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Diagnostics and updated checklist of Oriental *Pseudopostega* (Opostegidae), including the *matrona* species group with a new, extralimital species discovered in the Mediterranean

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Abstract

We provide diagnostics for eight species groups of Oriental *Pseudopostega* Kozlov (Lepidoptera: Opostegidae) and a pictorial key for their identification. We designate three new species groups, *P. frigida* and *P. strigulata* groups, and the *P. auritella* group for two Palaearctic species, and rename the *P. nigrimaculella* group as the *P. matrona* group. We assign *P. euryntis* (Meyrick), *P. zelopa* (Meyrick), and *P. subviolaceae* (Meyrick), three formerly unplaced species, to species groups based on re-examination of male and female genitalia. We list 22 currently known Oriental *Pseudopostega* species, and synonymize *Pseudopostega spilodes* (Meyrick), syn. nov., with *P. machaerias* (Meyrick). One new Mediterranean species with affiliations to the Oriental fauna, *P. matrona* Karsholt & Remeikis, **sp. nov.**, is described. The new species is illustrated with photographs of the adults and male genitalia. Additionally, we provide a distribution map of the *P. matrona* group, now extralimital to the Oriental region.

Keywords: Fauna, new species, pictorial diagnostics, South East Asia, white eye-cap moths

Introduction

Opostegidae, or white eye-cap moths, are among the smallest Lepidoptera, and their diversity, morphology, and ecology are remarkable. But they are wrapped in mystery because species are poorly known and insufficiently investigated, especially in tropical regions of the world. We estimate that currently the family Opostegidae is comprised of 204 species worldwide (including taxonomic changes in this paper): 198 named species and six additional documented, but unnamed, species in the genera *Opostegoides* Kozlov and *Pseudopostega* Kozlov from the Oriental region (Puplesis & Robinson 1999). The majority are from the Neotropics (95 species or 46.5% of the global fauna), followed by the Oriental fauna (44 species, i.e., 21.6% of the global fauna). Other biogeographical regions are less diverse: Holarctic region with 19 described species (12.7%), Pacific region (Hawaii) with 6 species (3%), Australian region with 18 species (8.8%), and Afrotropical region with 15 species (7.4% of the currently known world fauna). Species richness in the latter two biogeographical regions, especially the Afrotropics, is underestimated. In these regions, opostegids are even less studied than in other biogeographical areas, and therefore species numbers probably do not represent actual diversity and species numbers could be considerably higher. It should also be noted that Opostegidae are well-studied in boreal regions, including Europe and North America, but they are not as diverse as in tropical and subtropical regions (Davis & Stonis 2007; Stonis *et al*. 2020a).

Opostegidae are highly distinctive morphologically (Puplesis & Robinson 1999), and, together with its sister family Nepticulidae (Johansson *et al*. 1990), comprise a phylogenetically old lineage, the Nepticuloidea (Minet 1984; Kristensen & Nielsen 1980; Kristensen & Skalski 1999; Davis 1999; also see Regier *et al.* 2013 for a phy-

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logenetic discussion based on molecular data). Taxonomic inventory of these tiny, phylogenetically primitive lepidopterans, and other organisms, is important for many reasons, including the need to understand the complicated mechanisms of the global biota and the potential usage of lepidopteran data for monitoring biodiversity, and even for planning measures in the preservation of biodiversity in a rapidly changing world (Stonis *et al*. 2020a.).

Opostegidae adults are dorsoventrally flattened, with a wingspan ranging 4 to 16 mm, usually almost entirely white with very few markings, except for strigulae or short fine transverse lines at the forewing apex (Stonis *et al.* 2020b). There are a few exceptions worldwide where opostegid adults are not white, but instead are fuscous or adorned with a simple, pale brown or orange pattern (Eyer 1966; Puplesis & Robinson 1999; Davis & Stonis 2007). This includes the recently described, remarkably dark-coloured, *Notiopostega atrata* Davis (1989) from Chile and *Neopostega nigrita* Heppner & Davis (2009) from Guatemala. The head has a greatly expanded antennal scape (eye cap) that usually exceeds eye diameter and entirely covers the eye of a resting moth; the scape less expanded and smaller only in *Neopostega* Davis (Davis 1989). Like Nepticulidae, opostegids possess a frontal tuft comprised of erect piliform scales, but unlike nepticulids the tuft is small, simple, usually white, and only sometimes ochre or brown. The opostegid collar is unique in Lepidoptera; it is large and shield-like, covering the back of the head, partially overlapping the thorax, and comprised of smoothly arranged lamellar scales. In the male genitalia, opostegids are remarkable because they have a pedunculate cucullar lobe on the valva which bears a prominent pectinifer consisting of a single row of blunt spines and is connected to the valva by an elongate pedicellum (Davis & Stonis 2007). Detailed morphological characterization of Opostegidae was provided by Davis (1989), Puplesis & Robinson (1999), and most recently by Davis & Stonis (2007). Opostegidae biology is relatively obscure and not well studied (e.g., Grossenbacher 1910; Swezey 1921; Kumata 1984; van Nieukerken 1990; Puplesis & Diškus 2003). Biological data were sumarized by Davis (1989) and Davis & Stonis (2007), and briefly discussed by van Nieukerken *et al.* (2016). Larvae of some opostegid species were reported as cambium miners (Kumata 1984; Davis 1989), and as leaf or stem miners (Grossenbacher 1910; Swezey 1921; van Nieukerken 1990; Puplesis & Diškus 2003). It is interesting to note that, despite the very rarely seen immature stages due to their concealed feeding habits, in neotropical sites adults are frequently caught in light traps (Stonis *et al*. 2020b).

Opostegidae research early history. Although Opostegidae is widely distributed and morphologically distinctive, the literature is surprisingly scanty. The Euro-Asian *Pseudopostega auritella*, was the first described opostegid species; it was described more than two centuries ago (as *Tinea auritella*) by German entomologist Jacob Hübner from Europe (Hübner 1813). During the 19th and 20th centuries, many authors (cited in Davis 1989) contributed to studies of global opostegid fauna, including Lord Walsingham (1897, 1907, 1908, 1914) who described 11 species. Edward Meyrick (1854–1938) laid the foundation for modern systematics of the so-called Microlepidoptera (Hill 1939; Clarke 1955; Robinson 1986), coined the family name "Opostegides" for a subfamily of Tineidae in the late 19th century (Meyrick 1893) (a review on the history of generic taxonomy in Opostegidae was published recently by van Nieukerken *et al*. 2016), and was the most productive researcher during the initial stage of opostegid discovery. He described a great number of opostegid species from various regions: 16 species from southeastern Asia (Meyrick 1905, 1906, 1907, 1910, 1911a, 1915b, 1916, 1920, 1922), 14 species from South Africa (Meyrick 1911b, 1913, 1914, 1918, 1921a, 1928), 13 species from Australia and Tasmania (Meyrick 1880, 1893, 1915b, 1921b), and ten species from the Americas (Meyrick 1915a, 1920, 1931, 1935). Not unlike descriptions by other authors during the 19th and early 20th centuries, Meyrick's opostegid descriptions consisted of poorly diagnosed species. Descriptions were very short and based exclusively on external characters, without dissection of genitalia or documentation of immature stages or host plants. Currently, Opostegidae classification is based mostly on male genitalia characters, but many of Meyrick's specimens from Africa and Australia remain undissected. Dissection of Meyrick's material is greatly needed for species verification, diagnostics, and generic position.

