed, largely centred in the Oriental region and scarcely in the Neotropical and Australian regions. The larvae live in running freshwater, where they build silken tubes covered with fine sand and which are attached to rocks and other submersed substrates. They graze on fine organic particles of the biofilms of the substrate and on their tubes.

Genus *Palerasnitsynus* WICHARD, ROSS & ROSS, 2011

Type species: *Palerasnitsynus ohlhoffi* WICHARD, ROSS & ROSS, 2011.

Diagnosis: The extinct genus *Palerasnitsynus* can be distinguished from all other extinct and extant psychomyiid genera and species by the absence of fork III in the fore- and hindwings (Fig. 1B) and by the presence of latero-apical dark sporns at the 3rd maxillary palp segment (Fig. 1A, arrow).

Description: *Head and thorax:* Ocelli absent. Antennae smaller than or about as long as the forewings, consisting of strong scapus, small pedicellus and following cylindrical flagellomeres in variable numbers (19-30); first two flagellomeres often densely continuous, looking like a single, twice long flagellomere. Maxillary palps 5-segmented; 2nd segment as long as 1st segment or longer and often longer than 3rd segment, whose apex laterally bearing small dark spines (Figs. 1A, 7C); 4th segment longer than 3rd segment, terminal segment long, annulated and probably flexible. Labial palps 3-segmented, last segment longest.

Thorax and wings: Pronotum with two transverse round/ovoid setal warts. Mesoscutum with a pair of ovoid setal warts; mesoscutellum with a domed setal wart. All species possess a high conformity with their fore- and hindwing venations (Fig. 1B). In fore- and hindwings costal margin always straight, without any prominent costal point and always rounded at the wing apexes. Hindwings considerably shorter and narrower than

forewings. In forewings apical forks II, IV and V present, fork III absent. Discoidal and thyridium cells closed. Hindwing with forks II and V, discoidal cell closed.

Male genitalia: The species can be distinguished among each other by the combination of the genital characters consisting bilaterally of inferior and superior appendages, centrally of the phallic apparatus and dorsolaterally of a pair of intermediate processes, each split apically in two thin branches. The inferior appendage (gonocoxite) is two-segmented, with a weak crossing from coxopodite (cox) to harpago (har), always bearing a medio-distad process originate from the coxopodite, usually with long setae at the apex. Three variations of the inferior appendages can be described (Fig. 2A–C):

A) In ventral view the inferior appendages look like flat scales, short and stump, each consisting of an ovoid coxopodite and an apical harpago, small and half-rounded: *Palerasnitsynus lepidus* n. sp.

B) In ventral view the inferior appendages looking like elongate scales running straight or slightly arcuate, parallel to each other, bearing setae lengthwise at inner margin, at apex with distinct black spines. The basal coxopodite rounded, weak indicated, smaller than the elongate harpago: *Palerasnitsynus ohlhoffi*, *P. spinosus* n. sp., and *P. sukatchevae* n. sp.

C) Other inferior appendages basolaterally broad, then tapered and apically curved mediad, characterised by a sinusoidal inner margin, basally convex, subsequently concave; outer margin almost straight, then arcuate; at apex often formed a small bulbous covered with several black spines: *Palerasnitsynus gracilis* n. sp., *P. vulgaris* n. sp., *P. grandis* n. sp., *P. furcatis* n. sp., and *P. subglobolus* n. sp.

The preanal (superior) appendages are arranged dorsolaterally, running straight or slightly curved mediad, digitate, sometimes twisted or rod-shaped, some with an apical small knob. The phallic apparatus is placed dorsocentrally. The phallic apparatus seems stalked, often as long as the inferior appendages or shorter, at apex notched, amplified to the aedeagus. A dorsolateral basal pair of intermediate processes (probably paraproctal processes?); each process forked apically in two branches, often needle-like, with different lengths and shapes, straight or curved and twisted, at the apex often dark coloured.

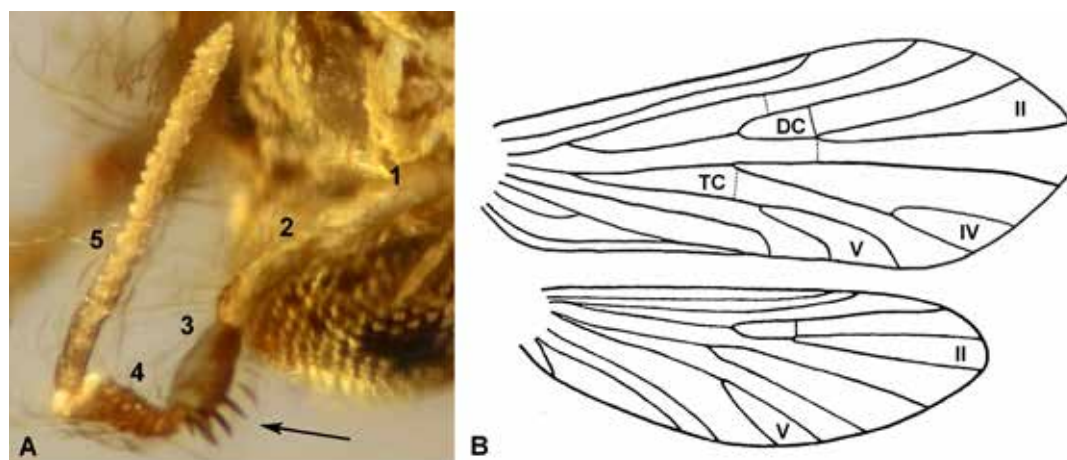


Fig. 1. Characteristics of the genus *Palerasnitsynus*. **A:** Lateroapical dark sporns at the 3rd maxillary palp segment (arrow). **B:** The absence of forks III in fore- and hindwings (here: *P. vulgaris* n. sp.; MB.I 7301).

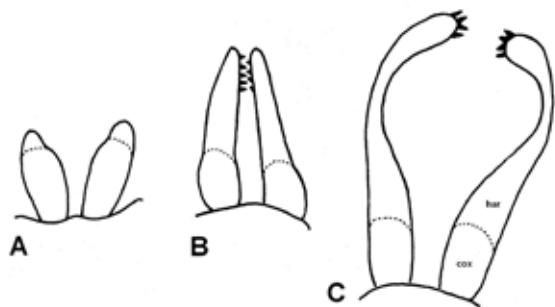


Fig. 2. Base shapes of the inferior appendages in the genus *Palerasnitsynus* in ventral view. **A:** Short ovoid scales. **B:** Elongate scales. **C:** Elongate arcuate inferior appendages; inferior appendages consisting of coxopodite (cox) and harpago (har).

Palerasnitsynus ohlhoffi WICHARD, ROSS & ROSS, 2011

Fig. 3

For clear comparisons, the male genitalia of *Palerasnitsynus ohlhoffi* WICHARD, ROSS & ROSS, 2011 is re-illustrated and re-diagnosed, based on the holotype (deposited in the amber collection of the Staatliches Museum für Naturkunde Stuttgart, inventory number BU-1), completed by further male genitalia of *Palerasnitsynus ohlhoffi*.

Additional specimens: Males embedded in Burmese amber, kept in the amber collection of the Museum für Naturkunde, Berlin, MB.I 7296 (BUB 751), MB.I 7297 (BUB 1874), ex coll. PATRICK MÜLLER.

Diagnosis: Male *P. ohlhoffi* n. sp. (forewing length 1.9 mm, 19 flagellomeres) can be distinguished from most other *Palerasnitsynus* species in the inferior appendages of type B and especially from the closely related *P. sukatchevae* in the digitiform preanal appendages and from *P. spinosus* in the medio-distad process.

Male genitalia (Fig. 3B, C) with scale-shaped inferior appendages, coxopodites slightly stretched and apically rounded, harpagos about twice as longer as coxopodites, setae present in mesal row of inner margin, at apex instead with short black spines. In ventrolateral view, the medio-distad processes of coxopodites bearing long setae. Preanal (superior) appendages reaching half-length of gonopodes, digitate, sometime twisted. The inner branches of the paired intermediate processes almost as long as the inferior appendages, the outer branches shorter, both at apex obtuse angled, running laterad.

Palerasnitsynus sukatchevae n. sp.

Fig. 4

Etymology: *P. sukatchevae*, named in honour of IRINA D. SUKATCHEVA for her studies on Mesozoic Trichoptera.

Holotype: Male embedded in Cretaceous Burmese amber, kept in the amber collection of the Museum für Naturkunde in Berlin, inventory number MB.I 7298 (ex coll. PATRICK MÜLLER, BUB 1504). The holotype is well preserved in clear amber. Right fore- and hindwings spread apart, therefore the wing venations are well visible; male genitalia visible in latero-ventral view.

