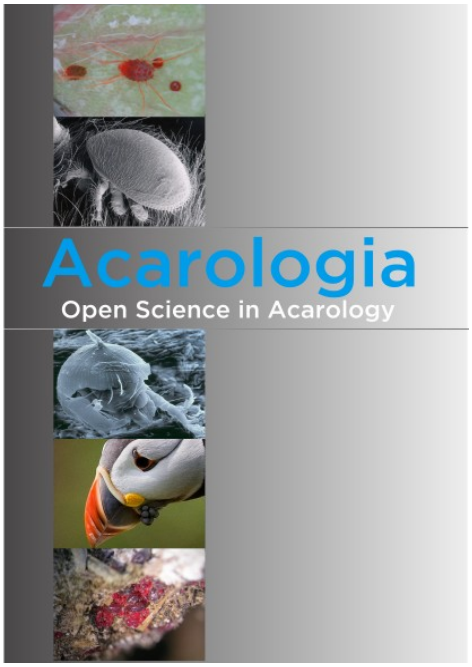

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On the taxonomy of chigger mites (Acariformes: Trombiculidae) parasitizing birds in Thailand and Malaysia, with the description of a new species

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Original research

ABSTRACT

Chigger mites were collected from 65 bird species in different regions of Thailand and Malaysia. In total, 21 species were recorded. The previously unknown fauna of chiggers parasitizing shorebirds of Thailand included one new species, *Neacariscus* (*Whartonacarus*) *andamanensis* **n. sp.** as well as *Neacariscus* (*Neacariscus*) *pluvius* (Wharton, 1945) previously recorded only in Oceania; *Neacariscus* (*Whartonacarus*) *shiraii* (Sasa, Kano & Obata, 1952) (known from Oceania and Japan); and *Neacariscus* (*Whartonacarus*) *sulae* (Oudemans, 1910) and *Schoengastia archaea* (Taufflieb, 1960), both described from West Africa. *Toritrombicula kirhocephales* Goff, 1982 described from Papua New Guinea was for the first time recorded in Asia (Thailand). *Neoschoengastia gallinarum* (Hatori, 1920) and *Helenicula comata* (Womersley, 1952) were for the first time recorded in Thailand. *Ascoschoengastia lorius* (Gunther, 1939) was for the first time recorded in Malaysia. Finally, *Ericotrombidium cosmetopode* (Vercammen-Grandjean & Langston, 1971) described from free larvae, was for the first time recorded on a host (bird *Pellorneum ruficeps* Swainson); and *Leptotrombidium miculum* (Traub & Audy, 1954) was for the first time recorded on a bird host. New host species were recorded for a large part of the collected chigger species.

Keywords chiggers; taxonomy; Southeast Asia; parasites of birds
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Introduction

Southeast Asia is one of the best-studied regions of the world about the taxonomy of chigger mites. The leading countries of this region are Malaysia, with 202 recorded chigger species, and Thailand, with 156 species (Stekolnikov 2021a). However, the chigger species specific to some groups of hosts, such as bats or birds, are under-explored even in such territories. In general, extensive investigations focused on bird chiggers are rare, as compared with chiggers from mammals (Trnka *et al.* 2022). Among the recent works on Southeast Asian chiggers, a paper based on the collections from Vietnam should be consulted (Kaluz *et al.* 2016), in which three species of *Neoschoengastia* Ewing, 1929 (including two new to science), *Odontacarus audyi* (Radford, 1946), *Helenicula scanloni* (Domrow & Nadchatram, 1964), *Neotrombicula elegans* Schluger, 1966, and six species of *Leptotrombidium* Nagayo *et al.*, 1916 were recorded on seven bird species. Noteworthy is that all of them, except for *H. scanloni*, were unknown previously in Vietnam, even though this country is the third most studied for chiggers in Southeast Asia, after Malaysia and Thailand (Stekolnikov 2021a).

Our collections performed over the timeframe of 2020 – 2022 obtained a large number of chiggers from birds across Thailand and Malaysia (1,531 individual hosts of 65 species), including one new trombiculid species and a series of unexpected new geographic and host records. Here, we provide a list of these chigger-host records compared with published data, alongside morphological descriptions of our specimens including one new species and notes on the genus *Neacariscus* and its constituent subgenera. The purpose of this work is to serve as the foundation for quantitative ecological studies of bird-chigger relationships in Southeast Asia that will be presented in a separate publication; thus, we limit our discussion to qualitative findings in the current study.

Material and methods

Approvals for bird sampling

In Peninsular Malaysia, the animal handling work was subjected to the approvals and guidelines from the Universiti Malaya Institutional Animal Care and Use Committee (Permission No: G8/07052020/09012020-01/R), and a wildlife research permit was obtained from the Department of Wildlife and National Parks (DWNP, Permit No. W-00064-15-21). Separate permits were obtained from the Sarawak Forest Department, National Parks and Nature Reserves, East Malaysia (Permit No. SFC.810-4/6/1 – 033 for collection of biological resources and Permit No. WL 13/2022 for permission to enter parks). In Thailand, the study was approved by the Faculty of Tropical Medicine Animal Care and Use Committee (FTM-ACUC, Certification No. 011/2020E) and the Department of National Park Wildlife and Plant Conservation (DNP), Ministry of Natural Resources and Environment (permission letter No. 0907.4/21997). The study was also approved by the Animal Welfare and Ethical Review Body of the University of Liverpool with reference nos. AWC0219 (Malaysia) and AWC0179 (Thailand).

