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First records of *Pseudogaurax* Malloch 1915 (Diptera: Chloropidae) from Singapore, with the description of two new species discovered with NGS barcodes

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Abstract. Only few species belonging to the genus *Pseudogaurax* Malloch, 1915 (Diptera, Chloropidae) have been recorded from the Oriental region after Cherian described the first in 1976. Here we describe two new species from Singapore, *Pseudogaurax sexnotatus* Ismay & Ang, new species and *P. striatus* Ismay & Ang, new species. We discuss the biogeography of this genus, as well as taxonomic issues that are related to the separation of *Pseudogaurax* from *Gaurax* Loew, 1863. The species were discovered using NGS barcodes and are part of an ongoing campaign to document the biodiversity of Singapore.

Key words. Chloropidae, Oscinellinae, taxonomy, diversity, new species

INTRODUCTION

Pseudogaurax Malloch, 1915 is an ecologically atypical genus in the subfamily Oscinellinae in that some of its species are known to be parasitoids of other arthropod immatures (Boulard et al., 1989; Barnes et al., 1992) while most Chloropidae (Diptera: Schizophora) are phytophagous or saprophagous. *Pseudogaurax* has ca. 60 described species known from all biogeographic regions except Antarctica. However, it is likely a predominantly Neotropical genus, with only nine species described from the Oriental region (as defined in Grootaert, 2009). Eight species are recorded from India (Cherian, 1976, 1989, 2013) and one from the Bonin Islands, Japan (Kanmiya, 1989). Undescribed species are known from Borneo (JW Ismay, pers. comm.), Java, Indonesia, Peninsular Malaysia (Ismay, 1987) and Leyte, Philippines (Grégoire Taillefer & Wheeler, 2018). Here, we describe two new species from Singapore: *Pseudogaurax sexnotatus*, new species and *P. striatus*, new species. These species are also the first species described from Sundaland and the first records for Singapore. We briefly discuss the biogeographic distribution of *Pseudogaurax*, their rarity in collections, as well as the taxonomic delimitation issues between *Gaurax* Loew, 1863 and *Pseudogaurax*.

The two new species were discovered as part of a "Biodiversity of Singapore" project that surveys many habitats in Singapore (Baloglu et al., 2018; Kutty et al., 2018) and then uses a newly proposed "reverse workflow" procedure for species discovery: specimens are not sorted into species based on morphology; instead, the specimens are first pre-sorted into putative species using "NGS barcodes" (Wang et al., 2018a). The pre-sorted material is then made available to taxonomic experts who revise species boundaries, identify known species, and describe new species (Grootaert, 2018; Munari, 2018a, 2018b; Ramos & Grootaert, 2018; Ramos et al., 2018; Samoh et al., 2018; Tang et al., 2018a, 2018b; Wang et al., 2018b, 2018c). The species are featured on a digital reference collection (see Ang et al., 2013) called "Biodiversity of Singapore" (https://singapore.biodiversity.online/), where more than 150,000 specimens have been sequenced and sorted into >7000 putative species; for many of the species, male, female, and immature specimens have been associated (Yeo et al., 2018), while known species interactions are also recorded. The photos of the two new species will be deposited in this reference collection so that they are easily available; users can zoom into these photos to look at the species in more detail.

MATERIAL AND METHODS

Sampling and storage. The materials used in this study are based on a series of long-running surveys of Singapore's biodiversity. In particular, many mangrove sites have been extensively sampled with Malaise traps. Collected samples were stored in 70% Ethanol and kept in –20°C freezers in the Lee Kong Chian Natural History Museum. In this study we examined samples collected from 8 August 2012 to 8 September 2015.

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NGS barcoding and morphology-based taxonomic assessment. Specimens were pre-sorted into molecular operational taxonomic units (MOTUs) using Next Generation Sequencing procedures that have been described in Wong et al. (2014), Meier et al. (2016) and Wang et al. (2018a). DNA sequences in the COI barcoding region were obtained and clustered into putative species based on Objective Clustering (Meier et al., 2006). MOTUs were stable between 3 and 5% clustering thresholds. This presorted material (423 barcoded Chloropidae specimens) was then inspected to verify morphological species integrity in the MOTUs and provide for taxonomic identifications. Two singleton specimens (ZRC_BDP0021667 & ZRC_BDP0025357) were found to be morphologically distinct from each other and are here described as species new to science. In this paper we have decided against the inclusion of a key to the genus in the Oriental region, because we are aware of further undescribed species, where these specimens are too damaged to be designated as types. A key under the present knowledge would simply add to the confusion.