Diagnosis: Male *P. sukatchevae* n. sp. (forewing length 1.9 mm, 22 flagellomeres) can be distinguished from other *Palerasnitsynus* in the inferior appendages of type B and especially from the closely related species, *P. ohlhoffi* in the elongate, rod-shaped preanal appendages and *P. spinosus* in the medio-distad process.

Description: Male, adult with general characters of the genus, forewing length 2.1 mm, antennae with 22 cylindrical flagellomeres, plus scapus and pedicellus.

Male genitalia (Fig. 4B–D) with a pair of scale-shaped inferior appendages, running parallel, straight, inner margin slightly curved. Coxopodites small and rounded, harpagos about 2.5 x longer than coxopodites, setae present in mesal row, with short black spines at apex; a medio-distad processes rising at coxopodites, bearing long setae at apex. Preanal appendages simple, elongate, rod-shaped, reaching 2/3 length of the gonopodes. Paired intermediate processes, each consisting of two needle-like branches, the inner one long, overhanging the gonopode, the outer one about half as long as the gonopode, both curved slightly outwards, at the apex black (Fig. 4 D).

Palerasnitsynus spinosus n. sp.

Fig. 5

Etymology: *P. spinosus*, named after the spinose medio-distad processes of the inferior appendages.

Holotype: Male embedded in Cretaceous Burmese amber, kept in the amber collection of the Museum für Naturkunde in Berlin, inventory number MB.I 7299 (ex coll. PATRICK MÜLLER, BUB 1811). The holotype well preserved in amber; in lateral view the body is partially covered by artificial dark bubbles.

Diagnosis: Male *P. spinosus* n. sp. (forewing length 2.1 mm, 24 flagellomeres) can be distinguished from other *Palerasnitsynus* by the medio-distad processes of the coxopodites stump and covered with strong dark spines - instead of elongate medio-distad processes bearing long setae in most other species of *Palerasnitsynus*.

Description: Male with general genus characters, forewing-lengths 2.1 mm, antennae with about 24 flagellomeres, plus scapus and pedicellus.

Male genitalia (Fig. 5B–E) with a pair of scale-shaped inferior appendages, coxopodites small and rounded, harpagos about twice as longer than coxopodites, setae present in mesal row of inner margin, at apex instead with short black spines; medio-distad processes of coxopodites stump with strong dark spines (Fig. 5 C) instead of long fine setae of other species. Preanal appendages rod-shaped, reaching half-length of gonopodes. The intermediate processes (Fig. D, E) each with two branches differ in their lengths and shapes. Inner branch almost as long as the inferior appendages, terminal part arcuate, running dorsad; the outer branch short and angulate.

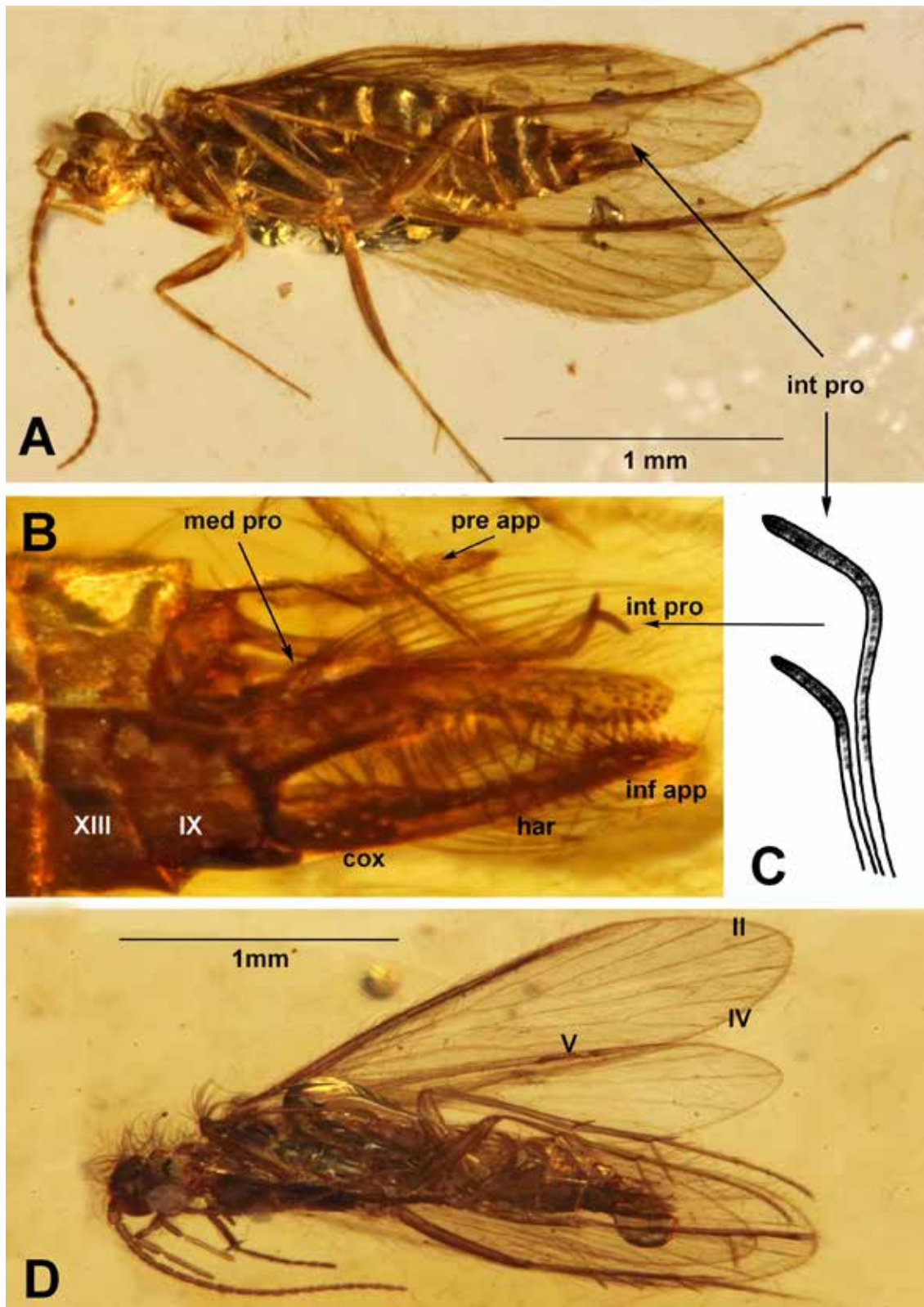


Fig. 3. *Palerasnitsynus ohlhoffi* WICHARD, ROSS & ROSS, 2011. **A:** Male (MB.I 7297) in ventrolateral view. **B:** Male genitalia in ventrolateral view. **C:** Short outer and long inner, rod-shaped branches of an intermediate processes. **D:** Male (MB.I 7296) in lateral view, right fore- and hindwings strutting apart, apical forks II, IV and V present.

