*RAFFLES BULLETIN OF ZOOLOGY* **66**: 258–267
Date of publication: 24 April 2018
http://zoobank.org/urn:lsid:zoobank.org:pub:5D7454E9-B00E-4CB7-9545-68241012AE07

# New data on the marine genera *Cymatopus* Kertèsz and *Thambemyia* Oldroyd (Insecta, Diptera, Dolichopodidae) from rocky shores in southern Thailand with the description of a new species

Abdulloh Samoh[1], Chutamas Satasook[1], & Patrick Grootaert[2*]

**Abstract.** Four species of the genus *Cymatopus* Kertèsz, 1901 and one species of *Thambemyia* Oldroyd, 1956 were found in southern Thailand. A key is given for all five species and new data of their distribution are provided. *Cymatopus mayakunae* sp. nov. is described as new for science. COI barcodes (313 base pairs) seem to be good indicators for delimitation of the species but do not support a phylogeny.

**Key words.** review *Cymatopus*, *Thambemyia*, southern Thailand

## INTRODUCTION

The present study forms part of a survey of the marine dolichopodid flies occurring in peninsular Thailand (Samoh et al., 2015; 2017). During this study a number of *Cymatopus* and *Thambemya* specimens were occasionally collected on rocky shores. Both *Cymatopus* and *Thambemyia* are in fact truly marine genera in which the adults are found foraging and displaying on rocks in the intertidal zone. The larvae and the pupae live inside the crusts of debris and algae on these rocks (Grootaert & Meuffels, 1993).

The genus *Cymatopus* is represented in Thailand by three informal species groups (Grootaert & Meuffels, 2001). The *longipilus*-group is characterised in the male by simple unmodified fore legs, but with modified hind legs bearing long bristles and hairs. The other two species groups have the fore legs modified and ornamented, but the hind legs are simple. The *malayensis*-group is composed of larger species (4.5–5.5 mm) with the hind border of the wing notched in the male and with fields of enlarged microtrichia on the wing membrane. The function of these fields is still enigmatic. The *thaicus*-group is composed of smaller species (2–3 mm) with the hind border of the wing not or a little folded and without fields of enlarged microtrichia on the wing membrane. Notes on display of *Cymatopus* can be found in Grootaert (1994) and on the general biology in Grootaert & Meuffels (1993). More references on Cymatopus of the Oriental and Australasian region can be found in Evenhuis & Grootaert (2002) and Evenhuis (2005).

The genus *Thambemyia* (in the sense of Masunaga et al., 2005) is readily recognised by the elongated mouthparts. They are generally found in the splash zone on cliffs and are often associated with oyster banks on rocks. Occasionally they are also found on the vertical surface of jetty's concrete pillars.

In the present paper we provide new distribution data of *Cymatopus* and *Thambemyia* with a key and illustrations of the habitus. A new species of *Cymatopus* is described from the coast of the Andaman Sea. Next Generation Sequencing (NGS) of COI barcodes (313 base-pairs) proved to be a reliable source for species identification of the observed species but the barcodes were unable to resolve relationships among them (Meier et al., 2016).

## MATERIALS AND METHODS

The specimens were hand-collected or collected with a sweep-net during a survey of both coasts of peninsular Thailand. All specimens were preserved in 70% ethanol in a refrigerator (4°C) in order to prevent DNA degradation. Type material was deposited in the collections of the Princess Maha Chakri Sirindhorn Natural History Museum of the Prince of Songkla University (NHM-PSU), Hat Yai, Songkhla, Thailand. The locality of the holotype is considered as the type locality. In addition, a few paratype specimens are also preserved in the collections of the Royal Belgian Institute of Natural Sciences (RBINS), Brussels, Belgium.

A focus stacking technique (see Brecko et al., 2014) was used to photograph all specimens. The high resolution pictures were stacked using Zerene Stacker software. The scale on the photos is 1 mm.

[1]Princess Maha Chakri Sirindhorn Natural History Museum (MNHM) of the Prince of Songkla University, Hat Yai, Songkhla, Thailand, 90110; Email: flywizme@gmail.com; samoh.a@yahoo.com

[2]Lee Kong Chian Natural History Museum, NUS, Singapore; Biodiversity Centre National Parks Singapore; Entomology, Royal Belgian Institute of Natural Sciences (RBINS), Vautierstraat 29, B-1000 Brussels, Belgium; Email: Patrick.Grootaert@naturalsciences.be (*corresponding author)


ISSN 2345-7600 (electronic) | ISSN 0217-2445 (print)

The NGS COI barcoding was done according to Meier et al. (2016).

The evolutionary history was inferred using the Neighbor-Joining method (Saitou & Nei, 1987). The optimal tree with the sum of branch length = 0.40236724 is shown. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (1,000 replicates) are shown next to the branches (Felsenstein, 1985). The tree is drawn to scale, with branch lengths in the same units as those of the evolutionary distances used to infer the phylogenetic tree. The evolutionary distances were computed using the Maximum Composite Likelihood method (Tamura et al., 2004) and are in the units of the number of base substitutions per site. The analysis involved 22 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There were a total of 313 positions in the final dataset. Evolutionary analyses were conducted in MEGA7 (Kumar et al., 2016).

## TAXONOMY

### Key to male *Cymatopus* and *Thambemyia* in Thailand

This key deals with marine dolichopodids from rocky shores with an apical arista on a triangular third antennal segment (postpedicel) and a pair of fronto-orbital bristles (bristle at each side of frons, halfway between base of antenna and vertex). For other marine dolichopodid genera, we refer to the key in Grootaert & Meuffels (2001).

