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Description of *Phyllium (Phyllium) conlei*, new species,
and a first look at the Phylliidae (Phasmatodea)
of the Lesser Sunda Islands, Indonesia

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Description of *Phyllium* (*Phyllium*) *conlei*, new species, and a first look at the Phylliidae (Phasmatodea) of the Lesser Sunda Islands, Indonesia

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Abstract. The Phylliidae (Phasmatodea) diversity of the Lesser Sunda Islands, Indonesia is preliminarily examined, and revealed to be notably lacking in completeness with only two species currently recorded. Of the nine islands/ island groups within the Lesser Sunda Islands, only the westerly islands (Bali and Lombok) have single species recorded: *Phyllium* (*Pulchriphyllium*) *pulchrifolium* Audinet-Serville, 1838, from Bali, and *Phyllium* (*Phyllium*) *conlei* Cumming, Valero, and Teemsma, **new species**, from Lombok. The latter species is herein described and differentiated from congeners. To conclude, with so few species recorded from the Lesser Sunda Islands, a key to species for Java and the Lesser Sunda Islands is presented for males.

Key words. Bali, leaf insect, Lombok, taxonomy, walking leaf.

Introduction

The Lesser Sunda Islands are a chain of islands containing little to no history of leaf insects based on a search through literature and through collections. The first literature record that could be found for the Lesser Sunda Islands was that of de Haan (1842) where he gives measurements of five specimens and lists two with the data of “Java, Timor” and “Timor, Nova Guinea” which he identified as *Phyllium* (*Phyllium*) *siccifolium* (Linnaeus, 1758). The accompanying figure with de Haan’s text is that of a male subadult (Fig. 1a) which without exact collection data is impossible to place taxonomically or even know if the specimen illustrated even truly was collected on Timor. Subsequent authors suggested the specimen figured was likely not *Ph.* (*Ph.*) *siccifolium* and was instead either the new species *Phyllium geryon* Gray, 1843 (Gray 1843; Westwood 1859), or was simply misidentified (Wood-Mason 1875). Gray even appears to have used de Haan’s illustration to base his own figure (a, p. 121) of his *Phyllium geryon* profemora (Gray 1843).

It is impossible to say whether or not de Haan’s subadult male was in fact from Timor or if he was referring to a different specimen for the distribution record. One such specimen which can be confidently confirmed as coming from the Lesser Sunda Islands is a male subadult from Lombok from within the Frank Hennemann collection (Germany) with the data: Indonesien: Sunda-Inseln, Prov. Nusa Tenggara Barat, Lombok, XI.2009, local collector [coll. FH No. 1019-1]. This specimen resembles the male subadult illustrated in de Haan’s work and leads us to believe that the specimen could have been of the same species as Hennemann’s Lombok specimen. With Lombok and Timor only a few small islands away of each other, it would not be surprising if they represented the same species or closely related species (Fig. 1a–b).

With the description of *Phyllium* (*Phyllium*) *conlei* Cumming, Valero, and Teemsma, **new species** from the island of Lombok, the specimen within the Hennemann collection could very well represent a

subadult *Ph. (Ph.) conlei* **new species**. But, as a subadult, an adequate identification cannot confidently be made.

Phyllium (Phyllium) conlei **new species**, with its slender abdomen, is most morphologically similar to *Phyllium (Phyllium) brassardi* Cumming, Le Tirant, and Teemsma, 2017 and *Phyllium (Phyllium) caudatum* Redtenbacher, 1906, known from Northern Borneo and Papua New Guinea respectively. It is likely that, once the female and egg of *Ph. (Ph.) conlei* **new species** are described, the relation to other species will become clearer and allow more accurate taxonomic placement.

This currently limited number of recorded species from the Lesser Sunda Islands is expected to increase significantly if/when the phylliid diversity of the islands is explored in more detail. At the moment, it appears as though collecting trips to these islands have either had poor luck (personal communication) or no interest in the phylliid insects. Searches through large institutional and personal phylliid collections having revealed no additional material.