Study sites and bird trapping

Bird trapping was conducted across eight provinces of Thailand (Nan, Nakhon Sawan, Kanchanaburi, Samut Sakhon, Phetchaburi, Rayong, Trang, and Satun) and seven states of Malaysia (Selangor, Pahang, Terengganu, Kedah, Perak, Johor, and Sarawak). Precise sampling locations are listed in Tables 1 and 2, with GPS coordinates provided in the Results. Names of birds follow the IOC World Bird List (Gill *et al.* 2023). Each location was sampled for 1 – 6 days in proportion to the scale of the site and bird abundance, and some locations were sampled on more than one occasion. Multiple strategies were applied to the capture of different bird species, with expert assistance from DWNP in Malaysia and DNP in Thailand. Passeriformes, Coraciiformes, Piciformes, Podargiformes, Strigiformes, Gruiformes, and Cuculiformes were

trapped using mist nets, which were checked every 15 to 20 minutes depending on the abundance of birds in the area of deployment. In Malaysia, Galliformes were captured using large scoop nets at night from 20:00 h to 00:00 h; whereas in Thailand, domestic chickens (only sampled in Ban Huai Muang village, Nan province) were brought by their owners for examination by the field team. Finally, waders (Charadriiformes) in Thailand were captured by cannon netting at diurnal high-tide roosts. In Thailand, birds were identified concerning Treesucon and Limparungpatthanakij (2018) and Lekagul and Round (1991); whereas in Malaysia, the key reference work was Robson (2018). After examination, wild birds were released in the site of capture; domestic birds were returned to the owners.

Chigger collection and examination

Trapped birds were handled gently during examination for the presence of chigger mites. Chiggers attached to the birds were removed carefully using fine forceps and placed in tubes containing 70% ethanol. These were labelled individually according to the number assigned to each of the bird hosts.

A survey of free-living chiggers in the environment was also conducted at Ban Huai Muang village after chigger infestations on chickens were confirmed. Briefly, square black plastic plates were deployed on the ground in a formation of six grids in different habitats inside and

Table 1 Material from Thailand. Mahidol Univ. – collection sites NW, W, and SW of Mahidol University campus; Albino Dragon – Albino Dragon Spine beach.

Province	Locality	Habitat	Month	Host species	Host order	Host family	Hosts	Slides
Kanchanaburi	Mahidol Univ.	Highland	December	*Dicrurus paradiseus* (L.)	Passeriformes	Dicruridae	1	1
Kanchanaburi	Mahidol Univ.	Highland	December	*Calliope calliope* (Pallas)	Passeriformes	Muscicapidae	2	7
Kanchanaburi	Mahidol Univ.	Highland	December	*Copsychus malabaricus* (Scopoli)	Passeriformes	Muscicapidae	15	61
Kanchanaburi	Mahidol Univ.	Highland	December	*Copsychus saularis* (L.)	Passeriformes	Muscicapidae	1	4
Kanchanaburi	Mahidol Univ.	Highland	December	*Cyornis tickelliae* Blyth	Passeriformes	Muscicapidae	11	42
Kanchanaburi	Mahidol Univ.	Highland	December	*Ficedula albicilla* (Pallas)	Passeriformes	Muscicapidae	2	2
Kanchanaburi	Mahidol Univ.	Highland	December	*Larvivora cyane* (Pallas)	Passeriformes	Muscicapidae	14	64
Kanchanaburi	Mahidol Univ.	Highland	December	*Pycnonotus aurigaster* (Vieillot)	Passeriformes	Pycnonotidae	2	3
Kanchanaburi	Mahidol Univ.	Highland	December	*Pycnonotus conradi* (Finsch)	Passeriformes	Pycnonotidae	11	21
Kanchanaburi	Mahidol Univ.	Highland	December	*Pycnonotus finlaysoni* Strickland	Passeriformes	Pycnonotidae	2	6
Kanchanaburi	Mahidol Univ.	Highland	December	*Rubigula flaviventris* (Tickell)	Passeriformes	Pycnonotidae	1	3
Kanchanaburi	Mahidol Univ.	Highland	December	*Rhipidura javanica* (Sparrman)	Passeriformes	Rhipiduridae	2	4
Kanchanaburi	Mahidol Univ.	Highland	December	*Mixornis gularis* (Horsfield)	Passeriformes	Timaliidae	2	3
Kanchanaburi	Mahidol Univ.	Highland	December	*Otus sunia* (Hodgson)	Strigiformes	Strigidae	1	2
Nan	Huai Muang	Village	December	*Gallus gallus domesticus* (L.)	Galliformes	Phasianidae	30	122
Nan	Ban Santisuk	Village	December	*Gallus gallus domesticus*	Galliformes	Phasianidae	2	3
Rayong	Koh Mun Nai	Island	March	*Alcedo atthis* (L.)	Coraciiformes	Alcedinidae	1	7
Rayong	Koh Mun Nai	Island	March	*Larvivora cyane*	Passeriformes	Muscicapidae	2	8
Rayong	Koh Mun Nai	Island	March	*Pachycephala cinerea* (Blyth)	Passeriformes	Pachycephalidae	3	12
Rayong	Koh Mun Nai	Island	March	*Phylloscopus tenellipes* Swinhoe	Passeriformes	Phylloscopidae	1	2
Rayong	Koh Mun Nai	Island	March	*Pycnonotus conradi*	Passeriformes	Pycnonotidae	2	2
Rayong	Koh Mun Nai	Island	March	*Geokichla citrina* (Latham)	Passeriformes	Turdidae	1	5
Rayong	Koh Mun Nai	Island	March	*Geokichla sibirica sibirica* (Pallas)	Passeriformes	Turdidae	1	3
Satun	Thung Sabo	Shore	March	*Charadrius leschenaultii* Lesson	Charadriiformes	Charadriidae	1	1
Satun	Thung Sabo	Shore	March	*Calidris tenuirostris* (Horsfield)	Charadriiformes	Scolopacidae	3	6
Trang	Albino Dragon	Shore	March	*Numenius arquata* (L.)	Charadriiformes	Scolopacidae	3	8
Trang	Koh Libong	Shore	March	*Pluvialis squatarola* (L.)	Charadriiformes	Charadriidae	1	2
Trang	Koh Libong	Shore	March	*Calidris tenuirostris*	Charadriiformes	Scolopacidae	2	4
Trang	Samran beach	Shore	March	*Charadrius leschenaultii*	Charadriiformes	Charadriidae	2	2
Trang	Samran beach	Shore	March	*Charadrius mongolus* Pallas	Charadriiformes	Charadriidae	2	4
Trang	Samran beach	Shore	March	*Calidris ruficollis* (Pallas)	Charadriiformes	Scolopacidae	2	3
Trang	Samran beach	Shore	March	*Calidris tenuirostris*	Charadriiformes	Scolopacidae	8	16
Trang	Samran beach	Shore	March	*Xenus cinereus* (Güldenstädt)	Charadriiformes	Scolopacidae	6	7