1. Proboscis much shorter than eye height (Fig. 1) ..... ..... 2 (*Cymatopus*)
– Proboscis much longer than eye height (Figs. 11, 12) ..... ..... *Thambemyia pagdeni* Oldroyd

2. Hind legs modified, hind tibia and first tarsomere with long hairs (Fig. 9) ..... *C. longipilus* Parent
– Hind legs simple without peculiar long hairs or bristles (Fig. 1) ..... 3

3. Wing with hind border deeply indented and with fields of longer microtrichia on wing membrane (Fig. 1, arrow); large species (> 2.5 mm)..... *C. malayensis* Parent
– Wing simple, hind border not deeply indented, at most a little folded (Fig. 3, arrow); smaller species (2–2.5 mm) ..... 4

4. Male with vein $R_{2+3}$ simple; fore tibia with a black twisted foliaceous anterior bristle near middle and a long black apical bristle (Fig. 6)..... *C. thaicus* Grootaert & Meuffels
– Male with vein $R_{2+3}$ near middle much thickened and undulating, costa also thickened (Fig. 3); fore tibia without black anterior foliaceous bristle and without long apical bristle ..... ..... *C. mayakunae* new species

### Genus *Cymatopus* Kertész, 1901

*Cymatopus* Kertész, 1901: 408. Type species: *Cymatopus tibialis* Kertesz, 1901 (monotypy).

*Vanduzeeia* Parent, 1934: 257. Type species: *Vanduzeeia cheesmanae* Parent, 1934 (monotypy).

**Diagnosis.** Aphrosylinae. Grey dusted species of moderate length (2–5 mm). Third antennal segment triangular with an apical arista. Proboscis short but strong. Fore femur thickened in male and female. Male fore leg generally with various adornments such as strong bristles on femur and tibia, leaf-like bristles on fore tarsus, lengthened metatarsus and apical tarsomeres flattened. Males of the *longipilus*-group have simple fore legs, hind tibia thickened bearing very long hair-like bristles.

### The *malayensis*-group

Only one species in Thailand.

#### *Cymatopus malayensis* Parent, 1935
Figs. 1, 2

Parent, 1935a: 208 (figs 26–31).

**Material examined.** THAILAND: Gulf of Thailand (South China Sea): 16 males, 16 females, Laem Kho Kwang, Chumphon Province, 17 February 2015, sweep netting, 10°30′48.7″N, 99°15′52.0″E; 13 males, 13 females, Ban Thong Tom Yai, Sawee, Chumphon Province, 19 February 2015, sweep netting, 10°12′39.2″N, 99°12′21.4″E. (PSUNHM). Andaman Sea (Indian Ocean): 8 males, 4 males, Tarutao Island, Langu, Satun Province, 9 January 2015, sweep netting, 6°44′19.2″N 99°38′45.4″E, coll. Abdulloh Samoh; 1 male; 4 females, Nang thong beach, 8°38′40.46′N, 98°14′47.71″E, Phang-Nga Province, 4 November 2017, hand collecting on concrete wall on the beach, leg. P. Grootaert & I. Van de Velde. (RBINS).

NGS barcodes see annex 1.

**Diagnosis.** A large species with modified fore leg. Fore tibia anteriorly with a black foliaceous bristle and metatarsus (tarsomere 1) elongated with a distorted tip bearing strong twisted bristles. Fore tarsomeres 4 and 5 flattened and brown. Wing with hind margin deeply indented (Fig. 1) and fields of enlarged microtrichia on wing membrane.

**Bionomics.** The adult flies are found in the splash zone of rocky shores.

**Distribution.** Shores of the Andaman Sea and the Gulf of Thailand (Grootaert & Meuffels, 2001). Thailand, Malaysia, Singapore and Borneo.

### The *thaicus*-group

The *thaicus*-group was informally proposed by Grootaert & Meuffels (2001) based on the smaller size of the specimens, the unmodified shape of the wings and the absence of fields of microtrichia on the wing membrane. The apparent lack of a confident morphological synapomorphy raises doubts about the monophyly of this group. Additionally, it is genetically not supported either, as can be seen on a neighbour joining tree based on the COI gene (Fig. 10). Yet, the group-name is provisionally still applied. It is represented by two species in Thailand: *C. thaicus* and *C. mayakunae*, new species.