Materials and Methods

Photos were taken with a Nikon D7100 with a Nikkor 60mm macro lens. Adobe Photoshop CC was used to prepare the plates. Measurements of the holotype were made by Pablo Valero to the nearest 0.1 mm using digital calipers. The acronym for the State Zoological Collection of Munich is ZSMC.

Results

Phyllium (Pulchriphyllium) pulchrifolium Audinet-Serville, 1838

(Fig. 2)

Distribution expansion. INDONESIA: East Java Province, Madura Island; Bali Province, Ubud District.

Discussion. It is not surprising that this species is recorded from the islands to the east of Java (the type locality) as Madura and Bali are closely situated off the coast. The distribution to the northwest on the island of Sumatra has been known for over a century. Unfortunately, there have been no recent sightings of *Ph. (Pu.) pulchrifolium* on the island despite recent *Phyllium* collecting activities (Lucas 1857; personal observation).

The recorded female from Madura Island is from the Royce Cumming collection (United States) [Coll. RC 16-031] and was collected in March 2012. The record from Bali is an observation record from several photos by tourists on vacation in Bali. The illustrated female observed by Nicolas Logelain (Belgium) from Ubud Bali in August 2013 was reported as being found in the wild (Fig. 2). The authors are not confident that *Ph. (Pu.) pulchrifolium* is native to the island of Bali as there have been records of the species being imported from Java to be put on display in local butterfly exhibits for guests to enjoy (personal communication). The authors would not be surprised by either scenario: either *Ph. (Pu.) pulchrifolium* is in fact native to Bali, which is likely with the island's proximity to Java; or that *Ph. (Pu.) pulchrifolium* was imported by an exhibit and has since been released onto the island and now is established.

The accidental introduction of a non-native phasmid to an area where it then thrives is not unheard of. The Indian laboratory stick insect, *Carausius morosus* (Sinéty), is one such example of a species that has done quite well outside of its native range. Originally native to Southern India, this species has now become established in several additional countries as far west as South Africa and the United States (Hendrick and Wilen 2011; Baker 2015).

***Phyllium (Phyllium) conlei* Cumming, Valero, and Teemsma, new species**

(Fig. 3a–i)

Holotype. Male: INDONESIA: Lombok Island; December, 2012. Deposited in the State Zoological Collection of Munich (ZSMC).

Differentiation. *Phyllium (Phyllium) conlei* **new species** morphologically fits within the *siccifolium* species-group as described by Hennemann et al., 2009 with the exterior lobe of the profemora which is thinner than the interior lobe. *Phyllium (Phyllium) conlei* **new species** is most morphologically similar to *Phyllium (Phyllium) bossardi* Cumming et al., 2017, and *Phyllium (Phyllium) caudatum* Redtenbacher, 1906 because of the slender abdomen with a maximum width of only about 30% of the overall abdominal length (Fig. 4a–c). No other males in the *siccifolium* species-group are known for having an abdominal shape with this ratio. It is likely that other closely related species such as *Phyllium (Phyllium) riedeli* van de Kamp and Hennemann, 2014, with the male still undescribed, also have a similar abdominal ratio.

Phyllium (Phyllium) conlei **new species** can be differentiated from *Ph. (Ph.) bossardi* and *Ph. (Ph.) caudatum* easily by the length of the antennae (Table 1). When the antennae are laying back flat along the dorsal surface of the body they are the same length as the tegmina versus notably shorter in *Ph. (Ph.) bossardi* with the antennae only reaching about half way along the tegmina, or antennae that are significantly longer than the tegmina in *Ph. (Ph.) caudatum*.

Table 1. Summary of distinguishing features between male *Phyllium (Phyllium) conlei* **new species**, *Phyllium (Phyllium) bossardi* Cumming et al., 2017, and *Phyllium (Phyllium) caudatum* Redtenbacher, 1906.