Opostegidae recent research. The first taxonomic reviews on Opostegidae were published in recent decades (i.e., Davis 1989; Puplesis & Robinson 1999; Davis & Stonis 2007; Stonis *et al*. 2020b). In the first account, Davis (1989) listed 106 species in six genera. Three genera, *Notiopostega* Davis, *Paralopostega* Davis, and *Eosopostega* Davis, were described as new, and one subgenus, *Pseudopostega* Kozlov (1985), was elevated to genus level. Most of Meyrick's species were retained in *Opostega* Zeller by Davis (1989), however, upon dissection, these species may not be congeneric, and instead belong to other genera, such as *Pseudopostega* and *Opostegoides* Kozlov. Ten years later, Davis (1989) was followed by a taxonomic revision of Oriental Opostegidae by Puplesis & Robinson (1999) who discussed the phylogeny of opostegid genera and described 28 new species. Puplesis & Diškus (2003) listed these and other opostegid species in a world catalogue of Nepticuloidea and Tischerioidea. Opostegidae of

the Americas were first reviewed by Davis & Stonis (2007), who listed 91 species, including 68 new species and two new subspecies that were later upgraded to species status (van Nieukerken *et al.* 2016). Recently, based on the study of new material from Mexico, Costa Rica, Colombia, Ecuador, and Peru, eight new species were added by Remeikis *et al*. (2009) and Stonis *et al*. (2020b). Stonis *et al*. (2020b) also included an updated catalogue of 102 American opostegid species.

Opostegidae fauna of the Oriental region is diverse and speciose, second only to the Neotropical region. However, only two decades ago, the Oriental Opostegidae numbered a scant 17 species. Most of the species were not dissected and, therefore, with uncertain generic positions. The Oriental fauna was first reviewed by Puplesis & Robinson (1999); they dissected and studied Meyrick's type specimens and described 21 new species. Seven more new species were documented but left unnamed pending availability of additional material. In total, 45 species were reported from the Oriental region (Puplesis & Robinson 1999). In adjacent East Asia, four genera and 11 species had been recorded, nine species were endemic: *Opostega kuznetzovi* Kozlov, *O. stekolnikovi* Kozlov (1985), *Eosopostega issikii* Davis (1989), *Opostegoides minodensis* (Kuroko, 1982), *O. sinevi* Kozlov, *O. omelkoi* Kozlov (1985), *O. albella* Sinev, *O. bicolorella* Sinev, and *O. padiensis* Sinev (1990), and two, *Pseudopostega auritella* (Hübner) and *P. crepusculella* (Zeller) (Kozlov 1985), exhibited trans-Palaearctic distributions. Recently, species occurring in the Russian Far East were included in the Catalogue of Lepidoptera of Russia (Sinev 2008, 2019); no species overlap was reported between the Oriental fauna and adjacent East Asia fauna.

Opostegidae and species groups diagnostics. Opostegids are so distinct that they cannot be confused with any other lepidopteran family, but at the species level they are very similar and difficult to differentiate externally (Stonis *et al*. 2020b). Moreover, in the most speciose genus, *Pseudopostega*, the absence of a chitinized phallus and cornuti, variation of external and internal characters, and differences in genitalia mounts due to pressure by a cover slip that can change the angle of the gnathos, the most important diagnostic character in *Pseudopostega*, may often make identification difficult, and lead to misidentifications (Stonis *et al*. 2020b).

Within the Opostegidae, it became practical to establish the use of species groups within genera in order to improve taxonomic orientation and make species differentiation easier. These informal units for diagnostic purposes are traditionally used in the Nepticulidae (e.g., Johansson 1971; Wilkinson & Scoble 1979; Johansson *et al*. 1990; Puplesis & Diškus 2003; van Nieukerken *et al*. 2016; etc.), Opostegidae (Puplesis & Robinson 1999; Davis & Stonis 2007; Stonis *et al*. 2020b), and other families, including Tischeriidae, Incurvariidae, Elachistidae (see Kaila 2011, 2015; Kaila *et al*. 2015), and many others. Species groups are especially valuable for diagnostics in speciose genera, such as *Pseudopostega* that encompasses 64 % of the global opostegid fauna.

Recently, we revised *Pseudopostega* species groups of the Americas and provided a pictorial diagnostic tool for all twelve species groups (Stonis *et al*. 2020b). In this paper about the Oriental fauna, we revise all eight *Pseudopostega* species groups, and provide a pictorial diagnostic tool for species groups, including two new species groups, the *P. frigida* and *P. strigulata* groups, that are designated for the first time. We provide an updated checklist of Oriental *Pseudopostega* with some taxonomic changes based on re-examination of the male and female genitalia. We found that Oriental species groups are not known to occur outside of this region, except for one, the *nigrimaculella* species group, which we rename here the *P. matrona* group. We describe one new species, *Pseudopostega matrona* Karsholt & Remeikis, sp. nov., from the Mediterranean with affiliation to the Oriental fauna, and provide a pictorial diagnostic tool for this group. We also designate a new species group from the Palaearctic region, the *P. auritella* group, for comparative purposes with the Oriental *machaerias* group (see Discussion below).

We hope that this publication will stimulate further studies in the Oriental Opostegidae and contribute to a more detailed account of the diversity of these tiny lepidopterans.

Materials and methods

The description of the new species is based on material collected by Ole Karsholt in Turkey and deposited in the ZMUC. All other specimens, holotypes, and paratypes of previously described species were available for our study from the collections of NHMUK, NNM, and LEU.

Preparation of temporary and permanent micro-mounts of genital structures were undertaken following the conventional method described by Stonis *et al*. (2014). After maceration of the abdomen in 10% KOH and subsequent cleaning, male genitalia were mounted in Euparal.

Permanent slides were photographed and studied using a Leica DM2500 microscope and Leica DFC420 digital camera. Adults were photographed using a Leica S6D stereoscopic microscope with attached Leica DFC290 digital camera.

The descriptive terminology of morphological structures follows Puplesis & Robinson (1999) and Puplesis & Diškus (2003), except for the term "cilia", which is referred to here as "fringe".

Repositories: LEU – Lithuanian University of Educational Sciences, Vilnius, Lithuania (formerly abbreviated as VPU); NNM – National Natuurhistorisch Museum, Naturalis, Leiden, Netherlands; NHMUK – Natural History Museum, London, UK; ZIN – Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia; ZMUC – Zoological Museum, Natural History Museum of Denmark, Copenhagen, Denmark.

Diagnostics of species groups of Oriental *Pseudopostega*

The Oriental fauna of Opostegidae can be separated into four genera: *Opostegoides* Kozlov, *Eosopostega* Davis, *Opostega* Zeller, and *Pseudopostega* Kozlov. *Pseudopostega* is the most speciose genus worldwide (Davis 1989; Puplesis & Robinson 1999; Stonis *et al*. 2020b) and it comprises slightly more than half of the opostegid species (55%) in the Oriental region. Davis & Stonis (2007) designated fourteen species groups of *Pseudopostega* in the Americas, which were recently revised and illustrated by Stonis *et al*. (2020b). The species groups from the Oriental region in Puplesis & Robinson (1999) were not recognized in a catalogue by van Nieukerken *et al*. (2016). Nevertheless, below we revise the species groups of Oriental *Pseudopostega*, and, for diagnostic purposes, designate two new species groups, provide diagnostic notes, and a pictorial key for all eight species groups of *Pseudopostega* (Fig. 1). It should be noted that anterior apophyses are reduced in *Pseudopostega*, therefore the term "apophyses" refers to the posterior apophyses.