around the village (Kundin *et al.* 1966). The plates were carefully examined for chiggers within 10 minutes following deployment; the free-living chiggers were removed using a fine paintbrush and transferred into 80% ethanol.

With the aid of a dissecting microscope, ~10 – 20% of chiggers from each host or environmental sample were selected by differences in size and appearance as subsamples representative of the chigger species composition. These were then washed in sterile water to remove ethanol, arranged in a dorsoventral position on a glass slide with a drop of Berlese fluid (TCS Bioscience Ltd, UK), and flattened with a round coverslip. Slides were allowed to dry at room temperature before microscopic examination. Initial identification (usually to subgenus) was performed using a combination of brightfield and autofluorescence microscopy (Kumlert *et al.* 2018). A list of the material from Thailand is given in Table 1 and from Malaysia in Table 2.

A proportion of the microscope slides was shipped to the Zoological Institute of the Russian Academy of Sciences (ZIN, Saint Petersburg, Russia) and examined by AAS under a Leica DM 2500 compound microscope (Leica Microsystems GmbH, Wetzlar, Germany) using differential interference contrast (DIC). Microphotographs were taken using a Leica DMC 4500 digital camera. Morphological drawings were prepared using a drawing tube. Measurements were taken using an ocular micrometer, on an MBI-3 microscope (LOMO plc, Saint Petersburg, Russia) with phase contrast optics. Identification of chigger mites to species was performed with the use of taxonomic revisions published by Nadchatram (1967a, b), Nadchatram and Traub (1971), Vercammen-Grandjean and Langston (1976), Stekolnikov (2013), and other sources cited below, and also by direct comparison with previously identified specimens from the collection of ZIN. The terminology, abbreviations, and diagnostic formulas are used in the present work following Goff *et al.* (1982) and Stekolnikov and González-Acuña (2015).

Holotype and paratypes of the new species are deposited in ZIN. Most of the Malaysian material was returned to the Universiti Malaya (UM); the material from Thailand is mainly deposited in the University of Liverpool (UoL).

Results

Genus *Neacariscus* Vercammen-Grandjean, 1960

Type species — *Acariscus pluvius* Wharton, 1945, by original designation.

Diagnosis — SIF = 7BS(7B)-N-2-3(2)111.1000; fPp = B/B/NNN or B/N/NNN; fCx = 1.1.(1 – 3); fSt = 2.2(4); scutum trapezoidal, with pronounced anterolateral shoulders, with dense puncta; flagelliform sensilla (trichobothria) branched in distal part, nude, or covered by cilia; eyes 2 + 2, often very large; solenidion (ω) of palpal tarsus rod-like or long and slender; parasubterminala (z) nude.

Remarks — The genus *Acariscus* Ewing, 1943 was a heterogeneous group. Its type species, *Trombicula flui* van Thiel, 1930, was synonymized with *Eutrombicula batatas* (Linnaeus, 1758) by Michener (1946). Thus, *Acariscus* became a synonym of *Eutrombicula* Ewing, 1938. Subsequently, Vercammen-Grandjean (1960) described a new genus *Neacariscus* comprising two subgenera – the nominative, with the type species *Acariscus pluvius*, and *Whartonacarus* Vercammen-Grandjean, 1960, with the type species *Trombicula thompsoni* Brennan, 1953. This work did not include lists of species. Loomis (1966) considered *Whartonacarus* as a subgenus of *Toritrombicula* Sasa, Hayashi & Kawashima, 1953; he included in it five species. At the same time, he synonymized *Neacariscus* with *Toritrombicula* and placed *A. pluvius* in the nominative subgenus of the latter. However, Vercammen-Grandjean & Langston (1976) disagreed with that decision and restored the generic status of *Neacariscus*, with three subgenera – the nominative (one species, *A. pluvius*), *Whartonacarus* (eight species), and *Loomiscus* Vercammen-Grandjean & Langston, 1976 (one species). Brennan & Goff (1977) included *Whartonacarus* in their key to genera as a genus, without a discussion. Later many authors used this name as generic (Domrow & Lester 1985; Hoffmann 1990; Mertins *et al.*

Table 2 Material from Malaysia. Behrang – Behrang Forest Reserve; Bestari Jaya – Bestari Jaya village; Gunung Gading – Gunung Gading National Park, Lundu; Jemaluang – Jemaluang Wildlife Conservation Centre; Kota Tinggi – Kota Tinggi plantation; Krau – Krau Wildlife Reserve; Machinchang – Gunung Machinchang, Langkawi Isl.; Pasir Raja – Pasir Raja Forest Reserve; Pueh – Pueh village, Sematan; Sungkai – Sungkai Wildlife Conservation Centre; Ulu Gombak – Ulu Gombak Forest Reserve.