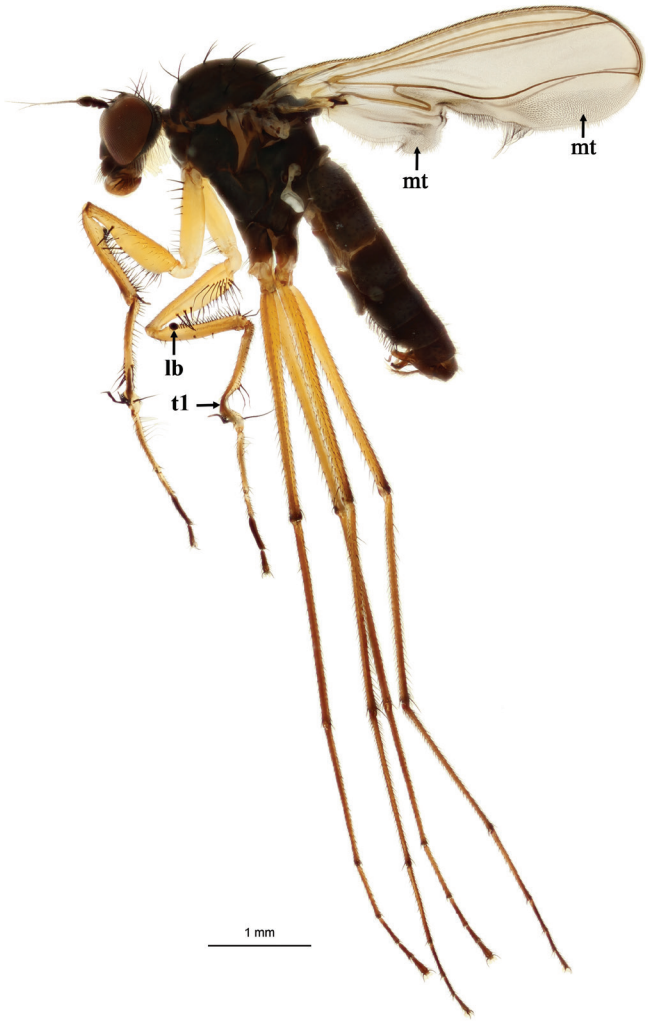


Fig. 1. *Cymatopus malayensis* Parent habitus male: lb: leaf-like bristle on fore tibia; mt: fields of microtrichia on wing; t1: twisted fore tarsomere.


Fig. 2. *Cymatopus malayensis* Parent habitus female.

### ***Cymatopus mayakunae*** **new species**

Figs. 3–5

**Material examined.** Holotype male: THAILAND, Laem Pakarang, Khao Lak, Takuapa, Phang Nga Province (Andaman Sea), 8°44′09.9″N, 98°13′21.5″E, 10 February 2015, sweep netting, coll. A. Samoh (PSUNHM) Paratypes: 30 males, 10 females, same collection as holotype. 13 males, 6 females, Tarutao Island, Langu, Satun Province (Andaman Sea), 6°44′19.2″N 99°38′45.4″E, 9 January 2015, sweep netting, coll. A. Samoh (PSUNHM, RBINS).

NGS barcodes see annex 1.

**Etymology.** The species is dedicated to Dr. Jaruwan Mayakuna who was so kind to take the first author to sample *Cymatopus* flies in the Langu mangroves, Satun Province (Andaman Sea).

**Diagnosis.** A small species (2–2.5 mm) with yellow legs. Fore tibia without black foliaceous bristle and without apical spur and apical bristle. Fore tibia dorsally near base with short bent bristles. Hind tibia with a dorsal row of bristles with dilated tips. Wing with veins $R_1$ and $R_{2+3}$ deformed and thickened. Posterior wing border a little deformed with longer hairs.

Male (Fig. 3). Body length 2.5 mm; wing length 2.5 mm.

Head. Frons and face black in ground-colour, greyish dusted. Clypeus protruding. Face wider than postpedicel is wide. Palpus brown with short black hairs, tips of apical bristles pale. A pair of strong ocellars, a pair of slightly shorter fronto-orbitals and a pair of minute postocellars. Postocular bristles black above, becoming whitish and hair-like below. Antenna black, pedicel darker than scape and postpedicel. Postpedicel conical, 1.5 times as long as wide. Arista nearly twice as long as scape, pedicel and postpedicel together.

Thorax black in ground-colour, greyish dusted. No acrostichals, 5 dc (anterior 4 equally long, prescutellar dc longer); a pair of long scutellars with a minute hair at outside. A minute humeral, a very long posthumeral, a short sutural, a minute notopleural, a longer supra-alar and a long postalar. 3 pale propleurals.

Legs yellow (Fig. 3) with mid and hind coxae black, apical two tarsomeres slightly brownish. Fore leg. Coxa with 2–3

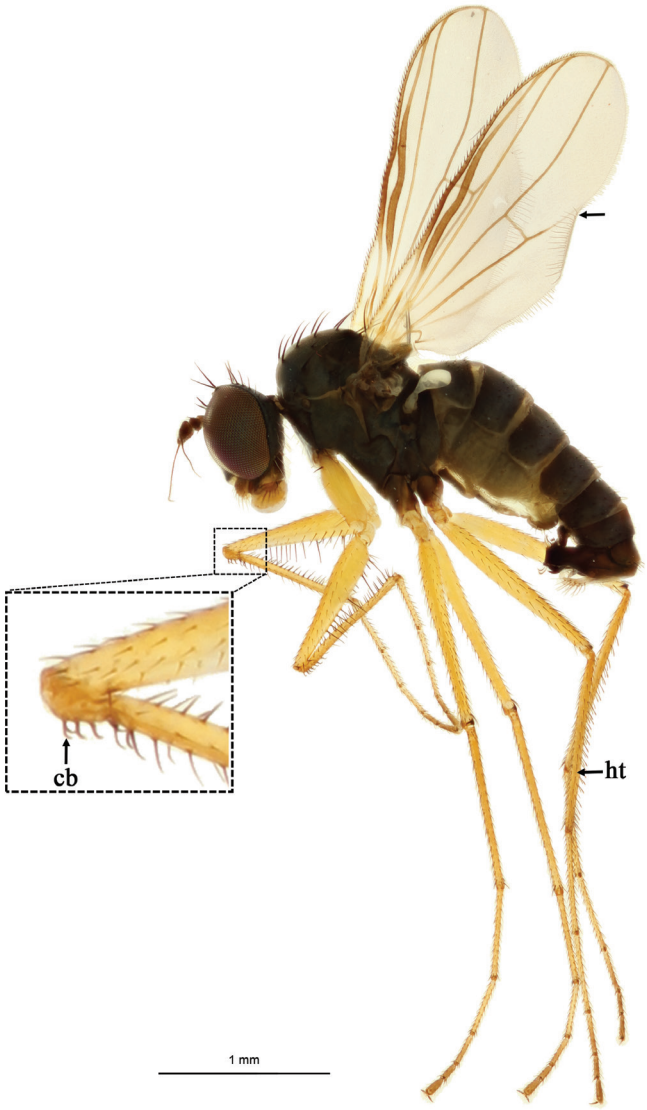


Fig. 3. *Cymatopus mayakunae* new species male habitus. cb: curved bristles on fore tibia; ht: hind tibia with dorsal row of bristles with swollen tip; arrow indicates fold in hind margin of wing set with long bristles.