Imaging. Specimens in this study were imaged at different focal depths using the Dun Inc. Passport II Imaging system (Canon 7D Mk II with MPE-65 lens at 5X magnification). Images were then focus-stacked using Zerene Stacker (Zerene Systems LLC) and prepared for publication using Adobe Photoshop CS5.

Deposition of types and codes. The holotypes are deposited in the Lee Kong Chian Natural History Museum (ZRC). The species names are registered with ZooBank (see title page header). DNA sequences for these specimens are uploaded into GenBank (MK541946 and MK541947).

Nomenclature. Morphological nomenclature follows Cumming &Wood (2017).

TAXONOMY

Oscinellinae Becker, 1910
Pseudogaurax Malloch, 1915

Generic diagnosis. Most *Pseudogaurax* species have a combination of characters that fit a typical form, as given by Ismay (1987: 593), based on Kanmyia (1983): "Head compressed from front to rear; eye pubescent, long axis usually vertical; frontal [=ocellar] triangle large and shining; 3rd antennal segment deeper than long or produced anterodistally, arista thickened in some species; vibrissal angle not acute; postvertical seta large, upright, crossed, outer vertical seta as large, upright, crossed, inner vertical small; anepisternum bare, scutellum elongate, usually triangular, flat on disc, apical setae long and approximated; legs with tibial organ, but no tibial spur or femoral comb; wing unmarked". However, some species can vary considerably, which can make them difficult to delimit from *Gaurax* (Cogan, 1977). As a result, some authors have reduced this definition depending on the species they are dealing with (e.g., Sabrosky, 1966; Cogan, 1977). A proper definition of *Pseudogaurax* would require a revision of both *Gaurax* and *Pseudogaurax*, which is beyond the scope of this paper. More on this topic will be mentioned in the discussion section. As such, we base our decision to describe both species as *Pseudogaurax* on the concept used in Ismay (1987) and Cherian (2013), but not as it was defined in Ismay (1987), as he widened his own concept within the same paper.

In attempting to identify the genus, both specimens keyed to *Gaurax* in Becker (1911); *Pseudogaurax* was later split off from this genus (Malloch, 1915). Both specimens could not be keyed out to existing species on Oriental or Australasian *Pseudogaurax* (Ismay, 1987; Cherian, 2013), and were hence identified to be new species and described in this paper.

Pseudogaurax sexnotatus Ismay & Ang, new species
(Fig. 1)

Type material. Holotype (here designated), female: SINGAPORE, Nee Soon Swamp Forest, from Malaise Trap NS1 [1°23′00.3″N 103°48′46.5″E] (Collection event: 29246, 17-25.xi.2011). Specimen code ZRC_BDP0025357, deposited in the LKCNHM (ZRC). Cytochrome oxidase I (COI) partial-cds for this specimen deposited in GenBank under reference MK541947.

Diagnosis. In female, almost entirely yellow species with six black thoracic markings and entirely yellow legs.

Description. Length. Body 2.31 mm, wing 2.25 mm.

Head. (Fig. 1A–C). Broader than deep (ocelli to proboscis) and longer (occiput to antennal sockets) than deep (1.16: 0.72: 0.78 mm), entirely yellow except for black pubescent arista with hairs twice as long as base of arista, blackened dorsal margin of postpedicel, blackened outer lateral margin of pedicel and black ocellar tubercle (the raised part within the ocellar triangle, delimiting the ocelli). Head and thoracic setae yellow. Ocellar setae short, reclinate and cruciate, equal to length of ocellar tubercle. About eight long, thin, pale, reclinate orbital setae developed, increasing in size posteriorly, the most posterior equal in length to width of palpus. Outer vertical seta strongly developed, as long as postpedicel is deep, lateroclinate and slightly reclinate; inner vertical seta as long as postocellars, incurved and proclinate, circa half-length of outer vertical seta, postocellar setae strongly developed, long, cruciate and reclinate, equal to outer vertical seta. Frons slightly broader than long (0.47: 0.34 mm), width measured at level of anterior ocellus, lateral margins of frons parallel, anterior margin in middle slightly convex, yellow, dusted with two rows of long, pale setulae along outer margin of ocellar triangle. Ocellar triangle bare, large, extending into a point to about one palpus width away from anterior margin, posteriorly to almost width of frons, distance between posterior corner and eye margin as wide as 1.5 times the width of an ocellus, lateral margins slightly concave, shiny, pale orange. Eye oval, long axis vertical with short, dense pubescence. Face pale yellow, dusted, slightly broader than deep, strongly concave; faint carina present, not visible below antennae; antennae pale yellow,