The *machaerias* group

Externally, species are characterized by dark markings (a spot or fascia) on the dorsal margin of the forewing; pure white, indistinctive frontal tuft of piliform scales on the vertex of the head. In the male genitalia, the uncus is comprised of two wide, short or long lateral lobes; the gnathos is a large plate with a distinctive, wide, non-spiny caudal process; and the vinculum has a distinctive, long, apically slightly widened, rod-like juxta (Fig. 1). In the female genitalia, apophyses are long; anal papillae with two rounded, closely set lobes or modified into a single, oval element (Fig. 1); the signum is absent (*P. machaerias*, *P. zelopa*), weakly developed, indistinctive (*P. epactaea*), well developed, lamellar (*P. parvilineata*), or spiny (*Pseudopostega* species 404).

From other groups of Oriental *Pseudopostega*, the *machaerias* group is distinguished by the combination of dorsal markings of the forewing, and gnathos with a large plate and distinctive, wide, non-spiny caudal process.

Distribution. Currently the group is comprised of four named and one unnamed species (see Introduction) distributed in India, Nepal, Sri Lanka, Indonesia, Thailand, Philippines, and Taiwan.

Remarks. Previously, *P. zelopa* was left unplaced in a species group (Puplesis and Robinson 1999). However, upon on re-examination of males and females of *P. zelopa*, we newly attribute this species to the *machaerias* group based on shared characters, including the apically widenned juxta in the male genitalia.

The *frigida* group

Externally, species are characterized by dark markings (a spot or fascia) on the costal margin of the forewing; a frontal tuft that is pure white to golden cream or dull yellow (*P. myxodes*), or orange-ochre (*P. subviolacea*). In the male genitalia, the uncus possesses two slender, short or long lateral lobes; the gnathos is a large plate with a distinctive, wide, spiny caudal process; and the vinculum has a distinctive, long, rod-like juxta (Fig. 1). In the female genitalia, apophyses are long; anal papillae are modified into a single, round, oval or triangular element (Fig. 1) (see Discussion); the signum is absent (*P. myxodes*), weakly developed, indistinctive (*P. subviolaceae*, *P. similantis*), or well-developed, lamellar (*P. frigida*).

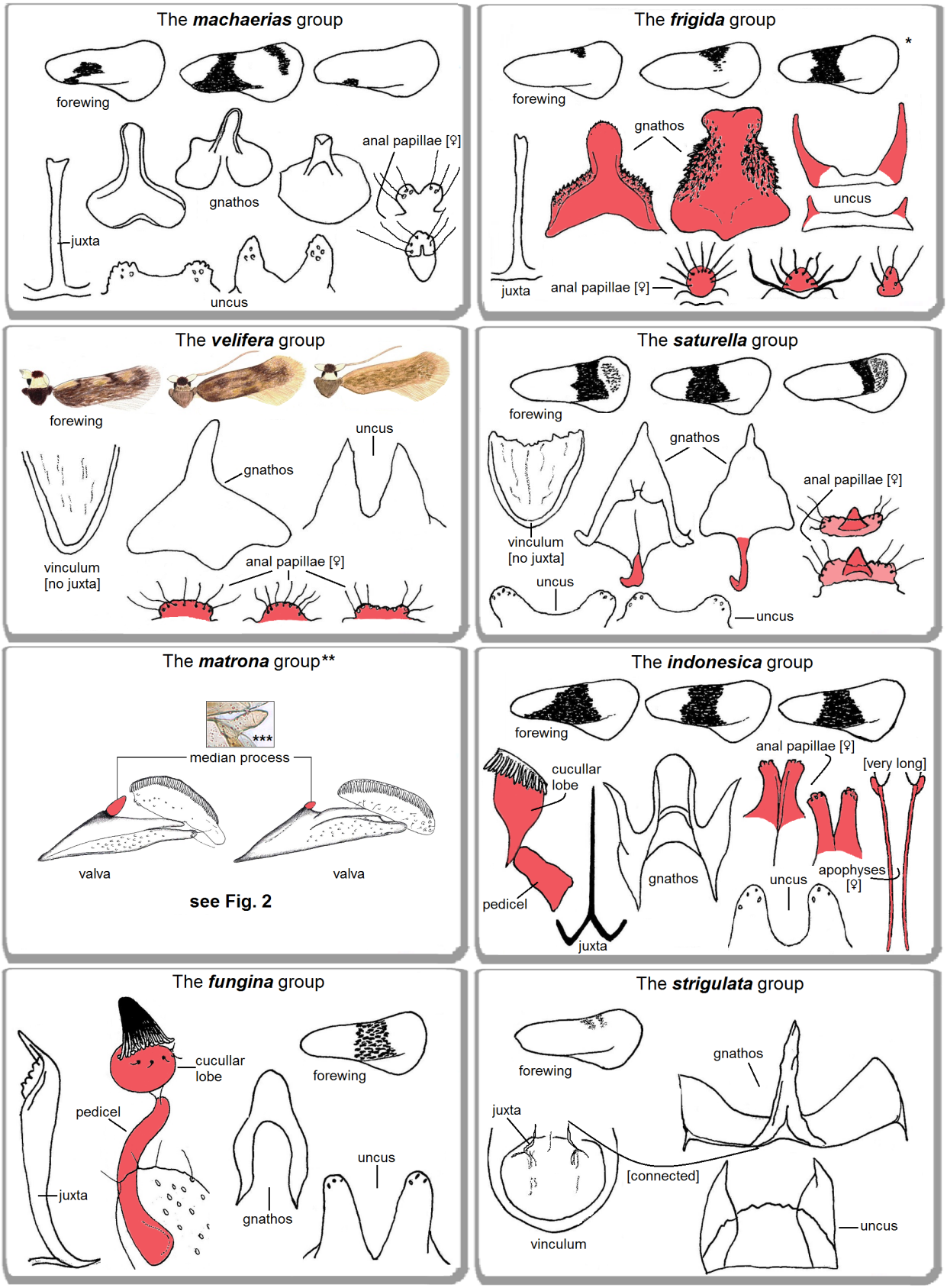


FIGURE 1. Pictorial diagnostic tool for identification of Oriental *Pseudopostega* species groups (Note: the morphological structures are drawn in different scales).

* – except for *P. similantis* with an indistinctive dorsal spot; ** – formerly the *nigrimaculella* group; *** – Mediterranean *P. matrona* sp. nov., described below

From other groups of Oriental *Pseudopostega*, the *frigida* group is distinguished by the combination of costal markings of the forewing, and a spiny gnathos.

Distribution. Currently the group is comprised of five species distributed in India, Nepal, Sri Lanka, Indonesia, Thailand, and Taiwan.

Remarks. Previously, *P. subviolacea* was left unplaced in a species group (Puplesis and Robinson 1999), but upon re-examination of the female genitalia of *P. subviolacea* we newly attribute this species to the *frigida* group because the anal papillae are modified into a single element, a character shared with other species in the *frigida* group.

The presence of modified anal papillae in the female genitalia makes the group distinctive (see Discussion).

The *velifera* group

Externally, species are characterized by the brown frontal tuft and dark pattern of the forewing, densely covered with brown and pale brown scales (except for the brownish cream costal margin in *P. sumbae* and three yellowish cream spots along the costa in *P. velifera*); apical strigulae and apical dot absent (Fig. 1). In the male genitalia, the uncus is comprised of two large, triangular lateral lobes; the gnathos is a triangular plate with a well-developed, slender caudal process; and the vinculum is without a juxta (Fig. 1). In the female genitalia, apophyses long; anal papillae are modified into a single, wide but short lobe (Fig. 1); the signum is strongly developed, lamellar, curved (*P. velifera* and *P. nepalensis*), or weakly developed (*P. sumbae*).