short black bristles at base and some longer black apical bristles. Femur swollen in basal half with long posteroventral bristles, near base as long as femur is wide, in apical half longer than femur is wide. The row is interrupted at the basal third where there are 2 shorter bristles. Tibia as long as femur, without apical spur and without apical spine-like bristle; ventrally set with a double row of spine-like bristles as long as tibia is wide; basal fifth of tibia dorsally set with a double row of short bristles with curved tip. Tarsomeres not flattened. Mid leg: Coxa with 2 short black exterior bristles. Femur much longer and thinner than fore femur. Tibia shorter than femur without particular bristles. Hind leg: Coxa with a short black exterior bristle. Femur a little wider than mid femur and shorter. Tibia dorsally set with a double row of short bristles with enlarged tips (Fig. 3).

Wing brownish tinged with brown veins. Costa near middle darker brown and slightly bowed. Costa and $R_{2+3}$ (Fig. 3) thickened and undulating near middle. Apical half of Cu pale, the hind border is a little notched there and the wing


Fig. 4. *Cymatopus mayakunae* new species female habitus.

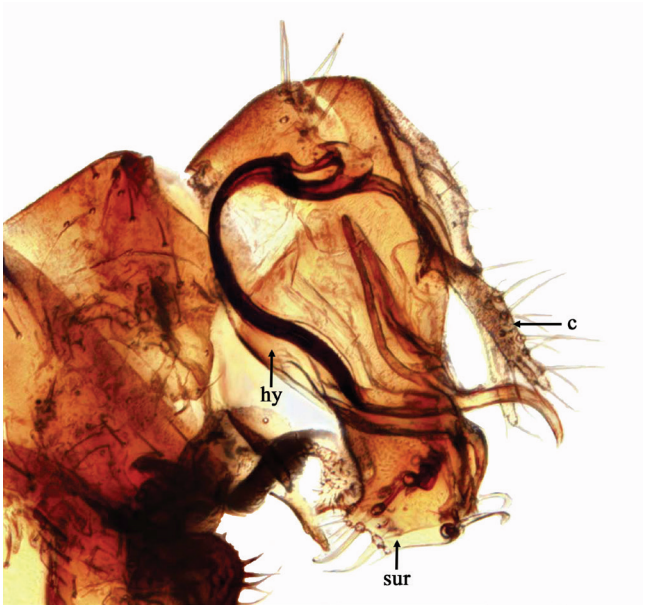


Fig. 5. *Cymatopus mayakunae* sp. nov. male terminalia. c: cercus; hy: hypandrium; sur: surstylus.

membrane is folded to the exterior and bears some longer bristles at that level. Haltere and squama white, bearing long white cilia.

Abdomen black in ground-colour, greyish dusted. Tergites with minute black bristles on apical border. Terminalia (Fig. 5). Cercus yellow with brown bristles longer than cercus is wide.

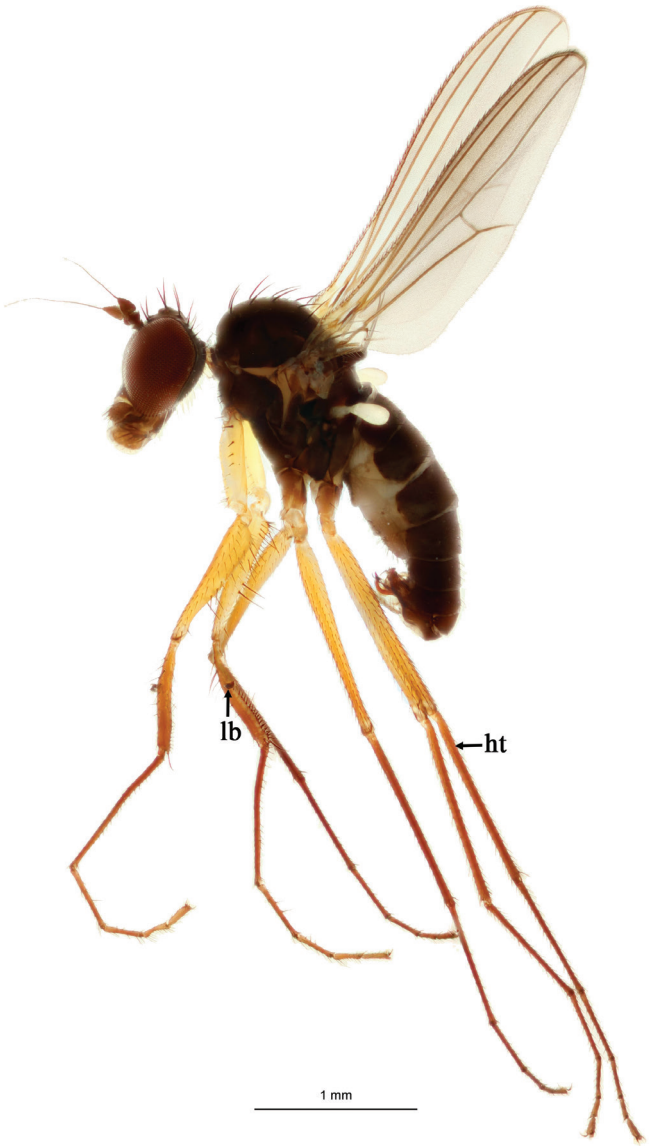


Fig. 6. *Cymatopus thaicus* Grootaert & Meuffels habitus male. lb: leaf-like bristle on fore tibia; ht: hind tibia.