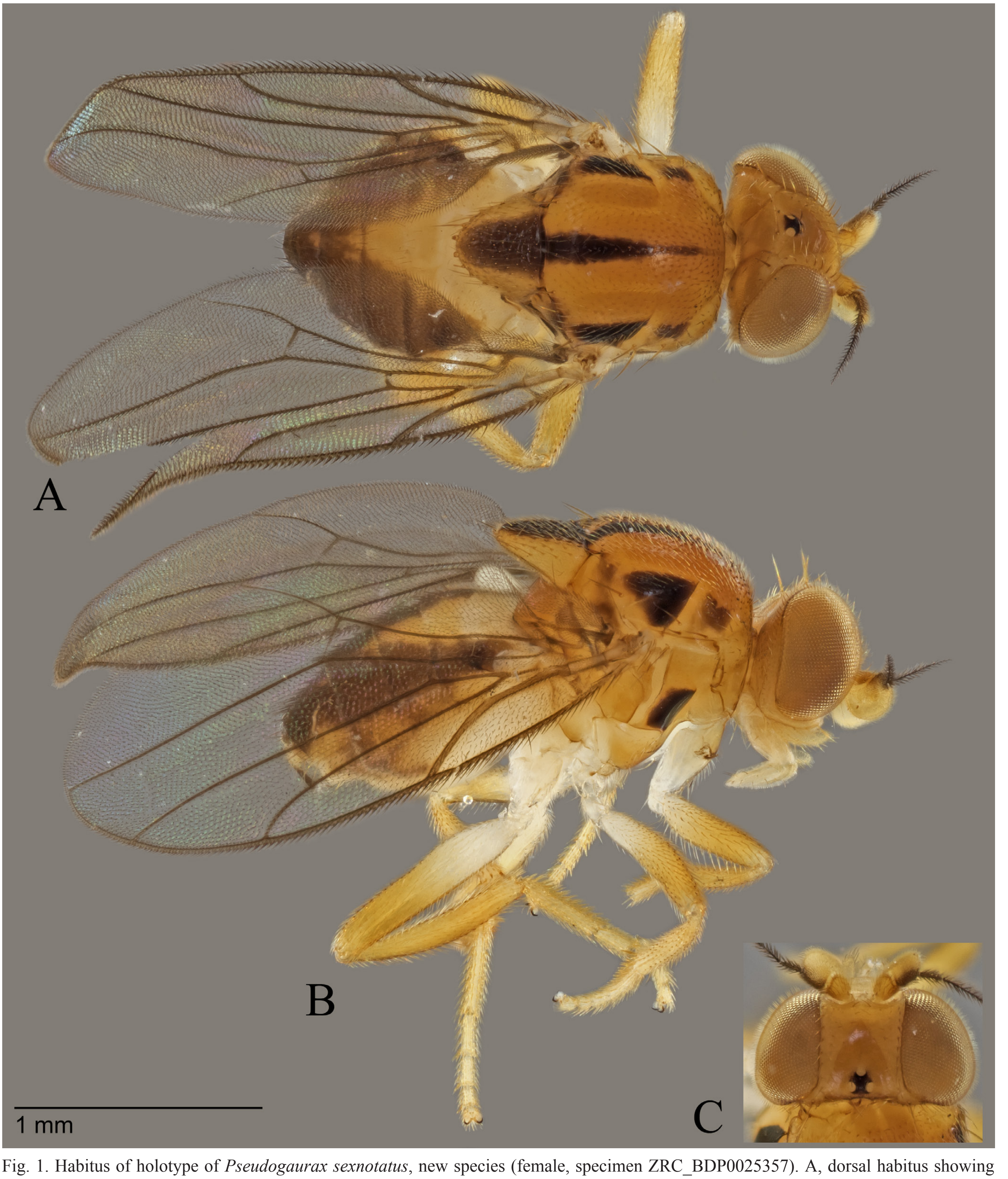

Fig. 1. Habitus of holotype of *Pseudogaurax sexnotatus*, new species (female, specimen ZRC_BDP0025357). A, dorsal habitus showing dorsal scutum and scutellum, as well as head capsule in oblique view, note the six distinct spots on thorax; B, lateral habitus showing thoracic pleura, head, legs and wing, as well as terminalia behind wing; C, dorsal view of head.