From other groups of the Oriental (or Neotropical) *Pseudopostega*, the *velifera* group is distinguished by the unique combination of a dark forewing and frontal tuft, absence of a juxta in the male genitalia, and single-lobed anal papillae in the female genitalia.

Distribution. Currently the group is comprised of three species distributed in India, Nepal, and Indonesia.

The *saturella* group

Externally, species are characterized by the dark brown fascia of the forewing (Fig. 1); creamish white or yellowish cream to ochreous yellow frontal tuft. In the male genitalia, the uncus is comprised of two short, rounded lateral lobes; the gnathos is uniquely-shaped, pointed apically and with a slender, hook-like projection basally; the vinculum is without a juxta, and heavily folded medially (Fig. 1). In the female genitalia, apophyses are long; anal papillae are unique, modified into a single, wide, short transverse lobe with a distinctive, trianglular process (Fig. 1); signum is strongly developed (*P. javae* and *P. amphivittata*) or weakly developed (*P. saturella*).

From other groups of the Oriental (or Neotropical) *Pseudopostega*, the *saturella* group is distinguished by the unique shape of the gnathos in the male genitalia and anal papillae with a distinctive, triangular process in the female genitalia.

Distribution. Currently the group is comprised of three species distributed in Thailand and Indonesia.

The *matrona* group (formerly the *nigrimaculella* group)

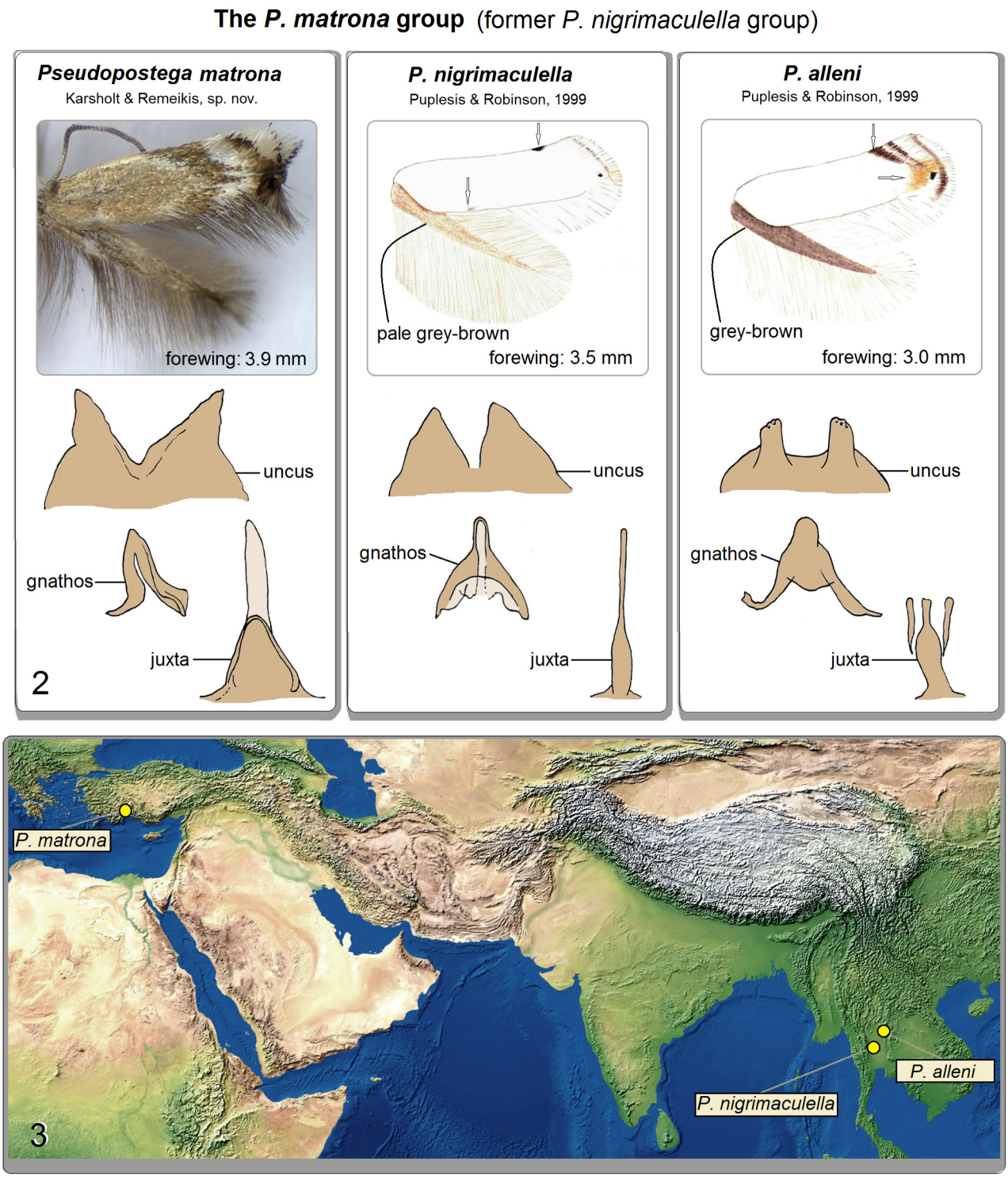
Externally, species possess various patterns of the forewing (Fig. 2), however, usually they have dark markings on the costal margin of the forewing; snow white frontal tuft. In the male genitalia, the uncus is comprised of two distinctive, but variously shaped lateral lobes (see Fig. 2); the gnathos is an inverted V-shape; the valva with a unique, short, oval-shaped, median process (Fig. 2); and the vinculum with a distinctive, elaborate, basally widened juxta. Females are unknown.

From other groups of Oriental (or Neotropical) *Pseudopostega*, the *matrona* group is easily distinguished by the unique median process of valva in the male genitalia (Fig. 2).

Distribution. Currently the group is comprised of two Oriental species from Thailand and one Mediterranean species described below (Fig. 3).

Remarks. The *nigrimaculella* group was erected in the taxonomic revision of the Oriental Opostegidae (Puple-

sis and Robinson 1999) based on two white-colored species described from Thailand: one possessing a tiny black costal spot on the forewing and another without a spot. The diminutive name *nigrimaculella* is derived from the Latin *nigrus* (black) and *macula* (a spot, stain) in reference to a black spot on the forewing of *P. nigrimaculella*. Because of the discovery of *P. matrona* sp. nov., described below, the concept of the species group was redefined. Within the species group, *P. matrona* sp. nov. is characterized by very distinctive external and internal (genital) characters but has no spot on the forewing. Because of the discovery of *P. matrona* sp. nov., we selected a new name for the species group: the *Pseudopostega matrona* group.



FIGURES 2–3. Diagnostic tool for species identification of the *Pseudopostega matrona* group and its distribution. 2, pictorial tool for species differentiation; 3, known distribution (map base, courtesy of T. Patterson, USA)

The *indonesica* group

Externally, species are characterized by a wide, dark brown or ochre fascia of the forewing; snow white frontal tuft. In the male genitalia, the uncus is comprised of two large, distally rounded lateral lobes; the gnathos is a small plate with large lateral arms and a large, distally rounded caudal process; the valva has a large, distinctive pedicel and triangular cucullar lobes; and the vinculum is bilobed anteriorly, with a distinctive, strongly thickened, rod-like juxta (Fig. 1). In the female genitalia, the apophyses are unique in comparison with other *Pseudopostega* because they are very long; the anal papillae with two deeply divided lobes (Fig. 1); and the signum is absent.