Province	Locality	Month	Host species	Host order	Host family	Hosts	Slides
Johor	Jemaluang	February	*Argusianus argus* (L.)	Galliformes	Phasianidae	1	2
Johor	Jemaluang	February	*Polyplectron malacense* (Scopoli)	Galliformes	Phasianidae	5	14
Johor	Kota Tinggi	June	*Gallus gallus domesticus*	Galliformes	Phasianidae	5	11
Kedah	Machincang	March	*Cyornis tickelliae* Blyth	Passeriformes	Muscicapidae	2	2
Kedah	Machincang	March	*Larvivora cyane* (Pallas)	Passeriformes	Muscicapidae	3	3
Kedah	Machincang	March	*Malacocincla abbotti* Blyth	Passeriformes	Pellorneidae	1	1
Kedah	Machincang	March	*Pellorneum ruficeps* Swainson	Passeriformes	Pellorneidae	3	4
Kedah	Machincang	March	*Geokichla citrina* (Latham)	Passeriformes	Turdidae	1	1
Pahang	Fraser's Hill	October	*Pellorneum ruficeps*	Passeriformes	Pellorneidae	1	3
Pahang	Krau	February	*Actenoides concretus* (Temminck)	Coraciiformes	Alcedinidae	1	4
Pahang	Krau	February	*Calyptomena viridis* Raffles	Passeriformes	Calyptomenidae	1	1
Pahang	Krau	February	*Terpsiphone atrocaudata* (Eyton)	Passeriformes	Monarchidae	1	1
Pahang	Krau	February	*Ficedula dumetoria* (Wallace)	Passeriformes	Muscicapidae	1	3
Pahang	Krau	February	*Malacocincla sepiaria* (Horsfield)	Passeriformes	Pellorneidae	1	1
Pahang	Krau	February	*Malacopteron cinereum* Eyton	Passeriformes	Pellorneidae	1	2
Pahang	Krau	February	*Malacopteron magnum* Eyton	Passeriformes	Pellorneidae	1	1
Pahang	Krau	February	*Pellorneum nigrocapitatum* (Eyton)	Passeriformes	Pellorneidae	1	1
Pahang	Krau	February	*Pellorneum malaccense* (Hartlaub)	Passeriformes	Pellorneidae	1	2
Pahang	Krau	February	*Turdinus macrodactylus* (Strickland)	Passeriformes	Pellorneidae	1	1
Pahang	Krau	February	*Cyanoderma erythropterum* (Blyth)	Passeriformes	Timaliidae	1	1
Pahang	Krau	February	*Macronus ptilosus* Jardine & Selby	Passeriformes	Timaliidae	1	2
Pahang	Krau	February	*Stachyris maculata* (Temminck)	Passeriformes	Timaliidae	2	2
Pahang	Krau	February	*Stachyris poliocephala* (Temminck)	Passeriformes	Timaliidae	3	12
Pahang	Krau	February	*Philentoma pyrhoptera* (Temminck)	Passeriformes	Vangidae	5	11
Pahang	Krau	February	*Meiglyptes tukki* (R.P. Lesson)	Piciformes	Picidae	1	12
Perak	Behrang	September	*Actenoides concretus*	Coraciiformes	Alcedinidae	2	4
Perak	Behrang	September	*Lanius tigrinus* Drapiez	Passeriformes	Laniidae	1	1
Perak	Behrang	September	*Copsychus malabaricus* (Scopoli)	Passeriformes	Muscicapidae	5	11
Perak	Behrang	September	*Cyornis brunneatus* (H.H. Slater)	Passeriformes	Muscicapidae	2	6
Perak	Behrang	September	*Larvivora cyane*	Passeriformes	Muscicapidae	2	2
Perak	Behrang	September	*Arachnothera longirostra* (Latham)	Passeriformes	Nectariniidae	1	1
Perak	Behrang	September	*Philentoma pyrhoptera*	Passeriformes	Vangidae	3	4
Perak	Behrang	September	*Batrachostomus stellatus* (Gould)	Podargiformes	Podargidae	1	1
Perak	Larut Hill	March	*Anthipes solitaris* (S. Müller)	Passeriformes	Muscicapidae	1	1
Perak	Larut Hill	March	*Turdus obscurus* J.F. Gmelin	Passeriformes	Turdidae	1	1
Perak	Sungkai	Jan., March	*Lophura rufa* (Raffles)	Galliformes	Phasianidae	2	15
Perak	Sungkai	January	*Polyplectron inopinatum* (Rothschild)	Galliformes	Phasianidae	3	8
Perak	Sungkai	January	*Polyplectron malacense*	Galliformes	Phasianidae	1	1
Sarawak	Gunung Gading	March	*Alcedo peninsulae* Laubmann	Coraciiformes	Alcedinidae	1	4
Sarawak	Gunung Gading	March	*Calyptomena viridis*	Passeriformes	Calyptomenidae	1	1
Sarawak	Gunung Gading	March	*Copsychus malabaricus*	Passeriformes	Muscicapidae	1	1
Sarawak	Gunung Gading	March	*Cyanoptila cyanomelana* (Temminck)	Passeriformes	Muscicapidae	1	1
Sarawak	Gunung Gading	March	*Philentoma pyrhoptera*	Passeriformes	Vangidae	1	1
Sarawak	Pueh	March	*Amaurornis phoenicurus* (Pennant)	Gruiformes	Rallidae	1	1
Sarawak	Pueh	March	*Lewinia striata* (L.)	Gruiformes	Rallidae	1	3
Sarawak	Pueh	March	*Mixornis bornensis* Bonaparte	Passeriformes	Timaliidae	1	2
Selangor	Bestari Jaya	April	*Gallus gallus domesticus*	Galliformes	Phasianidae	7	9
Selangor	Ulu Gombak	February	*Cacomantis sepulcralis* (S. Müller)	Cuculiformes	Cuculidae	2	2
Selangor	Ulu Gombak	February	*Copsychus malabaricus*	Passeriformes	Muscicapidae	1	1
Selangor	Ulu Gombak	February	*Eumyias thalassinus* (Swainson)	Passeriformes	Muscicapidae	1	1
Selangor	Ulu Gombak	February	*Tricholestes criniger* (Blyth)	Passeriformes	Pycnonotidae	1	2
Selangor	Ulu Gombak	February	*Stachyris nigriceps* Blyth	Passeriformes	Timaliidae	1	1
Selangor	Ulu Gombak	February	*Stachyris poliocephala*	Passeriformes	Timaliidae	1	1
Terengganu	Pasir Raja	October	*Copsychus malabaricus*	Passeriformes	Muscicapidae	1	1
Terengganu	Pasir Raja	October	*Cyornis brunneatus*	Passeriformes	Muscicapidae	1	2
Terengganu	Pasir Raja	October	*Enicurus ruficapillus* Temminck	Passeriformes	Muscicapidae	1	1
Terengganu	Pasir Raja	October	*Larvivora cyane*	Passeriformes	Muscicapidae	7	9
Terengganu	Pasir Raja	October	*Pellorneum nigrocapitatum*	Passeriformes	Pellorneidae	1	1
Terengganu	Pasir Raja	October	*Stachyris poliocephala*	Passeriformes	Timaliidae	4	4
Terengganu	Pasir Raja	October	*Philentoma pyrhoptera*	Passeriformes	Vangidae	5	6
Terengganu	Redang Isl.	October	*Copsychus malabaricus*	Passeriformes	Muscicapidae	11	33