postpedicel reniform, deeper than long, as long as palpus, black around insertion of arista; arista basal, black, with strong short pubescence (twice as long as basal diameter of arista), 1.2 times as long as postpedicel; gena very narrow, as deep as width of base of arista, pale yellow slightly shiny, one row of pale setulae on genal margin, as long as depth of antenna, vibrissal angle obtuse; occiput yellow, very narrow in lateral view, as wide as twice the width of the base of the arista; proboscis pale yellow, short, weakly sclerotised; palpus pale yellow, slightly longer than antenna, slightly curved dorsally, with several long, pale setulae; mouth edge slightly protruding; clypeus pale yellow.

Thorax. (Fig. 1A, B). Scutum slightly broader than long (0.75: 0.66 mm), yellow, with three stripes, the central black longitudinal stripe starting the width of the postpedicel posteriorly from the anterior margin as thin as the tip of the arista, ending at the posterior margin being half as wide as the postpedicel, the outer lateral stripes starting immediately posteriorly of suture widening into a broad triangle shape, ending just before posterior post alar bristle; a faint darker mark present on the dorsal notopleuron, separated from the transverse suture by a yellow band; scutum entirely shiny with dense, medium long, pale setulae; one posterior dorsocentral seta developed, as long as second apical anterior tarsus, no acrostichal setae developed; postpronotal lobe yellow with one long seta at lateral posterior margin, equal to ocellar setae; the dark brown mark surrounding the pale anterior spiracle as large as half the postpedicel; notopleuron yellow with 1 plus 2 long yellow setae, as long as the inner vertical seta, but the upper posterior seta slightly shorter; posterior post-alar seta yellow and as long as outer vertical seta. Pleura entirely shiny, and mostly bare, all yellow except for ventral half of anepisternum black, with faint metallic reflections, except for a fine yellow line at the ventral and posterior margin, front margin of katatergite with a black line twice as thick as the base of the arista at lower margin widening to smudgy dark grey mark in upper third, at upper margin 1.5 times as wide as arista including pubescence, anatergite with longitudinal dark grey smudgy mark along apical third of outer margin, postnotum light orange, shiny, ventral margin of katepisternum with several very long setulae, haltere very pale, almost white. Scutellum yellow with large black central mark, covering c. 80% of flattened disc of scutellum, leaving lateral and posterior margin yellow, shiny, about as long as wide (0.31: 0.34 mm), shield-shaped, disc and lateral margins with even but small black setulae; apical scutellar setae broken off, not approximated, originating from small tubercles, four pairs of short yellow lateral scutellar setae originating from small tubercles. Haltere pale yellow.

Wing. (Fig. 1B). Translucent with brown veins, covered in sparse brown microtrichia and long setulae along costal margin; costal ratios measured from base of basicosta to point where R_1 touches Costa, then along costal margin of r_{2+3}, then along costal margin of r_{4+5}: 0.91: 0.69: 0.41: 0.25 mm; cell r_1 broader than cell r_{2+3}, veins R_{4+5} and M_1 almost parallel up to costal wing margin, where they diverge very slightly, distinct kink in M_4, costal break basal to where R_1 touches Costa, basicosta white.

Legs. (Fig. 1B). All legs yellow, shiny, covered in yellow setulae that are longer than twice the width of the base of the arista; coxa pale yellow, basal third of femur pale yellow, mid and posterior femora and tibiae slightly darker yellow in apical two thirds; posterior femora and tibiae 1.5 times as thick as mid femora and tibiae; apical four left middle tarsal segments missing; yellow apical anteroventral straight spur on mid tibia as long as tibia is thick, femoral or tibial organ absent; apical tarsal segment scarcely wider than basal segment.

Abdomen. Ventrally white, anterior margin of tergite 1+2 white, middle third of posterior margin white, lateral thirds dark brown thus forming a trapezoidal white mark in middle; middle fifth of tergite 3 white at anterior margin forming a white triangle with a blunt end to posterior margin, laterally dark brown; tergites 4 and 5 dark brown, each with a small white spot in middle of anterior margin; all tergites with relatively long pale setulae; lateral thirds of tergite 4 dark brown.