Feature	<i>Ph. (Ph.) conlei</i> (Lombok)	<i>Ph. (Ph.) bossardi</i> (Borneo)	<i>Ph. (Ph.) caudatum</i> (Papua New Guinea)
Protibiae interior lobe	Smoothly arcing end to end and only about as wide as the protibial shaft	Smoothly arcing end to end and only about as wide as the protibial shaft	Triangular, not reaching end to end, only on the proximal two thirds of the protibial
Tegmina	Reaching into abdominal segment III, not past	Reaching at least halfway into abdominal segment IV, occasionally into segment V	Reaching no more than half way into abdominal segment III, generally shorter only just passing the posterior of II
Antennae length (when held flat back across the dorsal surface)	The same length as the resting tegmina	Notably shorter than resting tegmina, only a little longer than half of the tegmina length	Notable longer than the tegmina length with at least one third of the antennae length passing the resting tegmina

Coloration. Most of the body is of a yellow color which appears to have been caused by the drying technique as there are little patches of pale lime green throughout. The most prominent green areas are the tegmina, patches of the abdomen, and the interior lobes of the femora. The eyes are a dull rust color and the antennae are of a slightly darker yellow than that found throughout the body. As with many poorly dried *Phyllium* specimens it is likely the holotype was a more vibrant green in life but most of the green faded to yellow after death.

Morphology. Head capsule about as long as wide, with a slightly granulose vertex. Frontal convexity stout with a dull point. Antennae consisting of 21–22 segments (including the scapus and pedicellus), most basal segments are covered with pale setae that are longer as the antennae segment is wide, and the apical segments have shorter and more densely spaced setae. Compound eyes notably large but not significantly protruding away from the head. No developed ocelli. Pronotum with anterior margin only slightly concave and lateral margins that gently converge on the posterior margin that is only marginally narrower than the anterior rim. Anterior margin with a strong rim at least three times the size of the slight rims of the lateral margins, posterior margin without a rim and relatively smooth. Face of the pronotum with moderate furrow and the surrounding surface smooth. Prosternum with

slight granulation throughout, not highly noticeable. Mesosternum surface with more noticeable granules and with an underlying texture that is wrinkled, not smooth. Metasternum with a surface that is almost entirely wrinkled, with granulation that is not particularly noticeable. Mesopraescutum about as wide as long, with lateral rims with four to five small tubercles with the largest on the anterior and the posterior most little more than prominent nodes. Mesopraescutum crest along the sagittal plane with a moderate spine on the anterior margin and the remainder lacks prominent spines due to the wrinkled surface of the mesopraescutum disk. Mesopleura gradually diverging, ending only slightly wider on the posterior; lateral margin with eight to ten tubercles of rather uneven size, most in close proximity to the others or even with bases touching. Mesopleural face with two distinct pits, one on the anterior third and one on the posterior third with the remainder of the mesopleural surface with a wrinkled texture. Tegmina not particularly long, reaching three quarters of the way into abdominal segment III. Alae well developed, reaching the anterior of the anal abdominal segment. Abdomen slender, with segments II through IV gently diverging, and V through the anal abdominal segment steadily converging. Anal abdominal segment slightly longer than wide with lateral margins that for the anterior half are parallel then with the remainder converging prominently. Poculum starts halfway through abdominal segment VIII, broad with lateral margins which exceed the lateral margins of segment IX, and a posterior margin that slightly reaches under segment X. Cerci exceed the length of segment X, lateral margins are straight and the surface of the cerci are covered in nodes throughout and with thin transparent setae along the exterior margin. Vomer broad with margins gradually converging, the apical point is stout and hooks upwards into the paraproct. Profemoral exterior lobe smooth and barely detectable as they are significantly thinner than the profemoral shaft is wide and hugs the shaft along the entire length. Profemoral interior lobe almost entirely situated on the distal half, lobe not triangular in appearance, gently arcing and only slightly wider than the profemoral shaft is thick. Profemoral interior lobe with five serrate teeth of almost even size, arranged in a 3-2 pattern with the three on the proximal end similarly spaced to the two on the distal end but with a wider space between the sets of teeth. Mesofemoral exterior lobe thin, lacks dentition, and arcs from end to end with the widest portion on the distal third of the lobe. Mesofemoral interior lobe is the same width as the exterior lobe but with a straighter edge and five serrate teeth on the distal third of the lobe. Metafemoral exterior lobe thin and lacking dentition, hugging femoral shaft. Metafemoral interior lobe slightly wider than exterior lobe with seven small dull teeth on the distal half only. No exterior protibial lobe, interior lobe extends the entire length in a smooth arc, not triangular, with the widest portion in the center only as wide as the shaft of the protibia. Meso- and metatibia simple, lacking lobes.