2009; Stekolnikov & González-Acuña 2015). However, none of them discussed the status of *Neacariscus*. We note the following:

1. Both *Neacariscus pluvius* and all species of *Whartonacarus* significantly differ from *Toritrombicula* by a) a trapezoidal scutum with prominent anterolateral shoulders vs. a subrectangular scutum without anterolateral shoulders; b) two-pronged palpal claw vs. three-pronged; c) nude parasubterminala (*z*) vs. branched; d) presence of mastitarsala. This complex of traits constitutes a difference at the generic level.
2. All species of *Whartonacarus* differ from *N. pluvius* by the presence of palpal subterminala (ζ) and by the presence of three genualae I (σ) vs. two. These differences can at most justify the subgeneric status.

Therefore, we follow the system of Vercammen-Grandjean & Langston (1976), which included the genus *Neacariscus* with three subgenera – *Neacariscus*, *Whartonacarus*, and *Loomiscus*. The latter subgenus includes one species, *Neacariscus* (*Loomiscus*) *dupliseta* (Loomis, 1966), which differs from the species of *Neacariscus* (*Whartonacarus*) by the presence of multiple additional nude setae on the genuae of all legs. The subgenus *Neacariscus* (*Whartonacarus*) includes the following species: *N.* (*W.*) *anous* (Wharton, 1945), *N.* (*W.*) *chaetosa* (Brennan & Jones, 1961), *N.* (*W.*) *floridensis* (Mertins, 2009) (in Mertins *et al.* 2009), **n. comb.**, *N.* (*W.*) *nativitatis* (Hoffmann-Sandoval, 1950), *N.* (*W.*) *oceanica* (Brennan & Amerson, 1971), *N.* (*W.*) *shiraii* (Sasa, Kano & Obata, 1952), *N.* (*W.*) *sulae* (Oudemans, 1910), and *N.* (*W.*) *thompsoni* (Brennan, 1953).

Subgenus *Neacariscus* (*Neacariscus*) Vercammen-Grandjean, 1960

Type species — *Acariscus pluvius* Wharton, 1945, by original designation.

Diagnosis — SIF = 7B-N-2-2111.1000; fPp = B/B/NNN; fCx = 1.1.1; fSt = 2.2; flagelliform sensilla (trichobothria) branched in distal part; eyes 2 + 2, of normal size; solenidion (ω) of palpal tarsus long and slender.

Neacariscus (*Neacariscus*) *pluvius* (Wharton, 1945)

(Fig. 1A)

Distribution and hosts — This species was described from Bougainville Isl. (Solomon Islands archipelago) and from Guam (Mariana Islands), ex *Anous stolidus* (L.), *Anous tenuirostris* (Temminck) (Charadriiformes: Laridae), *Pluvialis dominica* (Statius Müller) (Charadriiformes: Charadriidae), and *Tringa incana* (J.F. Gmelin) (syn.: *Heteroscelus incanus*) (Charadriiformes: Scolopacidae). Loomis (1966) also reported *N. pluvius* from Ulithi Atoll (Caroline Islands), ex *Tringa incana* and *Sterna sumatrana* Raffles (Charadriiformes: Laridae). Here this species is for the first time recorded in Asia (Thailand). *Charadrius leschenaultii* and *Xenus cinereus* are new host species.

Material examined — Three larvae (ZIN 17963 – 17965) ex two *Charadrius leschenaultii* and one *Xenus cinereus*, THAILAND, Trang province, Samran Beach, 7.201348°N, 99.562105°E and 7.209399°N, 99.557854°E, 17 and 19 March 2021, coll. S. Koosakulnirand.

Subgenus *Neacariscus* (*Whartonacarus*) Vercammen-Grandjean, 1960

Type species — *Trombicula thompsoni* Brennan, 1953, by original designation.

Diagnosis — SIF = 7BS-N-2-3111.1000; fPp = B/B/NNN or B/N/NNN; fCx = 1.1.(1 – 3); fSt = 2.2(4); flagelliform sensilla (trichobothria) branched in distal part, nude, or covered by cilia; eyes 2 + 2, often very large; solenidion (ω) of palpal tarsus rod-like or long and slender.