Female terminalia. (Fig. 1C). Not extended, but tergite 6 dorsally black, laterally white; tergite and sternite 8 white, cercus long, as long as apical two anterior tarsi, black, with two very long, fine pale setulae as long as outer vertical.

Barcode. Cytochrome oxidase I (COI) partial-cds (313 b.p.; GenBank accession code MK541947) as follows:

---tttatcttcaattattgctcatggaggagcttcagttgatttagcaatttttcact
tcatttagctggagtatcttcaattttaggagcagtaaattttattactacagtaattaa
tatacgttcaacaggaattacatttgatcgaatacctttatttgtatgatcagtagtaat
tactgctttacttcttcttttatcattacctgtattagctggagctattactatattatt
aactgatcgaaatttaaatacttcatttttgatccagctggaggaggagatccaatttt
ataccaacatttattt

Etymology. The species name *sexnotatus* (six and marked) is derived from Latin, referring to the six distinct black marks on the thorax.

Remarks. This new species runs to couplets 6 in the keys by Ismay (1987) and by Cherian (2013), but this species does not agree with either of the two parts of these couplets. This species differs from both sides of couplet 6 in Ismay (1987) in that the scutellum is yellow with a wide central black stripe, whereas in couplet 6 the scutellum is differently coloured. It disagrees with Cherian (2013) couplet 6 in that it's ocellar triangle does not reach the anterior margin of the frons (as in *P. sabroskyi*), but the scutellum is longer than wide, while it ought to be wider than long in the second part of the couplet. It is therefore regarded as a new species.

Pseudogaurax striatus Ismay & Ang, new species
(Fig. 2)

Type Material. Holotype (here designated), female: SINGAPORE, Pulau Ubin Mangrove Forest, from Malaise Trap PU3 [1°25′16.536″N 103°56′54.095″E] (Collection event: 29243, 17-25.xi.2011). Specimen code ZRC_BDP0021667, deposited in the LKCNHM (ZRC). Cytochrome oxidase I (COI) partial-cds for this specimen deposited in GenBank under reference MK541946.

Diagnosis. Almost entirely yellow species with a black inverted 'U'-shaped marking on the scutum, a black lateral stripe on the pleura and yellow legs except for black markings on the middle and posterior tibia.

Description. Length. Body 2.3 mm, wing 1.44 mm.

Fig. 2. Habitus of holotype of *Pseudogaurax striatus*, new species (female, specimen ZRC_BDP0021667). A, lateral habitus showing thoracic pleura, head, legs and wing, note the stripe at the bottom margin of the anepisternum; B, dorsal habitus. Note extended terminalia on both A and B.

Head (Fig. 1A, B). Broader than deep (ocelli to proboscis) and as long (occiput to antennal sockets) as deep (0.47: 0.38: 0.38 mm), entirely pale yellow except for black ocellar tubercle (this is the raised part of the ocellar triangle around the ocelli), black dorsal margin of postpedicel, black arista, black posterior and ventral eye margins and two black marks on occiput, dorsal to insertion of neck. Head and thoracic setae yellow. Five orbital setae developed, long, slightly incurved and reclinate equal to length of ocellar setae, increasing in size posteriorly, the most posterior approximately equal in length to width of posterior margin of ocellar tubercle. Outer vertical seta strongly developed, slightly longer than half maximum width of frons, lateroclinate and reclinate; inner vertical seta, incurved and slightly proclinate, about 0.75 times length of outer vertical seta, postocellar setae strongly developed, long, cruciate and reclinate, 0.8 length of outer vertical seta, ocellar setae upright and cruciate, 0.75 length of postocellar setae. Frons slightly longer than broad (0.31: 0.25 mm), width measured at level of anterior ocellus, lateral margins of frons parallel, anterior margin slightly convex, pale yellow, dusted, with several longer setulae present outside of ocellar triangle, the anterior of these setulae incurved. Ocellar triangle bare, large, shiny, very pale yellow, almost white, extending almost to anterior margin of frons by pointed tip, gap equal to width of one ocellus, lateral margins slightly convex, posteriorly almost reaching eye margin, gap equal to width of one ocellus. Eye oval, long axis oblique with short, dense pubescence, ommatidia in anterior half enlarged. Face approximately 1.5 times as deep as wide, pale yellow, dusted, flat, carina absent; antennae pale yellow except for black mark on dorsal margin of postpedicel (about as large as two ocelli), postpedicel reniform, twice as deep as long, black around insertion of arista; arista laterodorsal, black, with fine, short pubescence (equal in length to diameter of arista), 2.5 times as long as length of postpedicel, long apical seta on pedicel; gena narrow, as deep as length of postpedicel, pale yellow, dusted, one row of pale setulae on ventral margin, two setulae dorsal to obtuse vibrissal angle, one setula each longer at anterior and posterior margin; occiput pale yellow except for black eye margin and two black reniform marks above insertion of neck and slightly smaller than postpedicel; proboscis pale yellow, almost white, short, weakly sclerotised; palpus pale yellow, almost white, as long as postocellar seta, with two apical long, pale setulae; mouth edge slightly protruding; clypeus dusted pale yellow, almost white.