Female (Fig. 4). Body length: 2.0 mm, wing length: 2.0 mm.

Identical to male but fore legs with shorter bristles and wing with veins not deformed. Fore tibia and hind tibia with normal bristling.

**Bionomics.** The adult flies are found in the splash zone of rocky shores.

**Distribution.** Shores of the Andaman Sea.

**Remarks.** The new species is unique in the genus in having the fore tibia dorsally near base set with short bent bristles. The hind tibia has a dorsal row of bristles with dilated tips. Veins $R_1$ and $R_{2+3}$ are deformed and thickened. In addition, the posterior wing border is a little deformed bearing longer hairs.


Fig. 7. *Cymatopus thaicus* Grootaert & Meuffels habitus female.

### *Cymatopus thaicus* Grootaert & Meuffels, 2001
Figs. 6–8

Grootaert & Meuffels, 2001: 351 (figs 31–36).

**Material examined.** THAILAND: Andaman Sea: 4 males, Lidi Island, Langu, Satun Province (Andaman Sea), 6°46′56.4″N, 99°45′58.5″E, 30 July 2015, sweep netting, coll. A. Samoh; 12 males, 4 females, Tarutao Island, Langu, Satun Province, 6°44′19.2″N 99°38′45.4″E, 9 January 2015, sweep netting, coll. A. Samoh; 1 male, 1 female, Nang thong beach, 8°39′06.01″N, 98°14′46.60″E, Phang-Nga Province, 5 November 2017, hand collecting on rocks in the sea, leg. P. Grootaert & I. Van de Velde; 6 males, 4 females, Ko Phra Thong, 9°07′33.9″N 98°14′58.5″E, Phang-nga Province, leg. A. Samoh (PSUNHM).

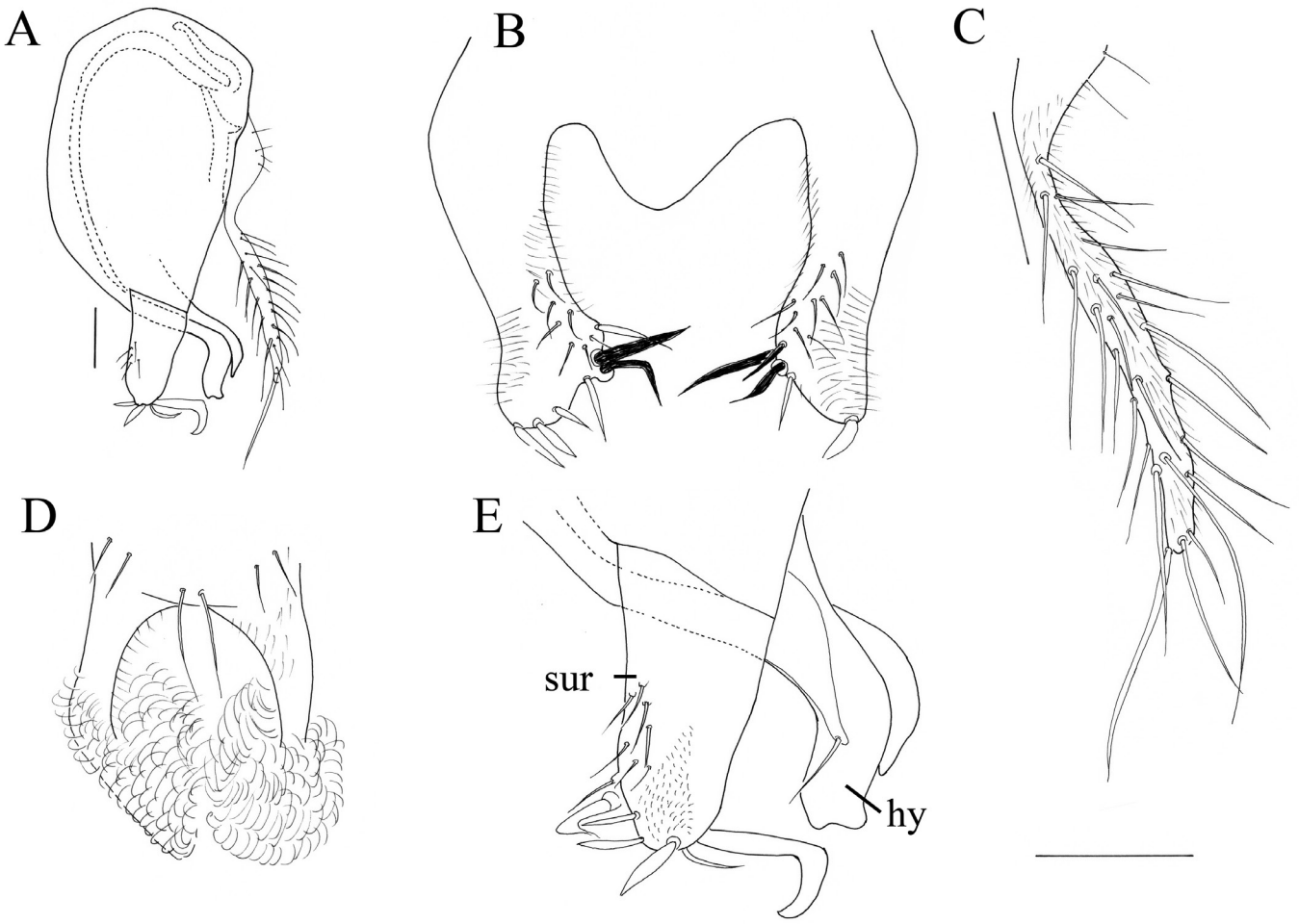


Fig. 8. *Cymatopus thaicus* Grootaert & Meuffels male terminalia. A, Genital capsule in lateral view; B, surstyli dorsal view; C, Cercus lateral; D, Extension on sternite 6; E, Detail surstylus in lateral view with tip hypandrium and aedeagus. Scale = 0.1 mm. hy: hypandrium; sur: surstylus.