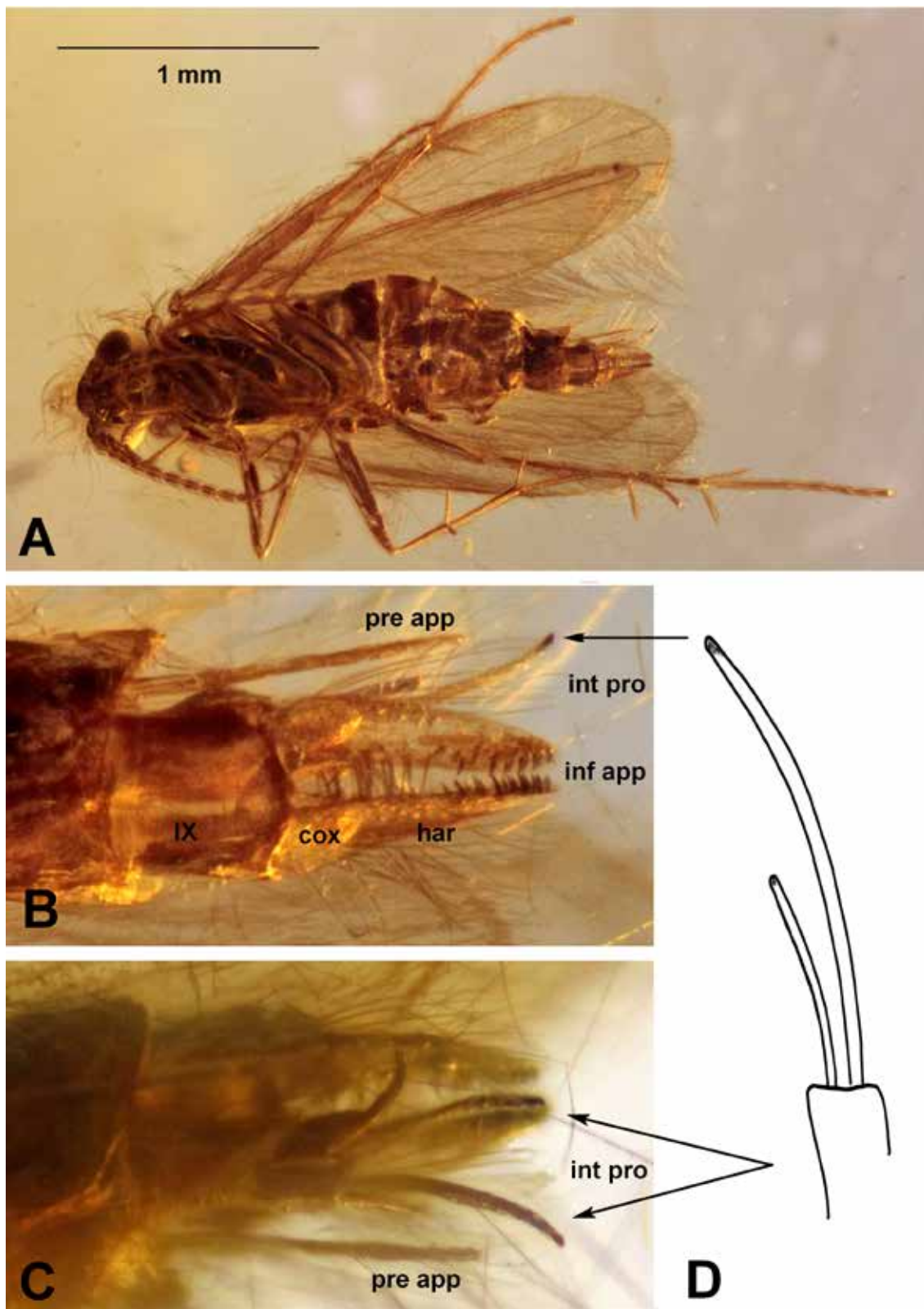


Fig. 4. *Palerasnitsynus sukatchevae* n. sp. **A:** Male holotype (MB.I 7298) in ventrolateral view. **B:** Male genitalia in ventral view. **C:** Male genitalia in dorsal view (via the hyaline wings). **D:** Short outer and long inner, rod-shaped branches of an intermediate processes.

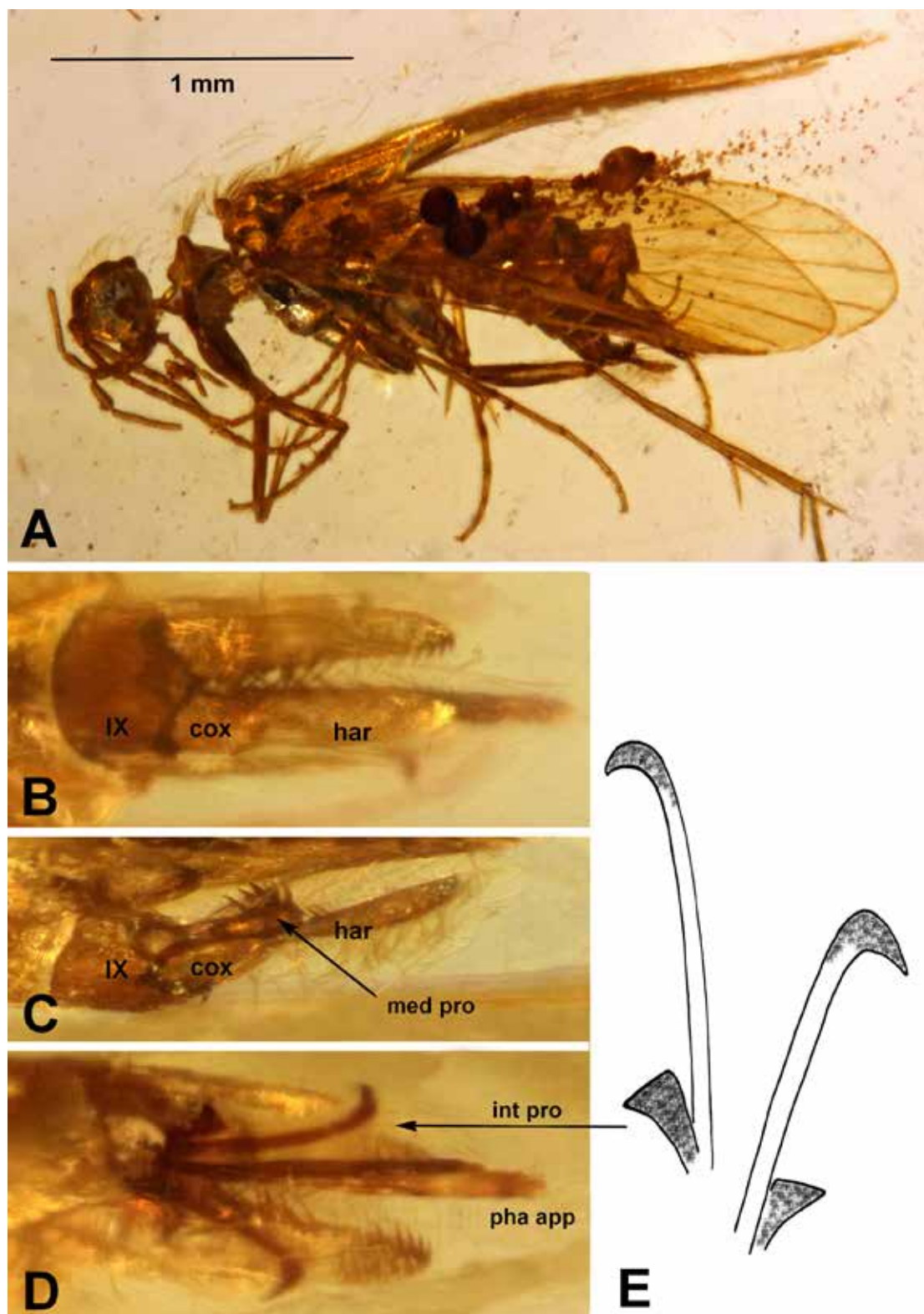


Fig. 5. *Palerasnitsynus spinosus* n. sp. **A:** Male holotype (MB.I 7299) in lateral view, partially covered by artificial dark bubbles. **B:** Male genitalia in ventral view. **C:** Male genitalia in lateral view, with a medio-distad processes of coxopodites bearing strong dark spines. **D:** Male genitalia in dorsal view, with the pair of terminal branches of the intermediate processes. **E:** A pair of short subtriangular outer and long rod-shaped inner branches of the intermediate processes.

Palerasnitsynus lepidus n. sp.

Fig. 6

E t y m o l o g y : *P. lepidus*, named after the graceful (= lepidus) species.

H o l o t y p e : Male embedded in Cretaceous Burmese amber, kept in the amber collection of the Museum für Naturkunde in Berlin, inventory number MB.I 7300 (ex coll. PATRICK MÜLLER, BUB 2590). The holotype well preserved in clear amber. Hindwings dorsally covered by forewings, venation of forewings in dorsal view, hindwing venation partially visible; male genitalia visible in ventral view.

D i a g n o s i s : Male *P. lepidus* sp. n. (forewing length 1.8 mm, 21 flagellomeres) can be distinguished from other *Palerasnitsynus* in the genital intermediate processes, all branches of equal lengths and needle-like. In ventral view the inferior appendages consisting of a plane sub-ovoid coxopodite and a small half-round harpago (type A).

D e s c r i p t i o n : Male, tiny adult with general characters of the genus, forewing length 1.8 mm, antennae with 21 cylindrical flagellomeres, plus scapus and pedicellus.

M a l e g e n i t a l i a (Fig. 6B) with inferior appendages each divided in a plate-like coxopodite and a small harpago. In ventral view coxopodite forms a sclerotized sub-ovoid lobe; the harpago small, simple, half-round, rising latero-apically from coxopodite. In ventral view preanal appendages digitate, long, overlapping the inferior appendages, curved mediad. The needle-like branches of the paired intermediate processes all of equal length, each inner branches curved ventrad, each outer branches running straight; in ventral view the four branches reach the level of the preanal appendages.