Thorax (Fig. 1A, B). Scutum longer than wide (0.53: 0.41 mm), yellow, darker orange yellow on central stripe, the latter occupying entire space between dorsocentral lines, this stripe pale yellow in posterior third, stripe laterally and anteriorly bordered by black lines forming an inverted ‘U’, the lines as thick as postpedicel is wide, the area lateral to lines equally wide as lines, this area presuturally almost white including postpronotal lobe, the latter with one strong, dark, reclinate, posterior seta, as long as inner vertical seta, postsutural area yellow, suture covered by dark stripe as wide as anterior tarsi; scutum only slightly convex and shiny, but central and lateral stripes covered in numerous, pale, long setulae, as long as inner vertical seta, these setulae form a bi-serial convergent line along the centre almost giving the appearance of acrostichals, one yellow posterior dorsocentral seta developed, 1.5 times as long as outer vertical seta, no acrostichal setae developed; yellow notopleuron with 1 plus 1 yellow setae, each as long as outer vertical seta; dark yellow posterior post-alar seta, as long as outer vertical seta. Pleura entirely shiny, pale yellow, almost white, except for small black mark around white anterior spiracle, joining black stripe along ventral margin of anepisternum and ending at suture, as thick as anterior tibia, ventral third of katepisternum yellow, not as pale as remaining pleura, with a strong pale yellow seta at posterior dorsal margin, directed anteriorly, as long as inner vertical seta. Dorsal half of katatergite and anatergite covered in dark brown mark, dorsal half of postnotum almost white, ventral half covered by black stripe, the latter is reduced to a thin line in the middle third by a ventral yellow mark, entire postnotum shiny. Scutellum pale yellow, shiny, broader than long (0.25: 0.16 mm), shield-shaped with sparse yellow setulae on flat disc, lateral margins bare; cruciate apical yellow scutellar setae not approximated, separated by 1.5 times the width of ocellar tubercle, 1.5 times as long as scutellum, arising from small tubercles, one pair of short yellow lateral scutellar setae, one third as long as apicals, separated from apical scutellars by half the distance between apical scutellars. Haltere pale yellow, almost white.

Wing (Fig. 1A, B). Translucent, covered in microtrichia, with thin, pale brown veins, cross-veins almost translucent, R_1 slightly thicker, Costa ending where M_1 joins margin, slightly beyond apex of wing, covered with setulae that are longest along apical half of R_1 and R_{2+3}; costal ratios measured from base of basicosta to point where R_1 touches costa, then along costal margin of R_{2+3}, then along costal margin of R_{4+5}: 0.56 : 0.47 : 0.38 : 0.16 mm; cell r_1 broader than cell r_{2+3} at point where R_1 meets Costa, cells br and bm+m unusually narrow, veins R_{4+5} and M_1 parallel up to costal wing margin, distinct kink in M_4, costal break basal to where R_1 touches Costa, basicosta white.

Legs (Fig. 1B). All legs mainly pale yellow, shiny, middle and posterior tibia black except for apical and basal one eighths; apical two thirds of all femora pale yellow, basal third paler, almost white; all setulae pale, several pale setae ventrally to anterior femur, as long as femur is deep; posterior femora and tibiae twice as wide as others; left apical four tarsal segments stuck on top of right tarsus; apical tarsal segment scarcely wider than basal segment; posterior tibial organ well developed, oval, silvery, in middle of black mark, as long as one eighths of tibia, as wide as one third of tibia, about three times as long as wide; femoral organ absent; long, pale, thin, anteroventral spur on mid tibia, as long as tibia is deep.