From other groups of Oriental *Pseudopostega*, the *indonesica* group is easily distinguished by the deeply bilobed vinculum, distinctive pedicel of the valva in the male genitalia, and the very long apophyses and deeply divided lobes of the anal papillae in the female genitalia.

Distribution. Currently the group is comprised of two species distributed in Indonesia, India, and Sri Lanka (Davis 1989), and possibly with wider distribution (D. R. Davis *pers. comm*.) (Fig. 1).

Remarks. Previously, *P. euryntis* was left unplaced in a species group (Puplesis & Robinson 1999). However, upon the study of the female holotype of *P. euryntis* we found it possesses all the diagnostic characters of the *indonesica* group: very long apophyses and deeply divided lobes of anal papillae. Therefore, we newly attribute *P. euryntis* to the *indonesica* group (see Checklist).

The *fungina* group

Externally, species are characterized by the brown fascia of the forewing (Fig. 1); cream or white frontal tuft. In the male genitalia, the uncus is comprised of two long, widely rounded lateral lobes; the gnathos is an inverted V-shape, with a short, wide, distally rounded caudal process; valva with a distinctive, long pedicel, small, rounded cucullar lobe, and a compact cluster of pectens of the pectinifer; and the vinculum with a large, distally pointed juxta (Fig. 1). Female is unknown.

The *fungina* group is distinguished from the other groups of the Oriental (or Neotropical) *Pseudopostega* by the combination of a large juxta, long pedicel of valva, small rounded cucullar lobes, and large lobes of the uncus in the male genitalia.

Distribution. Currently the group is comprised of a single species from India.

The *strigulata* group

Externally, species are characterized by the cream white forewing with a couple of oblique distal markings on the costal margin (Fig. 1); a white frontal tuft. In the male genitalia, the uncus is comprised of two large, distally pointed lateral lobes; the gnathos without a central plate, comprised of two very large lateral arms and a long, slender caudal process; and the vinculum with a membranous, laterally thickened juxta connected to the base of caudal process of the gnathos (Fig. 1). Female is unknown.

The *strigulata* group is distinguished from other groups of the Oriental (or Neotropical) *Pseudopostega* by the combination of large, distally pointed lobes of the uncus and the long, slender caudal process of the gnathos in the male genitalia.

Distribution. Currently the group is comprised of a single species from India (Fig. 1).

Updated checklist of the Oriental *Pseudopostega*

Pseudopostega Kozlov, 1985: 53, 54 (as a subgenus of *Opostega*).
Type species: *Tinea auritella* Hübner, 1813: Fig. 387.

The *machaerias* group

1. *Pseudopostega machaerias* (Meyrick, 1907)

Opostega machaerias Meyrick, 1907: 985, 986.
Pseudopostega spilodes (Meyrick, 1915), **syn. nov.**
Opostega spilodes Meyrick, 1915: 351, **syn. nov.**

Distribution. Sri Lanka, Thailand, India (southern).

Material examined. 1 ♂ (holotype), SRI LANKA, Maskeliya, iii.1906, Pole leg., genitalia slide no. 28648 (NHMUK). 1 ♂, THAILAND, Kanchanaburi, alt. 30 m, 10–11.ix.1986, G. S. Robinson leg., genitalia slide no. 28704 (NHMUK). 1 ♀, INDIA, Karnataka, Nilgiri Hills, N. Coorg, 14.xii.1906, L. Newcome leg., genitalia slide no. 28649 (NHMUK).

2. *Pseudopostega zelopa* (Meyrick, 1905)

Opostega zelopa Meyrick, 1905: 613.

Distribution. India (Assam), Nepal, Sri Lanka, Indonesia (Sumba, Timor), Thailand.

Material examined. 1 ♀ (holotype), SRI LANKA, Pundalu-oya, v.1903, Green leg., (NHMUK). 1 ♂, INDIA, Assam, Khasi Hills, v.1907, genitalia slide no. 28621 (NHMUK). 1 ♂, NEPAL, Terai, Dharan, secondary forest; 18.viii.1984, Allen leg. (NHMUK); 51 (uncounted mixture of males and females), 70 km W of Kathmandu, Baikuntapuri; 19.iv.1995, R. Puplesis leg., genitalia slide nos RP1001♂, RP1002♂, RP1012♀ (LEU, formerly abbreviated as VPU, with a further transfer to the collection of the Zoological Institute in St. Petersburg because of the LEU closure). 1 ♀, THAILAND, Uthai Thani District, Khao Nang Rum, 1.iii.1986, Allen leg., genitalia slide no. 28622 (NHMUK). 1 ♀, INDONESIA, SW Timor, xi–xii.1891, Doherty leg., genitalia slide no. 28806 (NHMUK); 2 ♂, Sumba, Lindi Watju, 27.ix–15.x.1949, Sutter & Wegner leg., genitalia slide nos Pupl.004♂, Pupl.020♂ (NNM); 2 ♀, same collection data as for preceding (NNM); 2 ♂, 7 ♀, Melolo, v–vi.1949, Sutter & Wegner leg. (NNM).

3. *Pseudopostega parvilineata* Puplesis & Robinson, 1999

Pseudopostega parvilineata Puplesis & Robinson, 1999: 31, 32.

Distribution. Indonesia: Sulawesi.

4. *Pseudopostega epactaea* (Meyrick, 1907)

Opostega epactaea Meyrick, 1907: 985.

Distribution. India, Sri Lanka, Indonesia (Java), Taiwan.

5. *Pseudopostega* species 404

Pseudopostega species 404, in Puplesis & Robionson 1999: 46
Distribution. Philippines.

Remarks. This species was documented but left unnamed by Puplesis & Robinson 1999.

The *frigida* group

6. *Pseudopostega frigida* (Meyrick, 1906)

Opostega frigida Meyrick, 1906: 416.

Distribution. Nepal, India (Rishikesh), Sri Lanka, Thailand (Chiang Mai), Indonesia (Sumba).

Material examined. 1♂ (lectotype) SRI LANKA, Peradeniya, ii.1905, Green leg., genitalia slide no. 28626 (NHMUK). 3♂, 1♀, INDIA, Rishikesh, 30°07′N, 78°19′E, alt. 550–650 m, Remeikis & Stonis leg., subtropical forest, genitalia slide nos RA273, RA274, RA275, RA276 (LEU, formerly abbreviated as VPU, with a further transfer to the collection of the Zoological Institute in St. Petersburg because of the LEU closure). 2 ♀, NEPAL, Chitwan National Park, Sauraha, 3–6.vi.1983, Allen, Brendell, Robinson & Tuck leg. (NHMUK); 1 ♂, 3 ♀, 70 km W of Kathmandu, Baikuntapuri, 19–21.iv.1995, Puplesis leg., genitalia slide nos RP1006, RP007, RP1008, RP1009 (LEU, formerly abbreviated as VPU, with a further transfer to the collection of the Zoological Institute in St. Petersburg because of the LEU closure). 1 ♂, THAILAND, Chiang Mai, alt. 325 m; 15–30.x.1984, Karsholt *et al.* leg., genitalia slide no. Pupl. 402 (ZMUC).

7. *Pseudopostega similantis* Puplesis & Robinson, 1999

Pseudopostega similantis Puplesis & Robinson, 1999: 33, 34.