Measurements of holotype [mm]. Length of body (including cerci and head, excluding antennae) 47.5, length/width of head 3.2/2.8, pronotum 2.6, mesonotum 2.1, length/width of tegmina 16.8/6.2, greatest width of abdomen 9.0, profemora 9.0, mesofemora 9.0, metafemora 10.3, protibiae 6.3, mesotibiae 5.8, metatibiae 8.0, antennae 23.0.

Distribution. The current knowledge of the phylliid diversity of the Lesser Sunda Islands is significantly lacking as the authors could only locate phylliid records for two of the numerous islands in the chain. *Phyllium (Phyllium) conlei* **new species** is currently only known from Lombok Island from the single holotype record, but it would not be surprising if it were eventually located on other nearby islands such as Sumbawa or other islands to the east with nonexistent phylliid records. Figure 5 illustrates the current lack in phylliid knowledge for the Lesser Sunda Islands. Only the two most westerly islands have records and all other islands in the chain are lacking phylliid records.

Etymology. Named in honor of Oskar Conle, who had the holotype in his private collection and kindly provided the specimen for this publication.

Key to known species for known *Phyllium* males of Java and the Lesser Sunda Islands.

Adapted from the keys in Cumming and Le Tirant (2018) and Cumming et al. (2017).

1. Several or all tibiae with an exterior lobe; antennae ventrally serrate: [subgenus *Pulchiphyllium*] . 2
- All tibiae lacking an exterior lobe; antennae simple/filiform: [subgenus *Phyllium*] 3

2. Exterior lobe of profemur a clear obtuse angle $\sim 130^\circ$; exterior lobe of protibiae reduced to only a sliver, many times smaller than the interior lobe; abdomen ovular with segment VII converging towards the apex ***Ph. (Pu.) shurei* Cumming and Le Tirant, 2018**
- Exterior lobe of profemur $\sim 100^\circ$ angle; exterior lobe of protibiae notable and only slightly thinner than interior; abdomen rectangular in appearance with segments V-VII parallel to slightly widening ***Ph. (Pu.) pulchrifolium* Audinet-Serville, 1838**
3. Interior lobe of the protibia triangular with a distinct angle, and slightly wider than the width of the protibial shaft; abdomen spade-shaped, with a greatest width of about 40–55% of the total abdomen length ***Ph. (Ph.) jacobsoni* Rehn and Rehn, 1933**
- Interior lobe of the protibia thin and arcing from end to end without a distinct triangular shape and slender, only about as wide as the protibial shaft; abdomen long and slender, at its greatest width only about 30% of the total abdomen length ***Ph. (Ph.) conlei* Cumming, Valero, and Teemsma, new species**