Palerasnitsynus gracilis n. sp.

Fig. 7

E t y m o l o g y : *P. gracilis*, named after the slim (= gracilis) phallic apparatus.

H o l o t y p e : Male NIGP154981, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Burmese amber. The holotype is well preserved in clear amber; venation of forewings in dorsal view, hindwing venation partially and male genitalia visible in ventral and dorsal view.

D i a g n o s i s : Male *P. gracilis* sp. n. (forewing length 1.8 mm, 26 flagellomeres) can be distinguished from all other *Palerasnitsynus* in male genitalia: The phallic apparatus stalked, slim, terminally (phallus) forming a widened "Y" apex.

D e s c r i p t i o n : Male, adult with general characters of the genus, forewing length 1.8 mm, antennae consisting of 26 flagellomeres, plus scapus and pedicellus. Third segment of maxillary palps latero-apical clearly equipped with spines, a character of genus *Palerasnitsynus* (Fig. 7C).

M a l e g e n i t a l i a (Fig. 7B) with inferior appendages broad at base, then tapering, at the apex curved mediad. In ventral view the outer margin straight, at the apex arcuate; the inner margin concave. The medio-distad process of inferior appendages thumb-shaped with latero-apical long, fine setae. The preanal appendages rod-shaped almost half-long as the inferior appendages. The intermediate processes not well visible. The phallic apparatus stalked, slim, terminally (phallus) forming a widened "Y" apex.

Palerasnitsynus vulgaris n. sp.

Fig. 8

E t y m o l o g y : *P. vulgaris*, very common (= vulgaris) in Burmese amber.

H o l o t y p e : Male embedded in Cretaceous Burmese amber, kept in the amber collection of the Museum für Naturkunde in Berlin, inventory number MB.I 7301 (ex coll. PATRICK MÜLLER, BUB 2573). The holotype is well preserved in clear amber. Hindwings covered partially by forewings; male genitalia visible in ventral and dorsal views.

P a r a t y p e s : MB.I 7302 (BUB 2574) and MB.I. 7303 (BUB 2577) kept in the amber collection of the Museum für Naturkunde in Berlin (ex coll. PATRICK MÜLLER).

A d d i t i o n a l m a t e r i a l : BUB 2579, BUB 2775, and BUB 2776 in private coll. PATRICK MÜLLER.

D i a g n o s i s : Male *P. vulgaris* n.sp. (forewing length 2.5 mm, 26 flagellomeres) can be distinguished from other *Palerasnitsynus* in male genitalia: In ventral view a pair of conspicuously slender and curved inferior appendages, at apex with short black spines, type C. Phallic apparatus stalked almost as long as the inferior appendages; the apex (phallus) densely surrounded by black spines. The intermediate branches almost needle-like, the outer one twice as long as the inner branch and slightly forked at the terminal part.

D e s c r i p t i o n : Male, adult with general characters of the genus, forewing length 2.5 mm, antennae with scapus (little stronger than flagellomeres), pedicellus (little smaller than flagellomeres) and further 26 flagellomeres. Third segment of maxillary palps latero-apically clearly equipped with spines, a typical character of the genus *Palerasnitsynus* (Fig. 1A).

M a l e g e n i t a l i a (Fig. 8B–D) with inferior appendages (gonocoxites) divided in a coxopodite and a longer harpago, about 1 : 2 in length. In ventral view conspicuously curved, at the apex expanded, curved mediad, bearing short black spines. The medio-distad process rising laterally from basal coxopodite, lengthwise with long setae. Preanal appendages digitate, half as long as inferior appendages. The intermediate process consists of two branches, the outer one is about twice as long as the inner branch. In ventral view the outer branch divides in a basal and a terminal part, about 3 : 1 in length, the apical part is needle-like, the basal part broader. The short inner branch is needle-like, with a small, black dilation at the apex. Phallic apparatus stalked almost as long as the inferior appendages; the apex (phallus) is armed with black spines.

Palerasnitsynus subgrandis n. sp.

Fig. 9

E t y m o l o g y : *P. subgrandis*, a comparatively large-sized (= grandis) species within the small-sized *Palerasnitsynus*.

H o l o t y p e : Male NIGP154982, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Well preserved in a Burmese amber. Hindwings covered dorsally by forewings; venation of forewings in dorsal view; hindwing venation partially visible; male genitalia visible in ventral and dorsal views.

P a r a t y p e s : Two males embedded together in one Burmese amber, NIGP154983, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences.

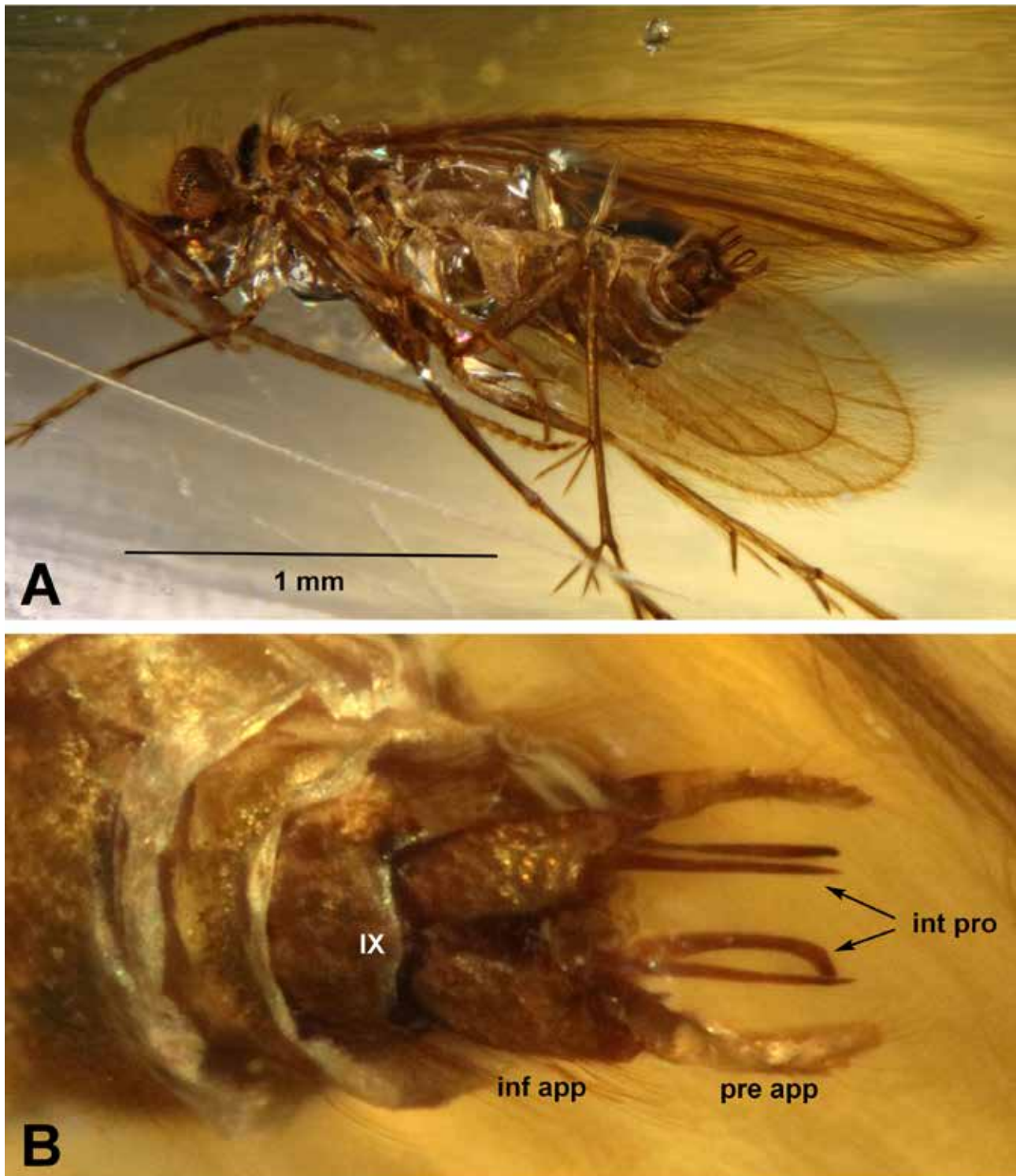


Fig. 6. *Palerasnitsynus lepidus* n. sp. **A:** Male holotype (MB.I 7300) in ventral view. **B:** Male genitalia in ventral view.