Neacariscus (*Whartonacarus*) *andamanensis* Stekolnikov, n. sp.

Zoobank: 67AFED09-1E7B-488C-A95B-AD69A8131720

(Figs 1B, C, 2A–E, 3A, C–E, 4)

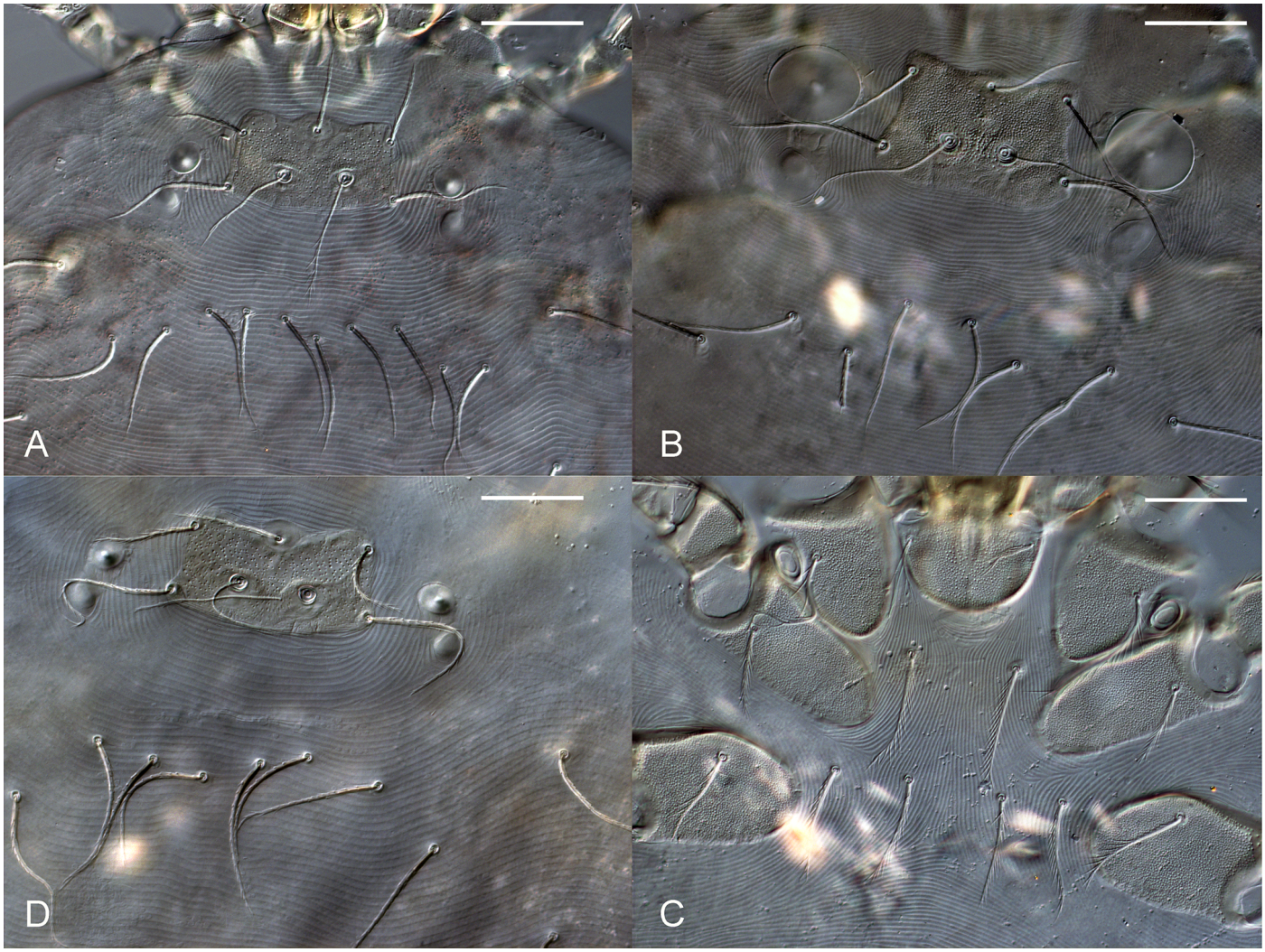

Figure 1 *Neacariscus* (*Neacariscus*) *pluvius* (Wharton, 1945), specimen ZIN 17965: A – anterior dorsal aspect of idiosoma. *Neacariscus* (*Whartonacarus*) *andamanensis* Stekolnikov, **n. sp.**, holotype: B – anterior dorsal aspect of idiosoma; C – sternal area. *Neacariscus* (*Whartonacarus*) *sulae* (Oudemans, 1910), specimen ZIN 18168: D – anterior dorsal aspect of idiosoma. Scale bars: 50 µm.

Diagnosis

SIF = 7BS-N-2-3111.1000; fPp = B/N/NNN; fCx = 1.1.1; fSt = 2.4; PL > AL ≥ AM; fD = 2H-11(13)-11(10)-(8 – 12)-(7 – 10)+(0 – 3); DS = 42 – 49; V = 64 – 84; NDV = 107 – 133; Ip = 1642 – 1697; eyes 2 + 2, very large; flagelliform sensilla (trichobothria) with few branches in distal part; sensillary bases anterior to level of PL; solenidion (ω) of palpal tarsus long and slender; leg tarsi with multiple sclerite bars. Standard measurements are given in Table 3.