NGS barcodes see annexe 1.

**Diagnosis.** A small species (2–2.2 mm) with yellow legs. Fore tibia with a black foliaceous bristle and without an apical spur, but with a long black apical bristle on a short tubercle. Tarsomere 4 dorsally somewhat excavated with long dorsal bristles and as long as the flattened tarsomere 5. Posterior wing border normal, set with equally long hairs. Veins not deformed. Male terminalia as in Fig. 8.

**Distribution.** Thailand, Malaysia and Singapore.

**The *longipilus*-group**

Only one species in Thailand.

***Cymatopus longipilus* Parent, 1935**
Fig. 9

Parent, 1935b: 61 (figs, 5–7).

**Material examined.** – No new material was found during the present study.


Fig. 9. *Cymatopus longipilus* Parent (Rayong prov.). Mid leg and swollen hind leg bearing long bristles. ht: hind tibia.

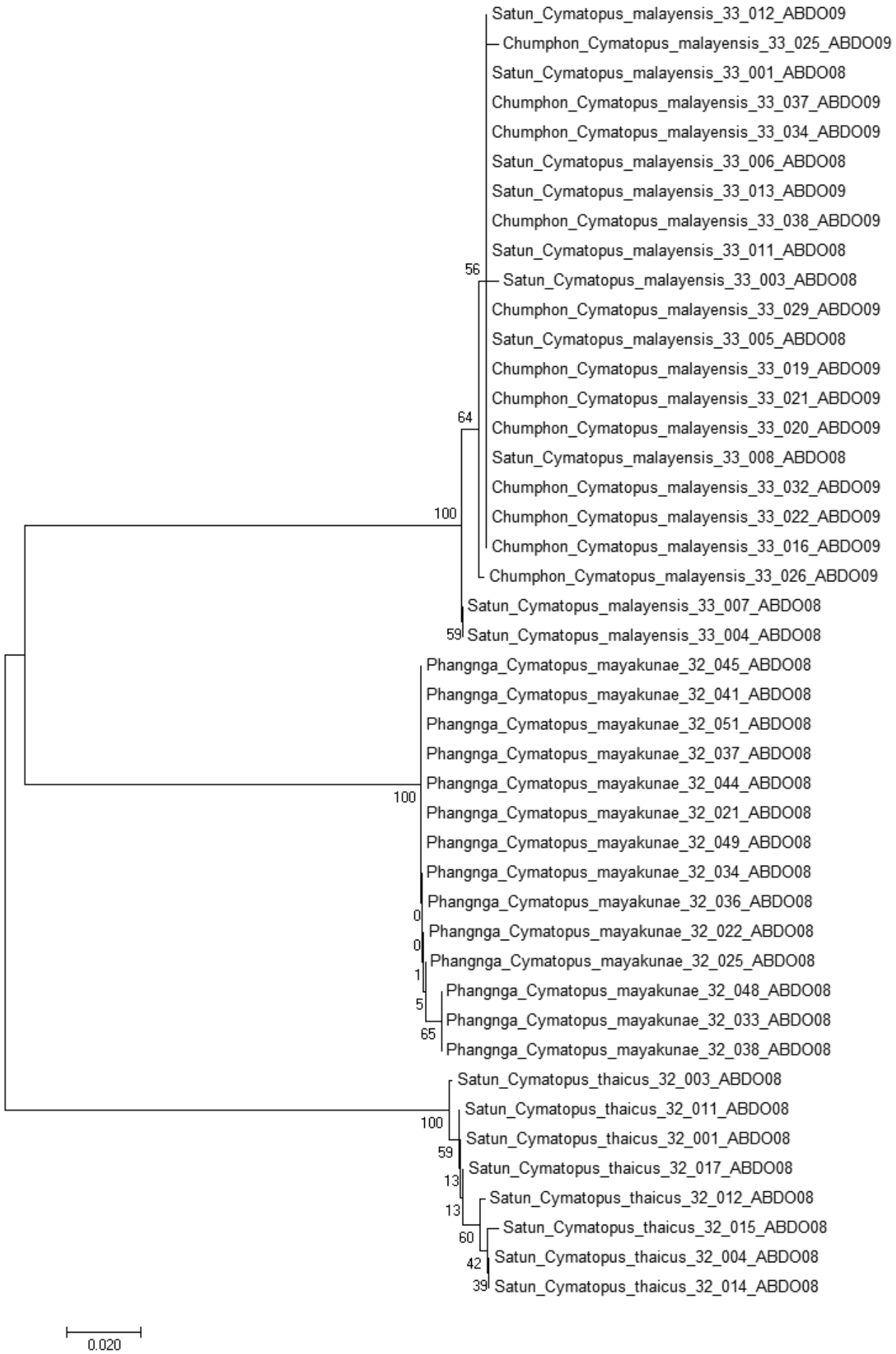


Fig. 10. Evolutionary relationships of taxa of *Cymatopus* based on NGS bacodes (Meier et al., 2016).

**Diagnosis.** A small (1.75 mm) dark species with dark brown legs. Tip of hind tibia in male enlarged and bearing very long black bristles, continuing on the hind metatarsus (Fig. 9).