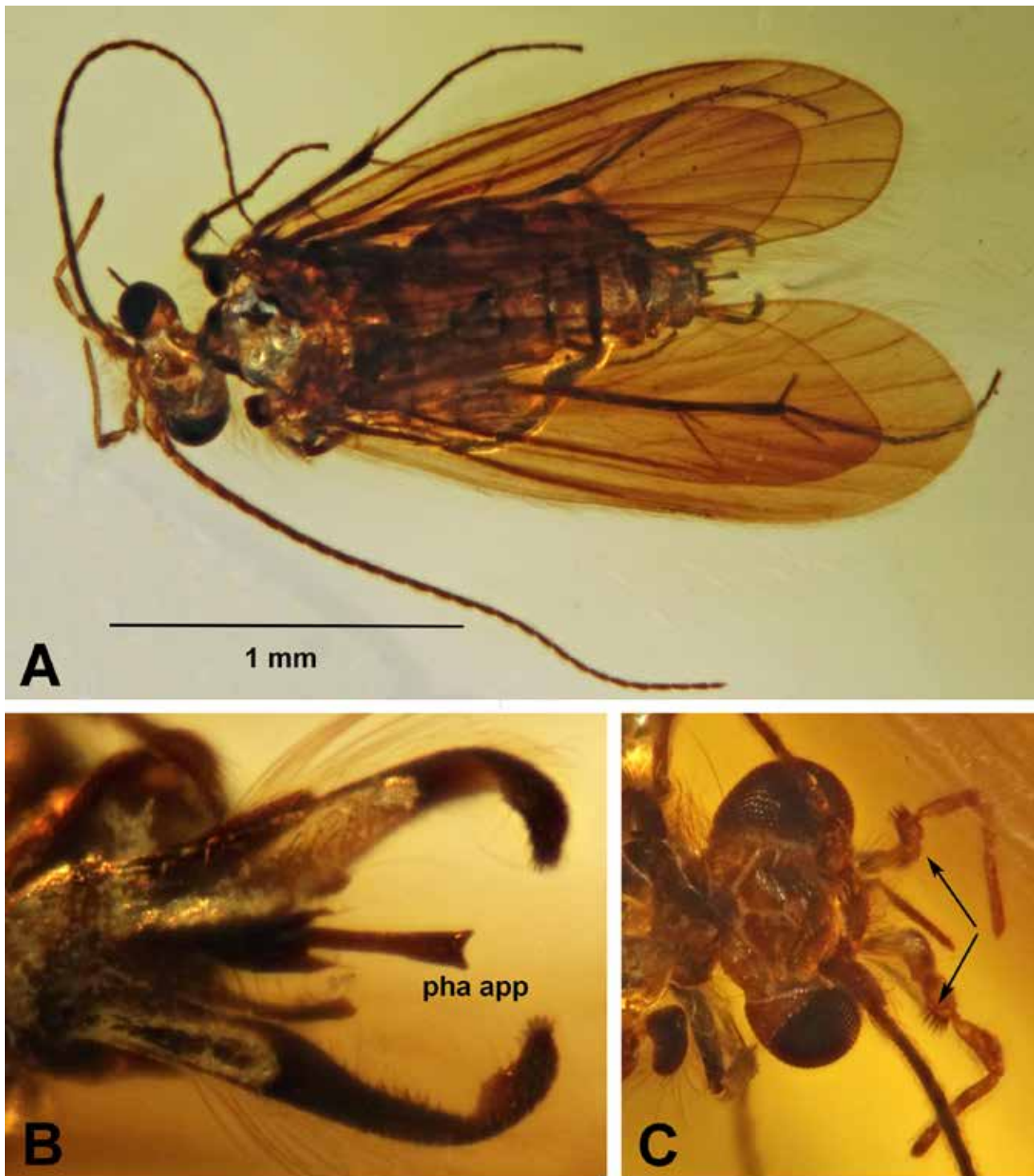


Fig. 7. *Palarasnitsynus gracilis* n. sp. **A:** Male holotype (NIGP154981) in ventral view. **B:** Male genitalia in ventral view. **C:** Head in dorsal view demonstrating dark sporns at the 3rd maxillary palp segments (arrows).

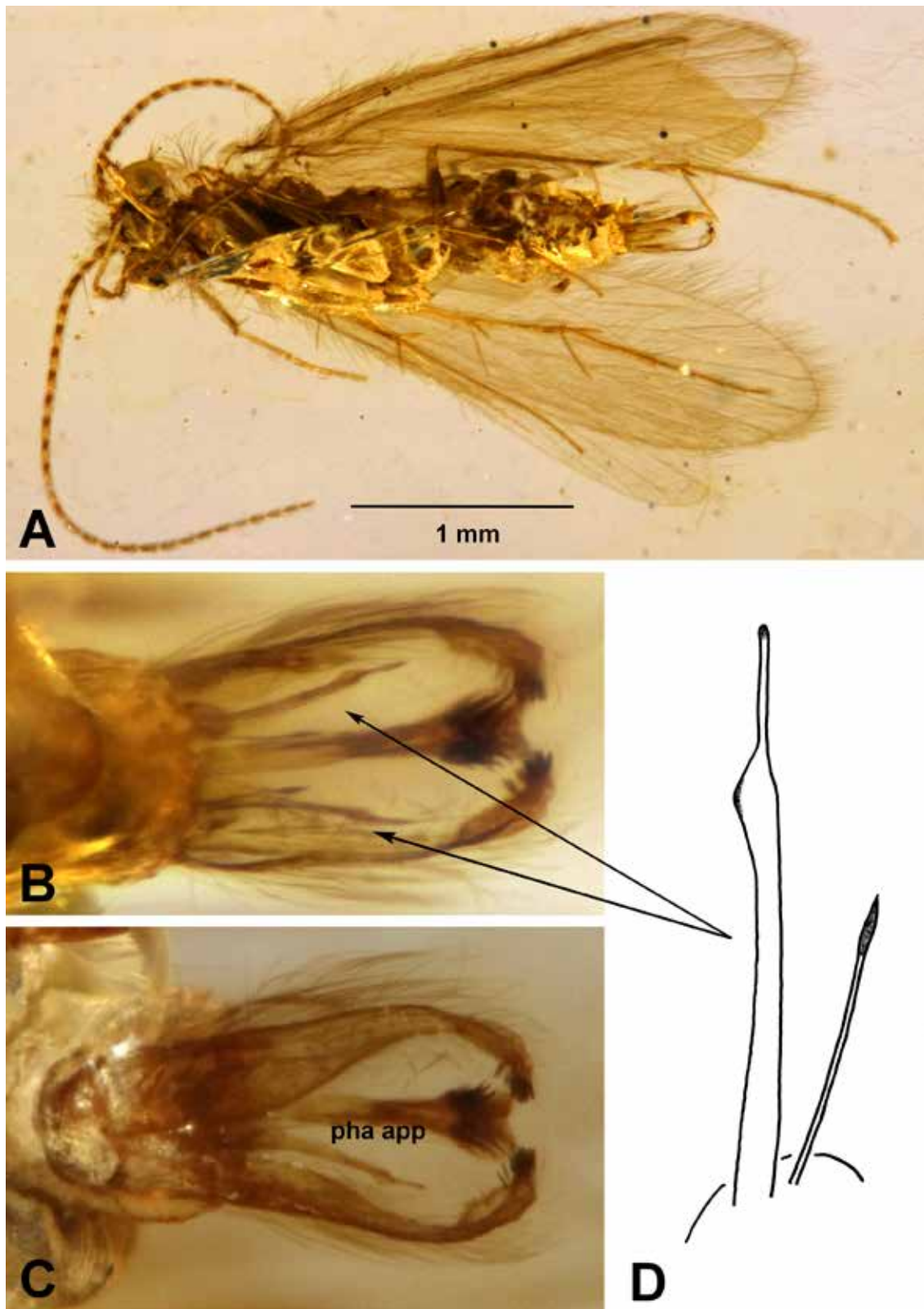


Fig. 8. *Palerasnitsynus vulgaris* n. sp. **A:** Male holotype (MB.I 7301) in ventral view. **B:** Male genitalia of paratype (MB.I 7302) in dorsal view. **C:** Male genitalia of paratype (MB.I 7303) in ventral view. **D:** Drawing of long outer and short inner branches of one of the paired intermediate processes.