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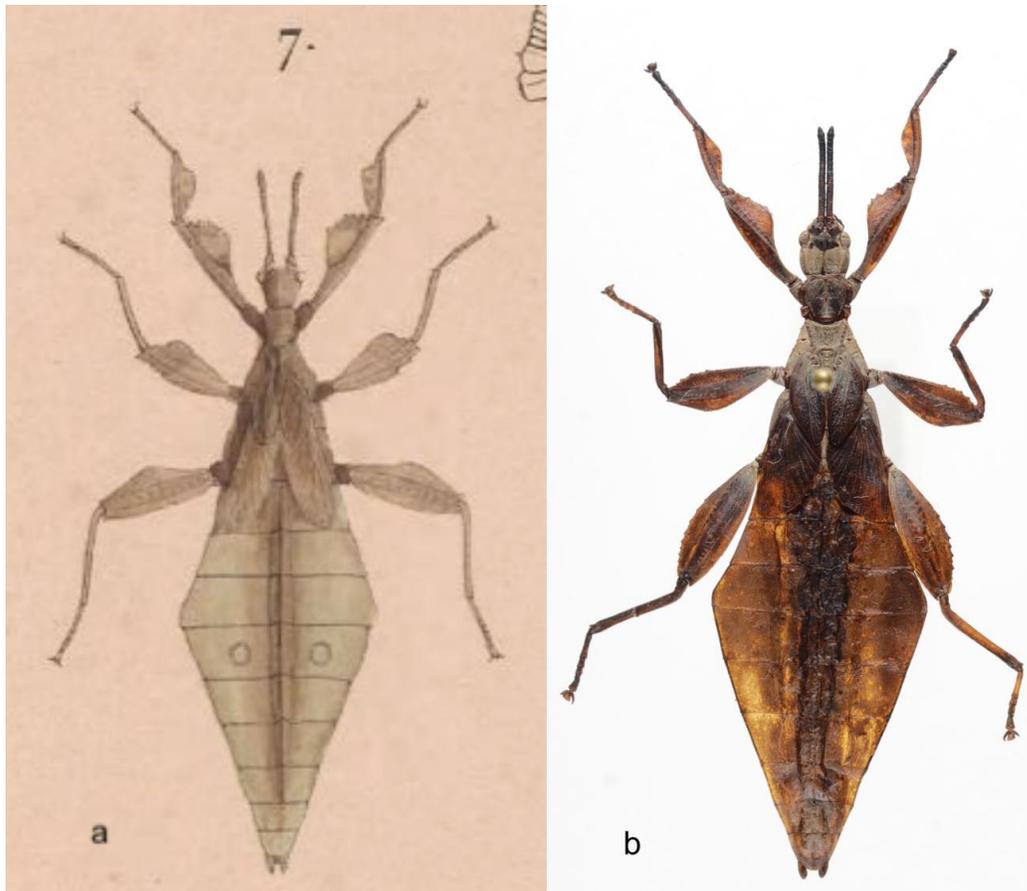


Figure 1. Male *Phyllium (Phyllium)* subadults. **A)** Illustration from de Haan's 1842 work with the possible locality of Timor. Scan courtesy of the Biodiversity Heritage Library online. **B)** Specimen from the collection of Frank Hennemann (Germany) collected on Lombok in 2009.



Figure 2. Female *Phyllium (Pulchriphyllium) pulchrifolium* found by Nicolas Logelain (Belgium) from Ubud Bali in August, 2013.