**Bionomics.** The adult flies are found in the splash zone of rocky shores and often they are found on vertical oyster beds.

**Distribution.** Shores of the Andaman Sea and the Gulf of Thailand (Grootaert & Meuffels, 2001), Christmas Island Indian Ocean (type locality).

**General discussion on *Cymatopus* in Thailand**

The genetic distance between the three species of *Cymatopus* in southern Thailand is between 21 and 23% (Fig. 10). This large distance probably indicates that the divergence time among the species is old and that the speciation events took place several million years ago. In addition, the number of haplotypes per species is also very high especially since the specimens were collected in only one site for *C. mayakunae* sp. nov. and *C. thaicus* and in two sites for *C. malayensis*. For the 14 individuals of *C. mayakunae* that were successfully sequenced, there are four different haplotypes that in fact do not differ much; by 0.3% at most, which is only a single base pair. Twenty-two individuals of *C. malayensis* collected in Chumphon (Gulf of Thailand) and Satun (Andaman Sea) have six different haplotypes. The difference varies between 0.3 and 1%. Variation in the Satun samples was the largest. Only eight individuals of *C. thaicus* were successfully sequenced and there are six different haplotypes. The variation in haplotypes ranges also between 0.3 and 1%.

So both genetic distance and haplotype variation suggest an old speciation of these three species.

**Genus *Thambemyia* Oldroyd, 1956**

*Thambemyia* Oldroyd, 1956: 210. Type-species: *T. pagdeni* Oldroyd (original designation).

*Conchopus* Takagi, 1965: 49. Type-species: *C. rectus* Takagi (original designation). Synonymised by Meuffels & Grootaert (1984), but see Masunaga et al. (2005) and Masunaga & Saigusa (2010).

Subgenus *Thambemyia* Oldroyd, 1956.

**Diagnosis.** Aphrosylinae. Grey dusted species of moderate length (2–5 mm). Third antennal segment triangular with an apical arista. Proboscis strong and longer than eye height. Fore legs simple not adorned. Fore metatarsus with a ventral incision.

Notes on the status of the genus are provided by Capellari (2015).

***Thambemyia pagdeni* Oldroyd, 1956**
Figs. 11, 12

Oldroyd, 1956: 211. Type locality: Malaysia: Penang.

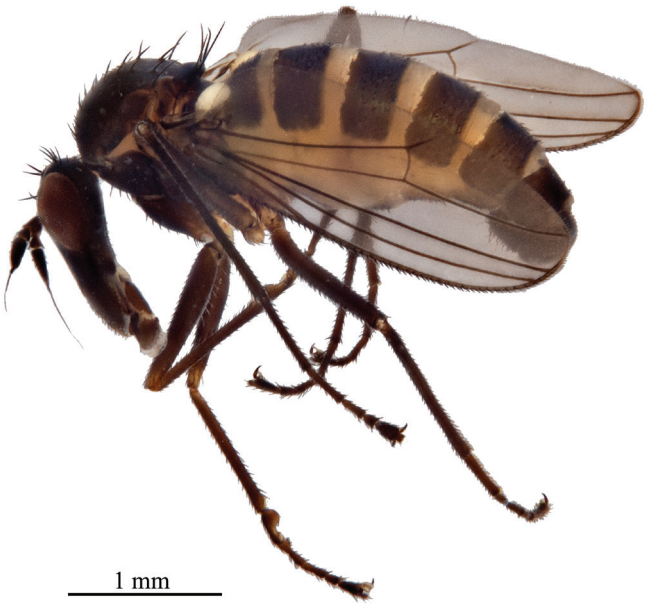


Fig. 11. *Thambemyia pagdeni* Oldroyd male habitus (photo credit = Maimon Husein).


Fig. 12. *Thambemyia pagdeni* Oldroyd female habitus (photo credit = Maimon Husein).

**Material examined.** THAILAND, Gulf of Thailand (South China Sea): 23 males, 15 females, Sakom (Tepha), Songkhla province, Gulf of Thailand (South China Sea), 28 March 2017, cliffs, 6°57′42,97″N 100°50′57.02″E; 29 March 201, on concrete pillars of a pier on a sandy beach 6°56′52,88″N 100°51′52.72″E (PSUNHM).

Andaman Sea: 1 male, 2 females, Khao Lak, Nang thong, Phang-Nga province, 9 April 1996, rocky beach (reg. 96050, leg. P. Grootaert; on pin in RBINS); 3 males, Nang thong

beach, 8°37′46.00″N, 98°14′35.43″E, Phang-Nga Province, 3 November 2017, hand collecting on rocks in the sea, leg. P. Grootaert & I. Van de Velde; 1 male, Nang thong beach, 8°39′06.01″N, 98°14′46.60″E, Phang-Nga Province, 5 November 2017, hand collecting on rocks in the sea, leg. P. Grootaert & I. Van de Velde (RBINS); 21 males, 24 females, Ko Phra Thong, 9°07′33.9″N 98°14′58.5″E, Phang-Nga Province, leg. A. Samoh (PSUNHM).

**Diagnosis.** Medium-sized (4–4.5 mm) black species with long yellowish brown to black legs. Mainly characterised by the long mouthparts like an elephant trump. The fore legs (Fig. 11) have tarsomere 1 with a ventral notch, tarsomere 2 with a basal protuberance and tarsomere 5 enlarged and flattened. The postpedicel is elongated triangular (2.5 times as long as wide) with a long apical arista. Female with simple fore tarsus (Fig. 12).