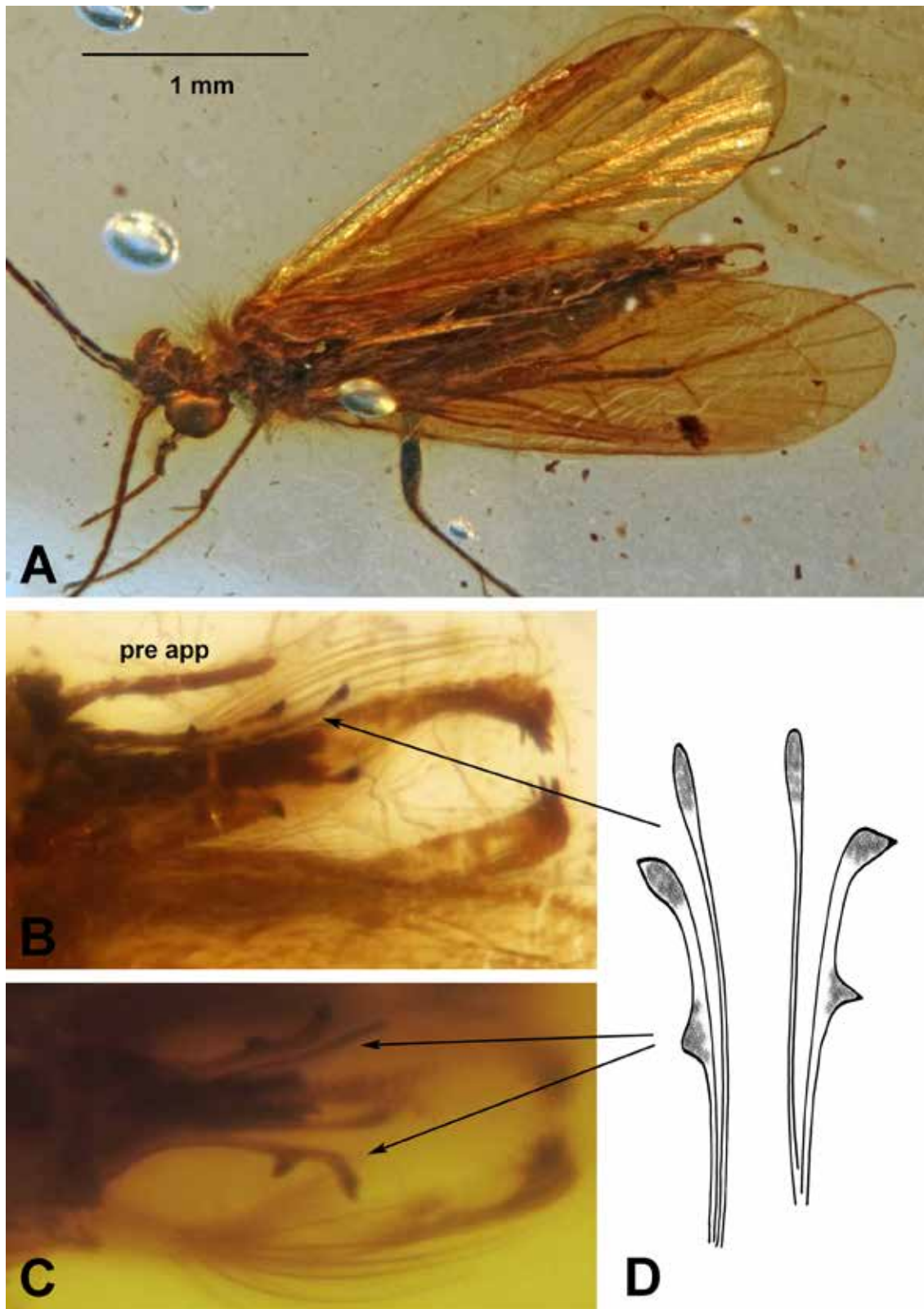


Fig. 9. *Palerasnitsynus subgrandis* n. sp. **A:** Male holotype (NIGP154982) in dorsal view. **B, C:** The genitalia of two paratypes in ventral view, embedded together in one Burmese amber (NIGP154983). **D:** Drawing of a pair of outer and inner branches of the intermediate processes.

Diagnosis: Male *P. subgrandis* n. sp. (forewing length 2.6 mm, 30 flagellomeres) can be distinguished from other *Palerasnitsynus* species by the paired genital intermediate process each consisting of a long and tapered inner branch and a short outer branch, which is forked into two strong spines.

Description: Male, adult with general characters of the genus, forewing length 2.5 mm, antennae with stronger scapus, short pedicellus and about 30 flagellomeres.

Male genitalia in ventral view (Fig. 9B–D): Inferior appendages long, outer margin almost straight, stiff; the inner margin sinusoid; basal part of the inferior appendages broad, with convex inner margin, in distal part mesally curved, with concave inner margin, at apex with some dark spines. Preanal appendages digitate, about half as long as inferior appendages. Phallic apparatus stalked, about as long as preanal appendages, phallus at the apex with two half-rounded lobes. The pair of intermediate processes running on both sides of the phallic apparatus, forming distally altogether four branches, each with black ends; the inner branches longer than the outer ones, curved slightly latero-dorsad.

Palerasnitsynus furcatis n. sp.

Fig. 10

Etymology: *P. furcatis*, named after the forked (= furcatis) branches of the intermediate processes.

Holotype: Male embedded in Cretaceous Burmese amber, kept in the amber collection of the Museum für Naturkunde in Berlin, MB.I 7304 (ex coll. PATRICK MÜLLER, BUB 543). The holotype well preserved in clear amber. Hindwings covered dorsally by forewings, both wings incomplete.

Paratypes: Males enclosed in a small Burmese amber, NIGP154984; four males enclosed in one Burmese amber, NIGP154985, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences.

Diagnosis: Male *P. furcatis* n. sp. (forewing length 2 mm, 26 flagellomeres) can be distinguished from other *Palerasnitsynus* species by the inferior appendages (type C) and by the intermediate process consisting of two branches of same lengths, inner branch tapered, outer branch at apex subtriangular with a lateral strong spine.

Description: Male, adult with general characters of the genus, forewing length 2 mm, antennae with stronger scapus, short pedicellus and about 26 flagellomeres.

Male genitalia (Fig. 10B–D): Inferior appendage running almost straight, at basis and in the middle broad, inner margin convex, afterwards the inferior appendage bent mediad, inner margin slightly concave, the apex with dark spines; the medio-distad process originated from coxopodite running straight, almost half as long as the inferior appendages, lengthwise with long setae. Preanal appendages slightly bent mediad, half as long as inferior appendage, at apex expanded, knob-shape, hairy. Phallic apparatus stalked, apically (phallus) notched, with two lateral lobes. The shape of the paired intermediate process, each with two branches, characterise the new species: the branches of same lengths, inner branch tapered, outer branch apically subtriangular, one vertex pinnated, the other one stump.

Palerasnitsynus subglobolus n. sp.

Fig. 11

Etymology: *P. subglobolus*, named after the closed ring of the paired inferior appendages in ventral view.

Holotype: Male NIGP154986, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. The holotype well preserved in Burmese amber, embedded together with some small artefacts; hindwings covered dorsally by forewings, hindwing venation and male genitalia partially visible in ventral view; head shrivelled.

Diagnosis: Male *P. subglobolus* n. sp. (forewing-length 2.4 mm, 30 flagellomeres) can be clearly distinguished from other species of *Palerasnitsynus* by the inferior appendages, simple, thin and elongate, almost uniform in total lengths.

Description: Male, adult with general characters of the genus. Forewing length 2.5 mm, antennae with strong scapus, short pedicellus and about 30 flagellomeres.

Male genitalia (Fig. 11B, C) in ventral views, inferior appendages simple, thin and elongate, uniform in total lengths, curved slightly mediad, apex subtriangular, inner margin lengthwise with strong setae; a weak crossing from coxopodite to harpago; a medio-distad process rising from basal coxopodite, straight, almost half as long as the inferior appendages, lengthwise with long setae. In lateral view inferior appendages bearing lengthwise a small membranous fringe tapered distad. Preanal appendages half as long as inferior appendage, curved mediad, at apex thickening in the shape of a bulb. Phallic apparatus stalked, short, the apex (phallus) notched, with two long lobes. The intermediate processes and their branches not clearly visible.

4. Key to the species of *Palerasnitsynus* from Cretaceous Burmese amber

Genus characters: Dark sporns at the 3rd maxillary palp segment (Fig. 1A, arrow) and the absence of fork III in fore- and hindwings (Fig. 1B).