Distribution. Indonesia (Sumba), Taiwan.

8. *Pseudopostega brevicaudata* Remeikis & Stonis, 2013
(Figs. 12–14)

Pseudopostega species 28623, Puplesis & Robinson 1999: 35–36.

Distribution. Nepal (Kathmandu).

9. *Pseudopostega myxodes* (Meyrick, 1916)

Opostega myxodes Meyrick, 1916: 619.

Distribution. India (Patna region), Indonesia (SW Timor).

10. *Pseudopostega subviolacea* (Meyrick, 1920)

Opostega subviolacea Meyrick, 1920: 357.

Distribution. India (western, lowlands).

Material examined. Material examined. 1 ♀ (holotype), INDIA, Gujarat, Kharaghoda, 17.viii.1919, Maxwell leg., genitalia slide no. 28655 (NHMUK).

The *velifera* group

11. *Pseudopostega velifera* (Meyrick, 1920)

Opostega velifera Meyrick, 1920: 357.

Distribution. India: Bombay.

12. *Pseudopostega nepalensis* Puplesis & Robinson, 1999

Pseudopostega nepalensis Puplesis & Robinson, 1999: 37.

Distribution. Nepal (tropical forest zone).

Material examined. 3 ♀ (holotype and paratypes), NEPAL, 70 km W of Kathmandu, Baikuntapuri, 19–20.iv.1995, Puplesis leg., genitalia slide nos RP1010 (paratype), RP1011 (holotype) (LEU, formerly abbreviated as VPU, with a further transfer to the collection of the Zoological Institute in St. Petersburg because of the LEU closure).

13. *Pseudopostega sumbae* Puplesis & Robinson, 1999

Pseudopostega sumbae Puplesis & Robinson, 1999: 37, 38.

Distribution. Indonesia: Sumba.

The *saturella* group

14. *Pseudopostega saturella* Puplesis & Robinson, 1999

Pseudopostega saturella Puplesis & Robinson, 1999: 38, 39.

Distribution. Indonesia (Java, Sulawesi, Sumba), Thailand.

Material examined: 1 ♂ (holotype), INDONESIA, Sulawesi Utara, Dumoga-Bone National Park, alt. 200–300 m, iii.1985, Project Wallace leg., lowland forest, genitalia slide no. 28692 (NHMUK). 1 ♀, THAILAND, Nakhon Nayok Province, KhaoYai National Park, alt. 700 m, 29.ix–6.x.1984, Karsholt *et al*. leg., genitalia slide no. Pupl.400 (ZMUC).

15. *Pseudopostega javae* Puplesis & Robinson, 1999

Pseudopostega javae Puplesis & Robinson, 1999: 39.

Distribution. Indonesia: Java.

16. *Pseudopostega amphivittata* Puplesis & Robinson, 1999

Pseudopostega amphivittata Puplesis & Robinson, 1999: 39, 40.

Distribution. Indonesia: Sulawesi.

The *matrona* group

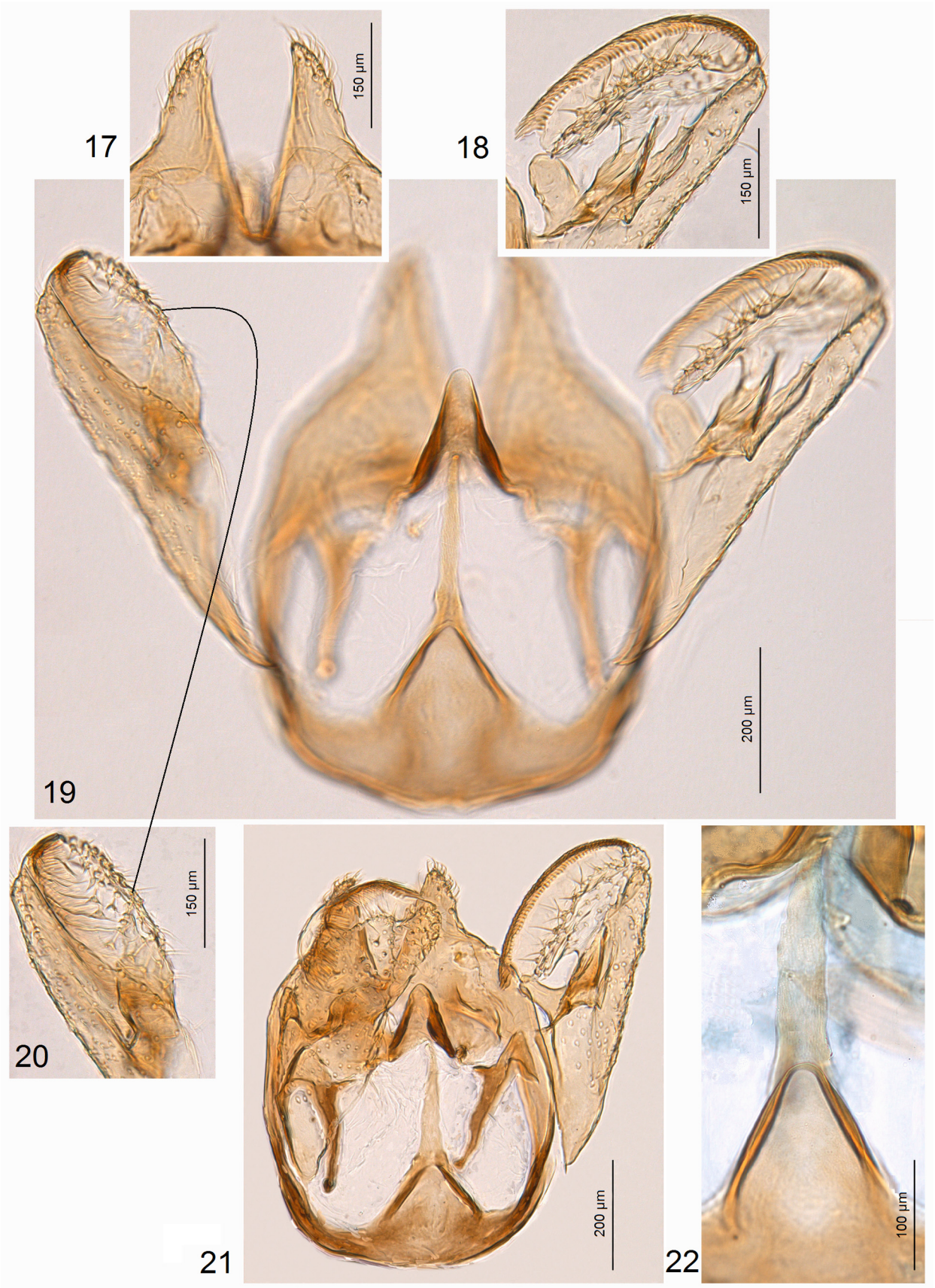
17. *Pseudopostega nigrimaculella* Puplesis & Robinson, 1999

Pseudopostega nigrimaculella Puplesis & Robinson, 1999: 40.