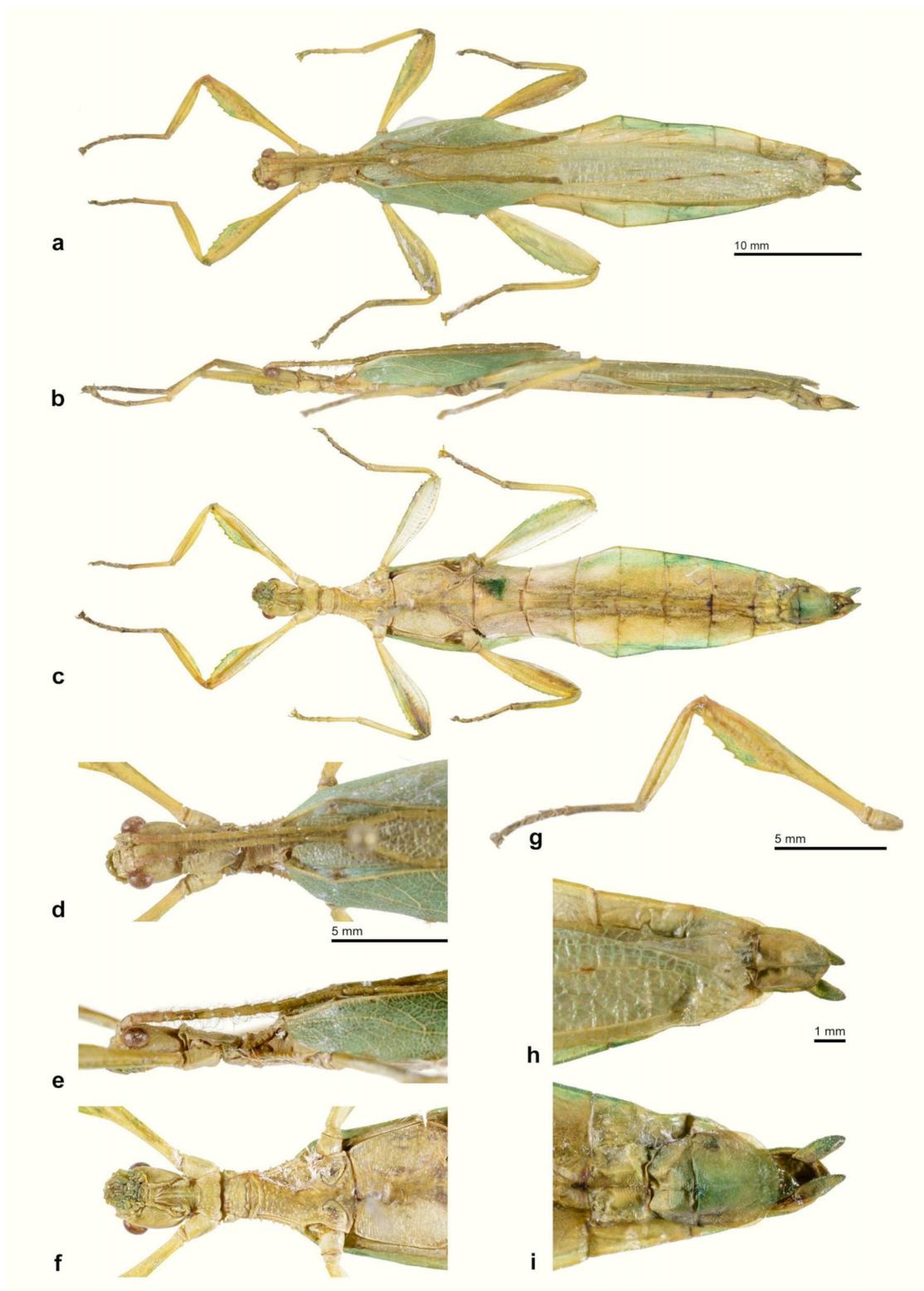


Figure 3. Holotype of *Phyllium (Phyllium) conlei* new species. **A)** Full body, dorsal. **B)** Full body, lateral. **C)** Full body, ventral. **D)** Head and thorax, dorsal. **E)** Head and thorax, lateral. **F)** Head and thorax, ventral. **G)** Right profemur. **H)** Terminal abdominal segments, dorsal. **I)** Terminal abdominal segments, ventral.