Male genitalia in ventral view:

- 1 inferior appendages scaled ovoid, short (Fig. 2A) *P. lepidus* n. sp.
- inferior appendages scaled oblongness, straight or slightly arcuate (Fig. 2B) 2
- inferior appendages elongated, arcuate, curved mediad (Fig. 2C) 4
- 2 medio-distad process of inf. app. stump, covered with dark spines *P. spinosus* n. sp.
- medio-distad process of inf. app. straight, apically with long setae 3
- 3 preanal appendages straight, rod-shaped *P. sukatchevae* n. sp.
- preanal appendages digitate, sometimes twisted *P. ohlhoffi*
- 4 phallic apparatus elongate, phallus bifid, forming a widened “Y” apex 5
- phallic apparatus elongate, phallus bifid, forming apically two half-rounded lobes 6
- 5 phallus simple, slim, without processes *P. gracilis* n. sp.
- phallus enclosed by dark spines *P. vulgaris* n. sp.

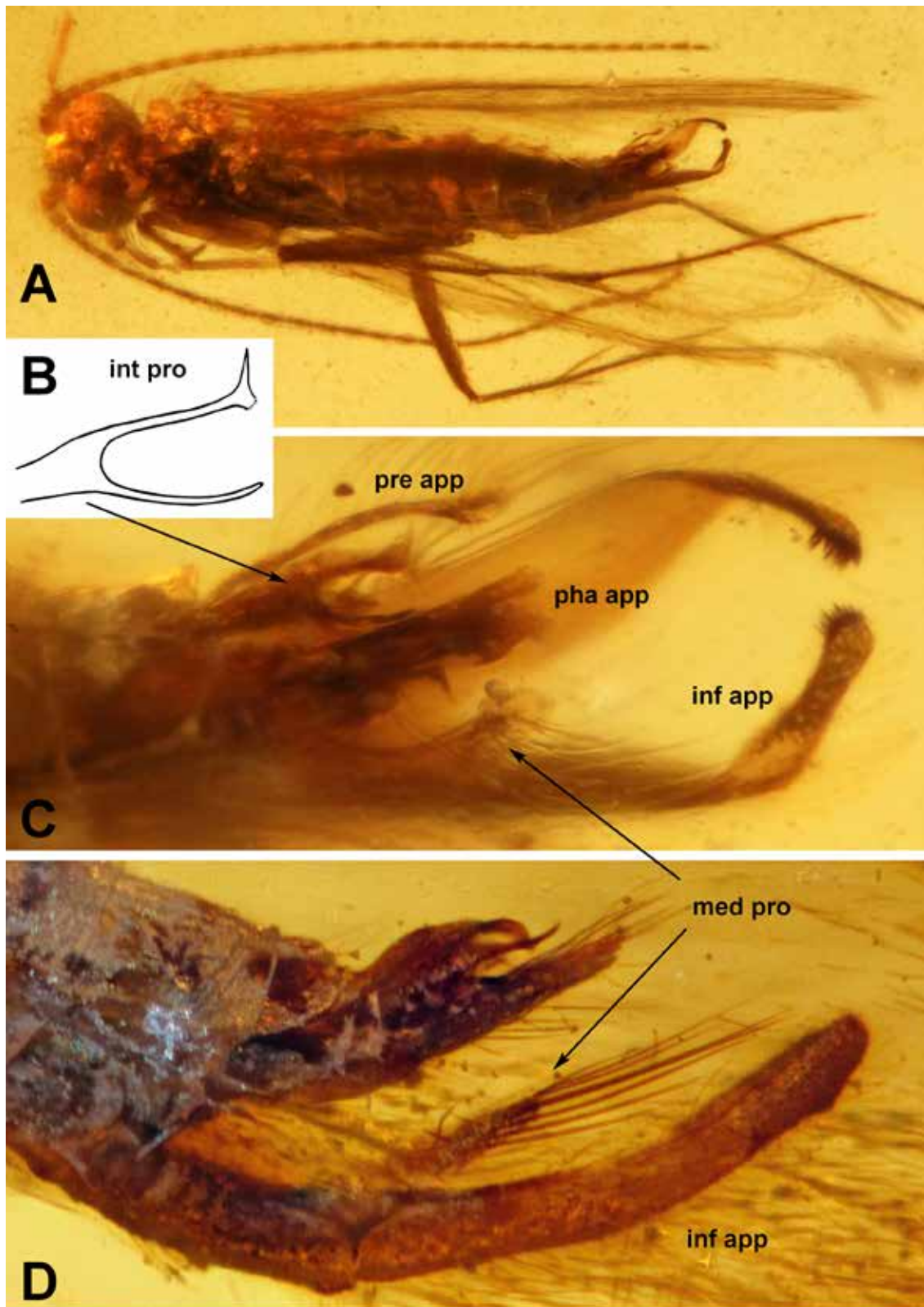


Fig. 10. *Palerasnitsynus furcatis* n. sp. **A:** Male holotype (MB.I 7304) in laterodorsal view. **B:** Drawing of an intermediate process with the terminal two branches. **C:** Male genitalia in laterodorsal view. **D:** Male genitalia of the paratype (NIGP154985) in dorsal view, the medio-distad process bearing long setae.

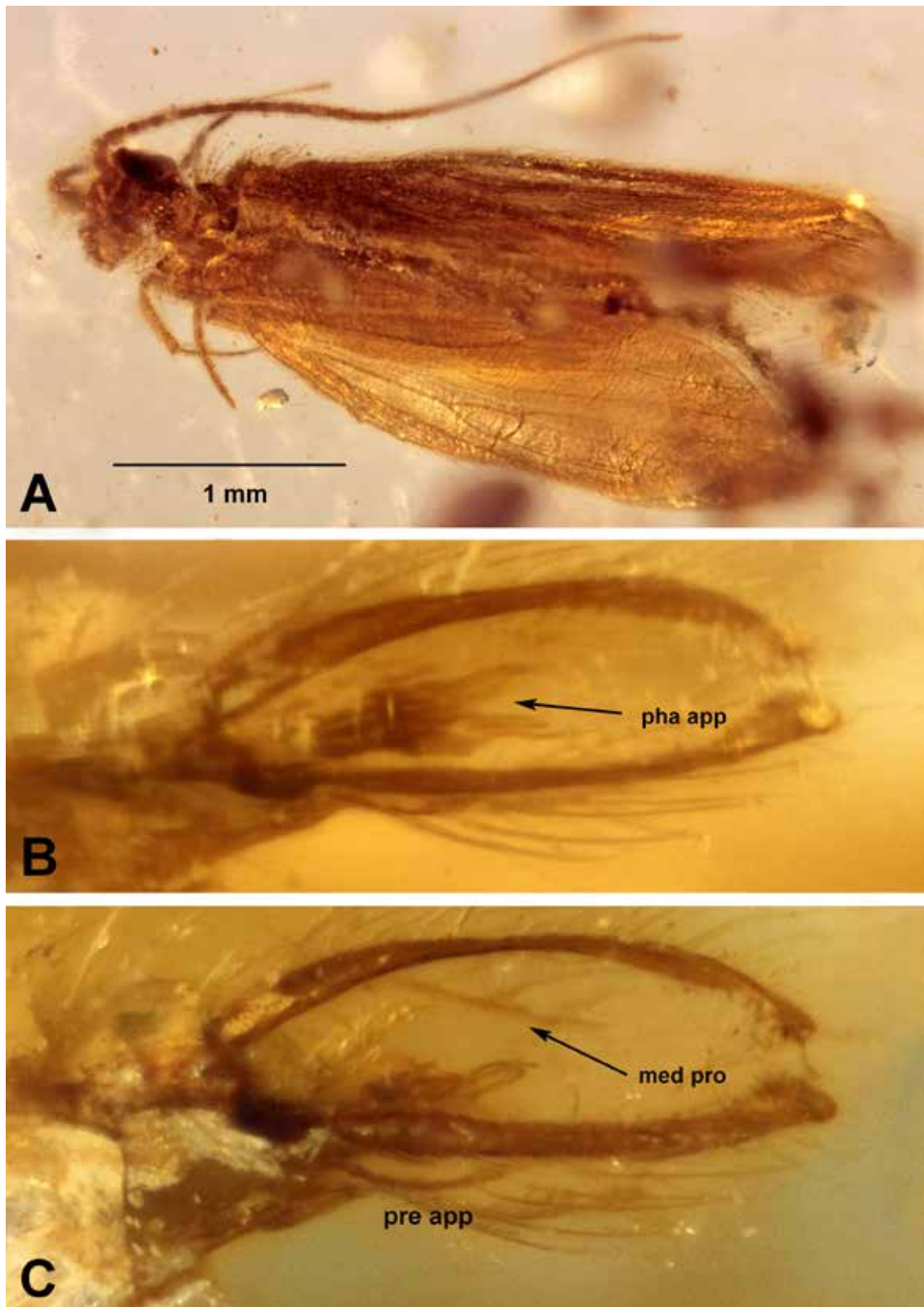


Fig. 11. *Palerasnitsynus subglobolus* n. sp. **A:** Male holotype (NIGP154986) in dorsal view. **B:** Male genitalia in ventral view, phallic apparatus with two terminal elongate lobes. **C:** Male genitalia in ventrolateral view, medio-distad process rod-shaped, preanal appendages curved mediad.