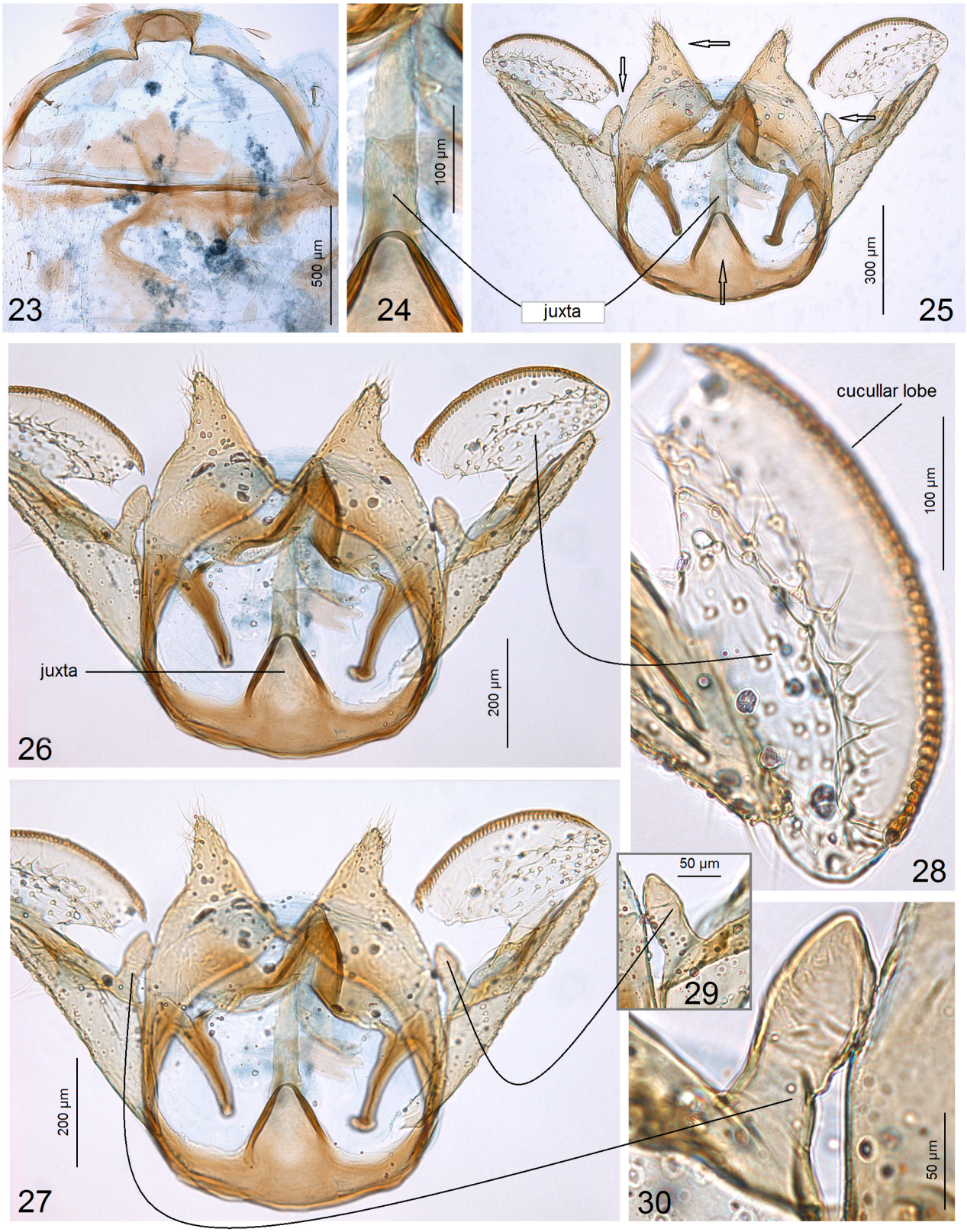
Distribution. Thailand.

Material examined. 1 ♂ (holotype), THAILAND, Loei Province, Phu Luang Wildlife Sanctuary, 8–14.x.1984, Karsholt *et al*. leg., genitalia slide no. Pupl.401 (ZMUC).

FIGURES 4–16. Male adult of *Pseudopostega matrona* Karsholt & Remeikis **sp. nov.**, holotype (ZMUC). 4–6, details of the head, dorsal view; 7, general view, right side; 8, 9, fragments of hindwing, upper side; 10, head, ventral view; 11, general view; 12, white scales of the forewing; 13, apex of forewing, upper side; 14, abdomen; 15, 16, apex of abdomen
ap.d. – apical dot; *c. str.* – costal strigulae; *t. str.* – tornal strigula; *tft.* – tuft of piliform scales



FIGURES 17–22. Male genitalia of *Pseudopostega matrona* Karsholt & Remeikis **sp. nov.** 17, holotype, genitalia slide no. RA1084, uncus (ZMUC); 18, same, cucullar lobe; 19, same, capsule; 20, same, apex of valva, ventral view; 21, paratype, genitalia slide no. RA1083, capsule (ZMUC); 22, paratype, genitalia slide no. OKarsholt5083, juxta (ZMUC)



FIGURES 23–30. Documentation of abdominal fragment and male genitalia of *Pseudopostega matrona* Karsholt & Remeikis **sp. nov.,** genitalia slide no. OKarsholt5083 (ZMUC). 23, sternum of 2nd abdominal segment; 24, juxta; 25, capsule, general view; 26, 27, same, at different focus; 28, cucullar lobe; 29, median process, left side of the capsule; 30, same, right side of the capsule, enlarged

18. *Pseudopostega alleni* Puplesis & Robinson, 1999

Pseudopostega alleni Puplesis & Robinson, 1999: 40, 41.

Distribution. Thailand.

Material examined. 1 ♂ (holotype), THAILAND, Uthai Thani District, Khao Nang Rum, 6–8.vi.1986, Allen leg., genitalia slide no. 28805 (NHMUK).

The *indonesica* group

19. *Pseudopostega indonesica* Puplesis & Robinson, 1999

Pseudopostega indonesica Puplesis & Robinson, 1999: 41, 42.

Distribution. Indonesia: Sulawesi, Sumba.

20. *Pseudopostega euryntis* (Meyrick, 1907)

Opostega euryntis Meyrick, 1907: 985.

Distribution. India.

Material examined. 1 ♀, INDIA, Karnataka, Nilgiri Hills, N. Coorg, Dibidi, 18vi.1906, Newcome leg., genitalia slide no. 28624 (NHMUK).

The *fungina* group

21. *Pseudopostega fungina* Puplesis & Robinson, 1999

Pseudopostega fungina Puplesis & Robinson, 1999: 42, 43.

Distribution. India.

The *strigulata* group

22. *Pseudopostega strigulata* Puplesis & Robinson, 1999

Pseudopostega strigulata Puplesis & Robinson, 1999: 45, 46.

Distribution. India: Assam.

Description of a Mediterranean species with affiliations to an Oriental species group

We discovered a new species based on dissection and identification of opostegid specimens collected in Turkey by Ole Karsholt in 1993. It shares many characters, including the median process of the valva, with two other species in the *P. matrona* group (formerly called the *P. nigrimaculella* species group) (Fig. 1). The *P. matrona* species group was previously known only from Thailand, but now it also includes a species from the eastern Mediterranean, which greatly expands its distributional range worldwide. Therefore, we describe this new species, *Pseudopostega matrona* Karsholt & Remeikis, **sp. nov**., and provide a pictorial diagnostic tool for species of this group (Fig. 2).

***Pseudopostega matrona* Karsholt & Remeikis, sp. nov.**
urn:lsid:zoobank.org:act:C615037C-7B30-4194-9EBE-753415C33E73

Type material. Holotype: ♂, TURKEY, 40 km NE of Antalya, road to Köprülü Canyon, National Park, alt. 200 m, 28–29.iv.1993, Karsholt leg., genitalia slide no. RA1084 (ZMUC). Paratypes: 2 ♂, same collection data as for holotype, genitalia slide nos RA1083, Karsholt5083 (ZMUC).