Description of larva

Description of larva [based on holotype (ZIN 17980), three paratypes (ZIN 17983 – 17985) and three additional specimens (ZIN 17976 – 17978)]

Idiosoma (Figures 1B, C, 2A – E) — Eyes 2 + 2, very large; 42 – 49 sharply-pointed dorsal idiosomal setae (including two clearly separated humeral setae) moderately covered with thin barbs; 1st posthumeral row (C excluding humeral setae) with 11 (in five specimens) or 13 (in two specimens) setae, 2nd row (D) with 11 (in four specimens) or 10 (in three specimens) setae, 3rd (E) row with 8 – 12 setae, 4th row (F) with 7 – 10 setae, remaining caudal setae 0 – 3 in

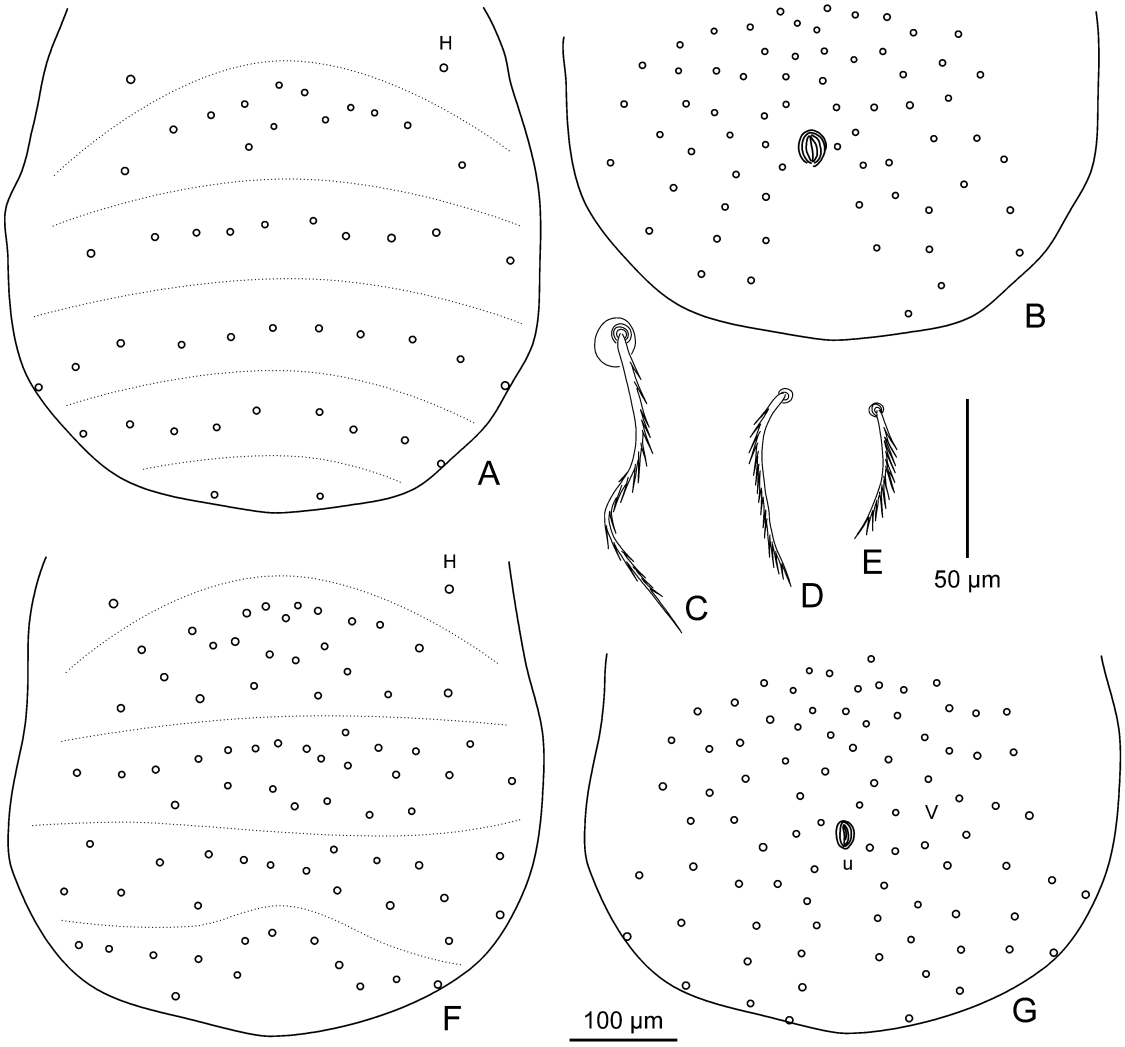

Figure 2 *Neacariscus* (*Whartonacarus*) *andamanensis* Stekolnikov, **n. sp.**: A – additional specimen ZIN 17976, dorsal aspect of idiosoma; B – additional specimen ZIN 17976, arrangement of ventral idiosomal setae; C – holotype, humeral seta; D – holotype, central seta of 2nd posthumeral row; E – holotype, preanal seta. *Neacariscus* (*Whartonacarus*) *shiraii* (Sasa, Kano & Obata, 1952), specimen ZIN 17981: F – dorsal aspect of idiosoma; G – arrangement of ventral idiosomal setae. Abbreviations: H – humeral seta; u – uropore (anus); V – ventral idiosomal setae. Scale bars: A, B, F, G – 100 µm; C – E – 50 µm.

number; in holotype, fD = 2H-11-11-10-10; two sternal setae between coxae I and four sternal setae between coxae III; 64 – 84 ventral setae; NDV = 107 – 133.

Gnathosoma (Figure 3C – E) — Cheliceral blade with tricuspid cap; cheliceral base densely punctate; gnathobase (infracapitulum) densely punctate, bears one pair of branched gnathocoxal (tritorostral) setae; galeal (deutorostral) seta nude; palpal claw (odontus) with two prongs, main inner and additional smaller outer; palpal femur, genu, and tibia with puncta; palpal femoral seta thick, covered with long branches; palpal genual and tibial setae thin, nude; palpal tarsus with seven branched setae, nude subterminala (ζ) and very long, pointed, curved tarsala (ω).