- 6 inferior appendages in ventral view uniform, simple, elongate *P. subglobolus* n. sp.
- inferior appendages basally broad convex, then tapering concave 7
- 7 branches of intermediate appendages unequal in length; inner branch longer than outer branch, apically forked; preanal appendages rod-shaped, simple *P. subgrandis* n. sp.
- branches of intermediate appendages equal in length, inner branch pointed, outer branch widened apically; preanal appendages rod-shaped, apically with a small knob *P. furcatis* n. sp.

5. Discussion

Fossil psychomyiids are known from the Eocene Baltic, Saxonian and Rovno ambers and belong to the extant genus *Lype* McLACHLAN, 1878 (IVANOV et al. 2016). Stratigraphically older fossils are found in Cretaceous deposits. *Arkharina oblimata* SUKATCHEVA, 1982 comes from the Upper Cretaceous of south-eastern Siberia. Originally placed in the family Philopotamidae, it belongs to Psychomyiidae (LI & MORSE 1997). At present, the oldest psychomyiid species come from mid-Cretaceous Burmese amber, belonging to the extinct genus *Palerasnitsynus*, with its type species *Palerasnitsynus ohlhoffi* WICHARD, ROSS & ROSS, 2011.

Adults of *Palerasnitsynus* species are very small and have forewings with lengths of 1.8–2.6 mm. They are smaller than most Hydroptilidae and can be also called micro-caddisflies. The tiny specimens of *Palerasnitsynus* are very numerous and account at present for almost 60 % of all caddisflies in Burmese amber. The majority of these specimens belongs to few species, such as *P. furcates* or *P. vulgaris*. Often they can be found in aggregations with

20 to 100 specimens in one piece of amber, thus indicating swarming activities of the adults (Fig. 12).

From the current point of view, the population of *Palerasnitsynus* is the greatest of all caddisflies in Burmese amber. Therefore, the number of extinct *Palerasnitsynus* species is likely to increase in further amber studies.

Acknowledgements

This research was supported by the National Natural Science Foundation of China (41572010, 41622201, 41688103), the Strategic Priority Research Program (B) of the Chinese Academy of Sciences (XDB26000000), and the grant (No. Y229YX5105) from the Key Laboratory of the Zoological Systematics and Evolution of the Chinese Academy of Sciences. We thank ANDREW ROSS and an anonymous reviewer for their linguistic corrections and critical remarks, which significantly helped to improve the paper. Last but not least, many thanks to the editor GÜNTER SCHWEIGERT for giving the paper its final shape.

6. References

- HOLZENTHAL, R. W., BLAHNIK, R. J., PRATHER, A. L. & KJER, K. M. (2007): Order Trichoptera KIRBY, 1813 (Insecta), Caddisflies. – *Zootaxa*, **1668**: 639–698.
- IVANOV, V. D., MELNITSKY, S. I. & PERKOVSKY, E. E. (2016): Caddisflies from Cenozoic resins of Europe. – *Paleontologicheskii Zhurnal*, **5**: 53–61.
- KANIA, I., WANG, B. & SZWEDO, J. (2015): *Dicranoptycha* OSTEN SACKEN, 1860 (Diptera, Limoniidae) from the earliest Upper Cretaceous Burmese amber. – *Cretaceous Research*, **52**: 522–530.
- KIRBY, W. (1815): Strepsiptera, a new order of insects proposed, and the characters of the order, with those of its genera. – *Transactions of the Linnean Society of London, Zoology*, **11**: 86–122.

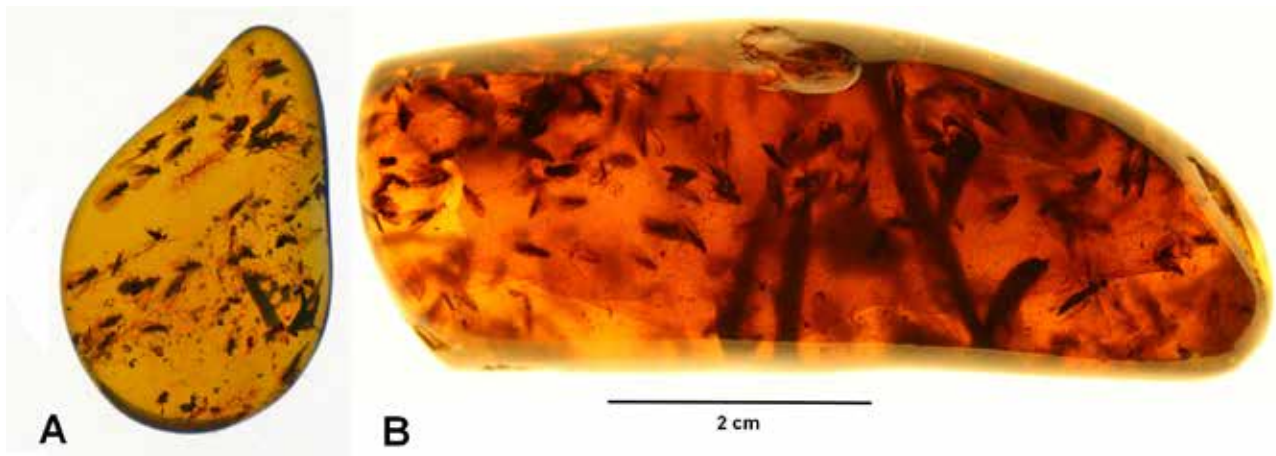


Fig. 12. Swarming caddisflies. **A:** About 20 specimens of *Palerasnitsynus furcatis* n. sp. (NIGP154987, deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences). **B:** Almost 100 specimens of *Palerasnitsynus vulgaris* embedded together with a few other syninclusions (BUB 2926, coll. P. MÜLLER).

- LI, Y. J. & MORSE, J. C. (1997): Phylogeny and classification of Psychomyiidae (Trichoptera) genera. – In: HOLZENTHAL, R. W. & FLINT, O. S. Jr. (eds.): Proceedings of the 8th International Symposium on Trichoptera: 271–276; Columbus (Ohio Biological Survey).
- MARTYNOV, A. V. (1924): Rucheyniki (caddisflies). – *Prakticheskaya Entomologiya*, **5**: 1–384 (in Russian).
- McLACHLAN, R. (1878): A monographic revision and synopsis of the Trichoptera of the European fauna, **7**: 349–428; London (Napier).
- SHI, G., GRIMALDI, D. A., HARLOW, G. E., WANG, J., WANG, J., YANG, M., LEI, W., LI, Q. & LI, X. (2012): Age constraint on Burmese amber based on U-Pb dating of zircons. – *Cretaceous Research*, **37**: 155–163.
- SUKATSheVA, I. D. (1982): The historical development of the order of caddisflies. – *Trudy Paleontologicheskogo Instituta Akademii Nauk SSSR*, **197**: 1–107. (In Russian).
- WALKER, F. (1852): Catalogue of the Specimens of Neuropterous Insects in the Collection of the British Museum, Part I: Phryganides–Perlides. 192 pp.; London (British Museum).
- WICHARD, W. & WANG, B. (2016): New Cretaceous caddisflies from Burmese amber (Insecta, Trichoptera). – *Cretaceous Research*, **61**: 129–135.
- WICHARD, W., ROSS, E. & ROSS, A. (2011): *Palerasnitsynus* gen. n. (Trichoptera, Psychomyiidae) from Burmese amber. – *ZooKeys*, **130**: 323–330.

Addresses of the authors:

WILFRIED WICHARD, Institut für Biologie, Universität zu Köln, Gronewaldstr. 2, 50931 Köln, Germany;

PATRICK MÜLLER, Friedhofstraße 9, 66894 Kähofen, Germany;

BO WANG, State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China & Center for Excellence in Life and Palaeoenvironment, Chinese Academy of Sciences, Nanjing 210008, China; Key Laboratory of Zoological Systematics and Evolution, Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China.

E-mails: wichard@uni-koeln.de; pat14789@web.de; bowang@nigpas.ac.cn

Manuscript received: 14 June 2018, revised version accepted: 24 July 2018.