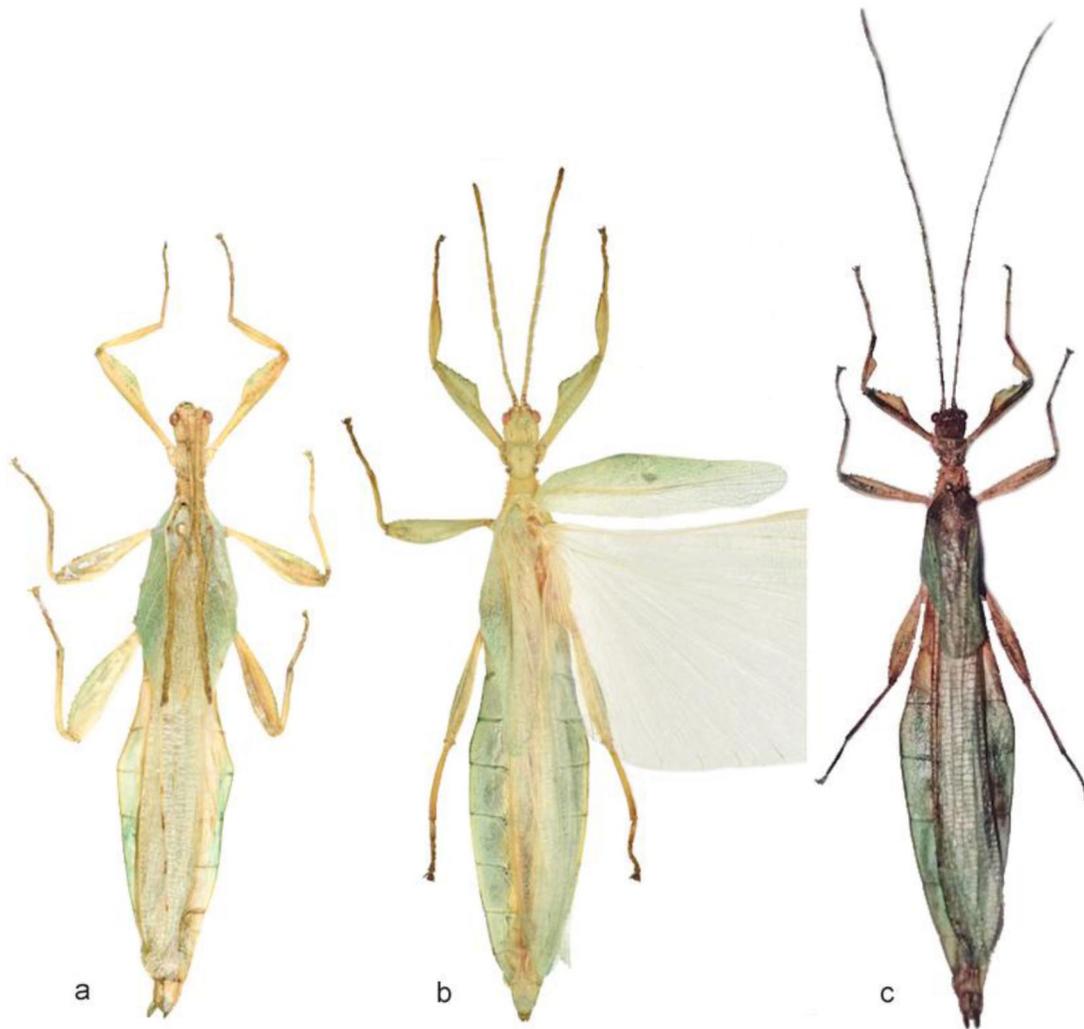


Figure 4. Comparative photo of the adult males of three species with similar morphology, specimens not to scale. **A)** *Phyllium (Phyllium) conlei* **new species**. **B)** *Phyllium (Phyllium) bossardi* Cumming et al., 2017. **C)** *Phyllium (Phyllium) caudatum* Redtenbacher, 1906.



Figure 5. Map of the Lesser Sunda Islands with two currently recorded Phylliidae species. Green point, *Phyllium pulchrifolium* from Ubud Bali. Yellow point, *Phyllium conlei* **new species** from Lombok. (Google Earth: Image Landsat/ Copernicus: Data SIO, NOAA, U.S. Navy, NGA, GEBCO: Image date December 13th, 2015; accessed October 30th, 2018).