Abdomen (Fig. 1A, B). Ventrally pale yellow, three fifths of tergite 1+2 pale yellow, almost white in middle, lateral one fifths dark brown, remaining tergites dark brown dorsally and laterally except for anterior margin that is pale yellow; setulae pale.

Female terminalia (Fig. 1A, B). Tergite 6 dark brown, 1.5 times as wide as tergite 7, tergite 6 slightly wider than long, separated from tergite 7 by white membrane, tergite 7 twice as long as wide, separated from tergite 8 by white membrane, cerci twice as long as wide, black with two long apical setulae.

Barcode. Cytochrome oxidase I (COI) partial-cds (313 b.p.; GenBank accession code MK541946) as follows:

---cctatcttcaattattgcccatggaggagcttcagttgatttagcaattttttcact
tcatctagctggagtttcatcaatcttaggagcagtaaattttattactactgtaattaa
tatacgttcaactggaattacatttgatcgaatacctttatttgtttgatcagtagtaat
tacagctttattattattgctttcattaccagttttagcaggagctattacaatattatt
aacagatcgaaatttaaatacatcattctttgacccagcaggtgggggagaccca
attctttatcaacatttattc

Etymology. The species name *striatus* (striped) is derived from Latin, referring to the stripe at the ventral margin of the anepisternum.

Remarks. This new species runs to couplet 7 in the key by Ismay (1987), but then does not fit the description for *Pseudogaurax chiyokoae* Kanmiya, 1972 as the scutal markings of *P. striatus*, new species are different. It also runs to couplet 6 in the key by Cherian (2013), but again does not fit the description for *P. sabroskyi* Cherian, 1989 in that the ocellar triangle in this new species does not reach the anterior margin and the anterior legs are entirely yellow.

DISCUSSION

A brief review of Oriental material and world distribution of *Pseudogaurax*. These two new species, *Pseudogaurax sexnotatus*, new species and *Pseudogaurax striatus*, new species, are the first records of this genus from Singapore and the first species of this genus to be described from Sundaland. Additionally, Ismay (1987) identified three Malaysian (locality: Sepang, Selangor, Peninsular Malaysia) specimens of *Pseudogaurax* from the Natural History Museum, London to be *P. chiyokoae* based on morphology; he noted the differences in host preference (Lepidoptera pupa vs. Arachnida eggs) and biogeographic locality (Japan is a Palaearctic country while Malaysia is in the Oriental Region). However, Barnes et al. (1992) already mentioned the following in their excellent summary of the natural history of this genus: "Some species are apparently opportunists, utilising a variety of host species or even hosts of different orders". Ismay (1987) also identified a female specimen from Indonesia (locality: "Buitenzorg" [=Bogor], Java) from the United States National Museum, Washington, but did not describe it due to its poor condition. Another undescribed specimen is also recorded from "Mt Pangasugan, 7km north Baybay" in Leyte, Philippines (Grégoire Taillefer & Wheeler, 2018). The only other described Oriental *Pseudogaurax* are eight species from India: *P. himalayaensis* Cherian, 1976, *P. sabroskyi* Cherian 1989, *P. orientalis* Cherian, 1989, *P. indicus* Cherian, 2013, *P. thompsoni* Cherian, 2013, *P. keralaensis* Cherian, 2013, *P. meghalayensis* Cherian, 2013 and *P. tristriatus* Cherian, 2013 and one species from Bonin Islands, Japan: *P. boninensis* Kanmiya, 1989 (Kanmiya, 1989; Cherian, 2013).