**Bionomics.** The adult flies are found in the splash zone of vertical walls such as cliffs and pillars of jetties.

**Distribution.** Thailand, Malaysia and Indonesia.

## ACKNOWLEDGEMENTS

This research was supported by the Higher Education Research Promotion and National Research University (NRU) Project of Thailand (No. SCI 540531 M), and Prince of Songkla University Graduate School Research funding. We also thank an Overseas Thesis Research Funding from the Faculty of Science, Prince of Songkla University for financial support and opportunity to conduct our research at the Royal Belgian Institute of Natural Sciences (RBINS), Brussels, Belgium. Plant Genetic Conservation Project under her Royal Highness Princess Maha Chakri Sirindhorn, project number SCI600085S. The authors thank Singtoe Boonrotpong and Entomology Research Unit (ERU) members for their highly appreciated guidance and generous help in the field. We also acknowledge the great help of Rudolf Meier, Wendy Wang and Darren Yeo for the sequencing of the material at the National University of Singapore. Finally we thank one anonymous reviewer and Renato Capellari for their useful and interesting comments to improve the manuscript.

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Annexe 1. Examples of haplotypes of NGS barcodes (COI, 313 base pairs) for each species of *Cymatopus*.

>Chumphon_**Cymatopus_malayensis**_33_025_ABDO09
(GenBank: MG972196)
TTTATCCGCAGGGATTGCCCATGGGGGGGCCTCAGTAGACTTAGCTATTTTTTCCCTCCACTTAGCCGGAATTTCTTCAATTT
TAGGGGCAGTAAATTTTATTACAACCGTAATTAATATACGATCAACAGGAATTACTTTCGACCGTATGCCCCTATTTGTGTG
ATCAGTGGTAATTACCGCTATTTTACTATTATTATCATTACCTGTATTAGCAGGTGCAATTACAATATTATTAACTGACCGAA
ATCTAAATACTTCATTCTTTGACCCCGCCGGAGGGGGTGACCCAATTTTATATCAACATCTATTT

>Satun_**Cymatopus_malayensis**_33_004_ABDO08
(GenBank: MG972197)
TTTATCCGCAGGGATTGCCCATGGAGGGGCCTCAGTAGACTTAGCTATTTTTTCCCTCCACTTAGCCGGAATTTCTTCAATTT
TAGGGGCAGTAAATTTTATTACAACCGTAATTAATATACGATCAACAGGAATTACTTTCGACCGTATACCCCTATTTGTATG
ATCAGTGGTAATTACCGCTATTTTACTATTATTATCATTACCTGTATTAGCAGGTGCAATTACAATATTATTAACTGACCGAA
ATCTAAATACTTCATTCTTTGACCCCGCCGGAGGGGGTGACCCAATTTTATATCAACATCTATTT

>Phangnga_ ***Cymatopus_mayakunae*** _32_034_ABDO08
(GenBank: MG972198)

TTTATCAGCAGGAATTGCGCATGGAGGAGCATCAGTTGACCTAGCTATTTTCTCCCTCCACTTAGCTGGTATTTCATCTATTT
TAGGAGCCGTAAATTTTATTACTACAGTAATTAATATACGATCAACAGGAATTACATTTGACCGAATACCCTTATTTGTATG
ATCAGTAGTAATTACAGCTATTCTATTACTTTTATCACTTCCTGTCCTAGCAGGAGCCATTACTATATTATTAACTGATCGTA
ACTTAAATACATCATTCTTTGACCCCGCAGGAGGGGGAGACCCTATTTTATACCAGCATCTATTC

>Phangnga_***Cymatopus_mayakunae*** _32_025_ABDO08
(GenBank: MG972199)
TTTATCAGCAGGAATTGCGCATGGAGGAGCATCAGTTGACCTAGCTATTTTCTCCCTCCACTTAGCTGGTATTTCATCTATTT
TAGGAGCCGTAAATTTTATTACTACAGTAATTAATATACGATCAACAGGAATTACATTTGACCGAATACCCTTATTTGTATG
ATCAGTAGTAATTACAGCTATTCTATTACTTTTATCACTTCCTGTCCTAGCAGGAGCCATTACTATATTATTAACTGATCGTA
ACTTAAATACATCATTCTTTGACCCCGCAGGAGGGGGAGACCCTATTTTATACCAGCATCTATTC

>Satun_***Cymatopus_thaicus***_32_008_ABDO08
(GenBank MG972200)
ATTATCTGCTGGAATTGCCCATGGAGGAGCATCAGTTGATTTAGCAATTTTCTCTCTTCACCTAGCAGGTATTTCATCTATCC
TAGGAGCAGTAAATTTTATTACAACAGTAATTAATATACGTTCAACAGGAATTACATTTGACCGAATACCCTTATTTGTGTG
ATCTGTCGTAATTACAGCTATTCTACTTTTATTATCCCTCCCAGTTCTTGCAGGAGCAATCACAATACTTTTAACTGACCGAA
ATTTAAATACTTCATTTTTTGACCCTGCCGGAGGAGGAGACCCAATTTTATATCAACATCTATTT

>Satun_***Cymatopus_thaicus***_31_003_ABDO08
(GenBank MG972201)
ATTATCTGCTGGAATTGCCCATGGAGGAGCATCAGTTGATTTAGCAATTTTCTCTCTTCATCTAGCAGGTATTTCATCTATCC
TAGGAGCAGTAAATTTTATTACAACAGTAATTAATATACGTTCAACAGGAATTACATTTGACCGAATACCCTTATTTGTGTG
ATCTGTCGTAATTACAGCTATTCTACTTTTATTATCCCTCCCAGTTCTTGCAGGAGCAATCACAATACTTTTAACTGACCGAA
ATTTAAATACTTCATTTTTTGACCCTGCCGGAGGAGGAGACCCAATTTTATACCAACATCTATTT