Diagnosis. Externally, the new species differs from other members of the *matrona* species group by the golden glossy, grey-brown, apically ornated forewing (*P. nigrimaculella* Puplesis & Robinson and *P. alleni* Puplesis & Robinson possess a snow-white forewing with very few markings apically). In the male genitalia, *P. matrona* sp. nov. differs from *P. nigrimaculella* by the basally very wide and strongly chitinized juxta, and from *P. alleni* by the large, triangular lobes of uncus, distally pointed gnathos, and very long juxta (Fig. 2).

Male (Figs. 4–16). Forewing length 3.8–4.1 mm; wingspan 8.5–8.8 mm (n = 3). Head: palpus cream, short; frontal tuft large, comprised of piliform, snow-white scales (Figs. 4, 5); collar very large, distally slightly bilobed (Figs. 4, 6), comprised of lamellar, grey-brown scales with strong golden gloss; scape very large, snow-white, distally with some bronze scales; antenna golden glossy, pale grey-brown, exceeding 2/3 of the forewing. Thorax and tegula grey-brown with strong golden gloss and little purple iridescence. Forewing (Fig. 7) grey-brown with golden gloss and little purple iridescence in basal half and with white and dark grey-brown markings in apical half (Fig. 13). Apex of forewing curved up, with a large, black apical dot, three brown-black costal strigulae and one brown-black tornal strigula, and a distinctive tuft of dark piliform scales; fringe grey-brown; forewing underside dark grey-brown, without spots or androconia. Hindwing and fringe dark grey-brown with golden gloss and little purple iridescence on upper side and underside. Legs grey-brown with golden gloss and some cream scales, especially abundant on hindleg underside. Abdomen brown with strong golden gloss and little purple iridescence on upper side, pale brown with golden gloss and many white-tipped scales on underside; genital plates golden cream, contrasting with colour of the abdomen (Figs. 15, 16); anal tufts yellowish cream, short (Fig. 14).

Male genitalia (Figs. 17–30). Capsule 735–770 µm long, 565–590 µm wide. Uncus with two very large lateral lobes and wide median excavation (Figs. 17, 26). Gnathos inverted V-shaped, with a large central element (Figs. 2, 19, 26). Valva 580–610 µm long, with a large, 320–390 µm long cucullar lobe (Fig. 28) and about 110 µm long median process (Figs. 27, 29); transtilla absent. Juxta strongly chitinized, wide, triangular proximally, slender, little chitinized distally (Figs. 2, 24, 25). Vinculum widely rounded, without lateral lobes.

Female. Unknown.

Bionomics. Based upon specimens available, adults fly in late April. The type specimens were netted during the day by sweeping the vegetation in a moist meadow with low bushes – in an otherwise agricultural area. Otherwise, biology is unknown.

Distribution. This species is known from a single locality in southern Turkey, eastern Mediterranean, at an elevation of about 200 m.

Etymology. The species name is a noun, derived from the Latin *matrona* (a matron), with reference to the exceptionality of the new species, possessing the most distinctive external as well as internal (genital) characters within the species group. In ancient Rome, *matron* was applied to a women high status, typically the respected mother of the family or household.

Discussion

The Oriental *Pseudopostega* fauna seems to be isolated geographically, except for the new species, *P. matrona*, from the Mediterranean. There is no geographic overlap at the species level and very little at the species group level between the fauna of the Oriental region and the rest of world.

We made some significant observations regarding opostegid variation and/or distribution of characters in the male and female genitalia. We found that the anal papillae in the female genitalia of *Pseudopostega* is an important character. It shows morphological variation in *Pseudopostega* worldwide, and, as such, may provide useful characters for diagnostic and phylogenetic purposes. There are at least four different morphological types of the anal papillae in the females of the Oriental *Pseudopostega* (Fig. 1): 1) bilobed anal papillae (with two distinctive lateral lobes) in the *indonesica* group; 2) papillae in a shape of a single, thickened, oval or round element in the *frigida* group, but

also in some species of the *machaerias* group; 3) papillae in a shape of slender transverse lobe without projection medially in the *velifera* group; 4) papillae in a shape of slender transverse lobe with a distinctive triangular, caudally pointed projection medially in the *saturella* group. In the Western Hemisphere, many species of the *Pseudopostega* species groups are characterized by a bilobed anal papillae, with the lobes either distinctly separated or close to each other. There are very few exceptions in the Neotropical fauna where the anal papillae are not bilobed: *P. acrodicra* Davis & Stonis, *P. protomochla* (Meyrick), *P. venticola* (Walsingham), *P. paromias* (Meyrick), and *P. elachista* (Walsingham) (see Davis & Stonis 2007). Bilobed anal papillae are also characteristic for *Paralopostega* species. The most remarkable and highly derived anal papillae occur in the *frigida* group, where the shape of the single element is round, and in the *saturella* group where the shape of the single element is a slender transverse lobe with a triangular projection (Fig. 1).

We also observed morphological similarities in male genitalia between Oriental species groups and two species groups in the Western Hemisphere and one in the Palaearctic region. In the male genitalia, the Oriental *machaerias* group resembles *spatulata* and *triangularis* species groups from the Western Hemisphere (see Stonis *et al*. 2020b). However, the *machaerias* group does not possess the basal fold of the gnathos, and most likely represents an independently derived entity from the species groups of the Western Hemisphere. The *machaerias* group also resembles the Palaearctic *auritella* group, which is newly designated here, and is comprised of the trans-Palaearctic *Pseudopostega auritella* (Hübner, 1813) and *P. crepusculella* (Zeller, 1839). However, in the male genitalia the *auritella* group is characterized by the absence of a juxta (present and well-developed in the *machaerias* group), and in the female genitalia by slender, distinctly separated anal papillae and a short outer canal of the ductus spermathecae. The Oriental *frigida* group also resembles the *spatulata* group from the Western Hemisphere (see Stonis *et al*. 2020b), however, the *frigida* group possesses a modified anal papillae in the female genitalia, and a spined gnathos in the male genitalia, but does not possess the basal fold of the gnathos, and, therefore, represents a separate entity from the *spatulata* group.

We expanded and refined the morphological concept of the *matrona* species group (previously called the *nigrimaculella* group) upon discovery of *P. matrona* from the Palaearctic region. It is now the only Oriental species group that has a representative species outside the Oriental region. However, it is possible that there are undiscovered species in this group. Although species of the *matrona* group are slightly different externally, the unique small median process on the valva is a highly consistent and robust character for group's definition. We hypothesize that it is an apomorphic character and the *matrona* group represents a monophyletic group. All three species are easily differentiated by the forewing pattern and by unique morphology of male genitalia structures, such as the uncus, gnathos, and particularly the juxta (Fig. 2).

Contributions to the research

Contributions to this research are as follows: JRS: concept and design of research, diagnostics of new species, manuscript writing, and technical preparation of illustrations; AR: dissection, photographic documentation and measurement of *P. matrona*, provided measurement scales for illustrations, discussion on diagnostics of *P. matrona*, participation in preparation of Fig. 1, manuscript writing; MAS: observations concerning specimens at the National Museum of Natural History, Smithsonian Institution, Washington D.C., manuscript writing, scientific expertise of data, elaboration of the concept, and discussion on results; OK: collection of all type series adults of *P. matrona* in Turkey and *P. nigrimaculella* in Thailand, preparation of genitalia slide no. 5083 (ZMUC), recognized that the Turkish specimens represented an undescribed species, and contributed to the first and final versions of the manuscript.

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