Eight species of *Pseudogaurax* are described from Australasia: *Pseudogaurax novaeguineae* Ismay, 1987, *P. collessi* Ismay, 1987, *P. pleuralis* Ismay, 1987, *P. flavipes* Ismay, 1987, *P. solomensis* Ismay, 1987, *P. trimaculatus* Ismay, 1987, *P. flavidorsatus* Ismay, 1991 and *P. cassideus* Ismay, 1991 (Ismay, 1987, 1991), but overall not many records are known from the Oriental and Australasian Region. The majority of other recorded occurrences of *Pseudogaurax* are from Costa Rica (>200), but also significantly from other countries in the Neotropical region (Brazil, Ecuador, Peru, Puerto Rico, Panama), the Nearctic (United States), the Afrotropical Region (Nigeria, South Africa, Sierra Leone), and Europe (GBIF.org, accessed 17 July 2019). While there have been concerns over the use of GBIF data for predicting species distributions (Yesson et al., 2007; Ferro & Flick, 2015), we feel that the data are likely to be reliable for *Pseudogaurax* because a large number of *Pseudogaurax* specimens are found in Neotropical samples and many species are undescribed (JW Ismay, pers. comm.). However, we have found only two specimens in a 2-year long Malaise trap survey in Singapore. We suspect that future revisionary work on *Pseudogaurax* is likely to confirm that *Pseudogaurax* is more diverse in the Neotropics.

Scarcity of *Pseudogaurax* in collections. *Pseudogaurax* specimens are not often encountered, and therefore comparatively rare in collections. Ismay (1987) mentions that "*Pseudogaurax* are rarely found by general collecting", while Barnes et al. (1992) added that "specimens are rare in collections, and many existing specimens are teneral and inappropriate for taxonomic study." This is also evident in our study, where 423 chloropid specimens sampled over three years via Malaise trapping only yielded two female specimens. It is likely that because *Pseudogaurax* are predators of mostly spider and mantid eggs (i.e., eggs from other predatory groups), which usually do not occur in large numbers, their highly-specialised ecological niche means that it is unlikely to find many *Pseudogaurax* specimens by general collecting. Ismay (1987) stated that *Pseudogaurax* specimens 'will be found more easily by rearing from the hosts' based on experience in other faunal regions, but we note that such chances will probably be low, as he also reported that several attempts to rear them from spider and mantid eggs in Papua New Guinea only produced hosts and parasitic Hymenoptera.

Taxonomic limits between *Gaurax* and *Pseudogaurax*. Ismay (1987), who gave a combination of characters based on Kanmiya (1983) by which the genus *Pseudogaurax* in its typical form may be recognised, also noted considerable variation between species which may not fit this typical form. For example, two species were described by him, one as having a scutellum as long as wide (*P. trimaculatus* Ismay, 1987) – in fact, similar to the two new species – as opposed to the typical "elongate, usually triangular" scutellum (Ismay, 1987: 593), and another having apical scutellar setae not approximated (*P. solomonensis* Ismay, 1987) and thus also similar to the two new species. One of the two new species, *P. striatus,* displays slightly non-typical characteristics, such as having the apical scutellar setae not approximated as in many *Pseudogaurax,* which is a character considered part of the genus definition by Ismay (1987) and Sabrosky (1966). Nonetheless, we place both species in *Pseudogaurax* in the present paper, as they fit the main characters of this genus better than in *Gaurax*.

We also note that *Pseudogaurax* and *Gaurax* can be morphologically similar, and the separations between the genera are not very clear, as stated (Cogan, 1977: 118): "With the exception of the elongate scutellum, I + 2 notopleurals, and the reniform third antennal segment, characters not always present in typical forms, there are no reliable characters that delimit Pseudogaurax from Gaurax and related groups. Taken in combination, typical species may be assigned satisfactorily to a genus. Some species could, however, be placed in either genus, and the problem remains as to whether the two genera Pseudogaurax and

Gaurax can be delimited on a world basis". It is likely that a future revision involving *Pseudogaurax* and *Gaurax* will be required to provide clearer delimitations between the two genera, and species might need to be transferred to the other genus when a clear concept becomes more defined. Such a revision should ideally include the use of both morphology and DNA sequence data comparatively. In the meanwhile, existing morphological evidence suggests that the two new species in this paper fit more firmly in *Pseudogaurax* than in *Gaurax*.

Natural history. *Pseudogaurax* includes species whose larvae are known predators of egg masses of spiders, including the Black Widow, *Latrodectus mactans* (Fabricius, 1775), and of mantid ootheca. They also parasitise Lepidoptera pupae (Barnes et al., 1992) and the eggs of dobsonflies (Megaloptera: Corydalidae) (Melo & Wheeler, 2009). One species, *Pseudogaurax paratolmos* Wheeler, 2016 (in Gonzalez et al., 2016), has also been observed to attack the larvae of fungus growing ants (Gonzalez et al., 2016). It is believed that most, if not all, species within this genus are predators of egg masses or parasites of pupae or larvae, although the latter only to a lesser extent.

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