Scutum (Figures 1B, 3A) —Trapezoidal, with pronounced anterolateral shoulders, with dense puncta; anterior margin sinuous, lateral margins concave, posterior margin almost straight in middle part and obliquely cut at edges; AM placed at level of AL; sensillary (trichobothrial) bases placed anterior to level of PL (PSB – P-PL = 4 – 10 µm, mean 8); PL > AL ≥ AM; all scutal setae barbed similarly to dorsal idiosomal setae; sensilla (trichobothria) flagelliform,

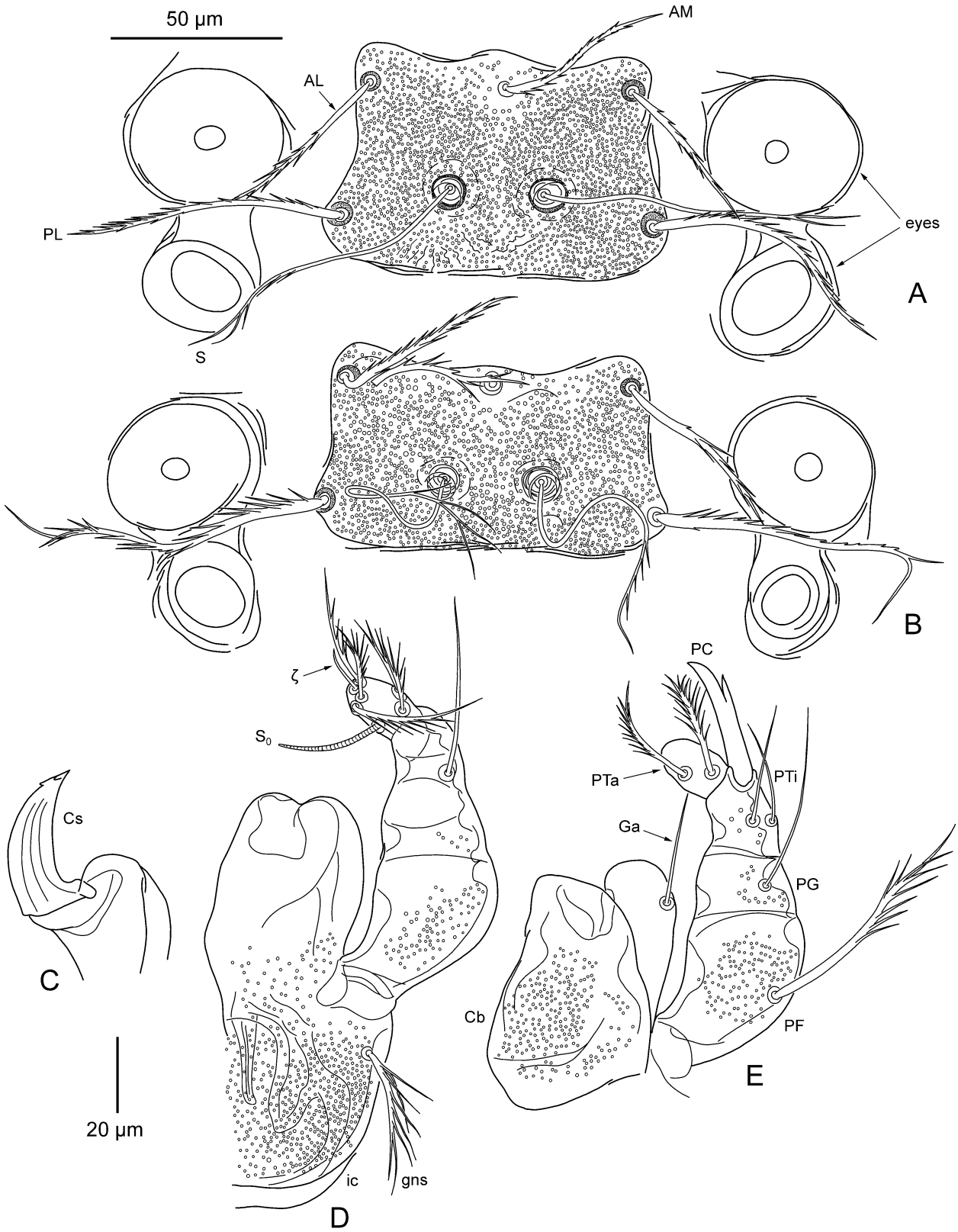

Figure 3 *Neacariscus* (*Whartonacarus*) *andamanensis* Stekolnikov, **n. sp.**: A holotype, scutum and eyes; C – additional specimen ZIN 17976, cheliceral blade; D – paratype ZIN 17984, ventral aspect of gnathosoma; E – paratype ZIN 17984, dorsal aspect of gnathosoma. *Neacariscus* (*Whartonacarus*) *shiraii* (Sasa, Kano & Obata, 1952), specimen ZIN 17981: B – scutum and eyes. Abbreviations: AL – anterolateral scutal seta; AM – anteromedian scutal seta; Cb – cheliceral base; Cs – cheliceral blade; Ga – galeal (deutorostral) seta; gns – gnathocoxal (tritorostral) seta; ic – infracapitulum (gnathobase, gnathocoxa); PC – palpal claw (odontus); PF – palpal femur; PG – palpal genu; PL – posterolateral scutal seta; PTa – palpal tarsus; PTi – palpal tibia; S – sensillum (trichobothrium); S_0 – palpal tarsala (ω); ζ – palpal subterminala (ζ). Scale bars: A, B – 50 µm; C – E – 20 µm.

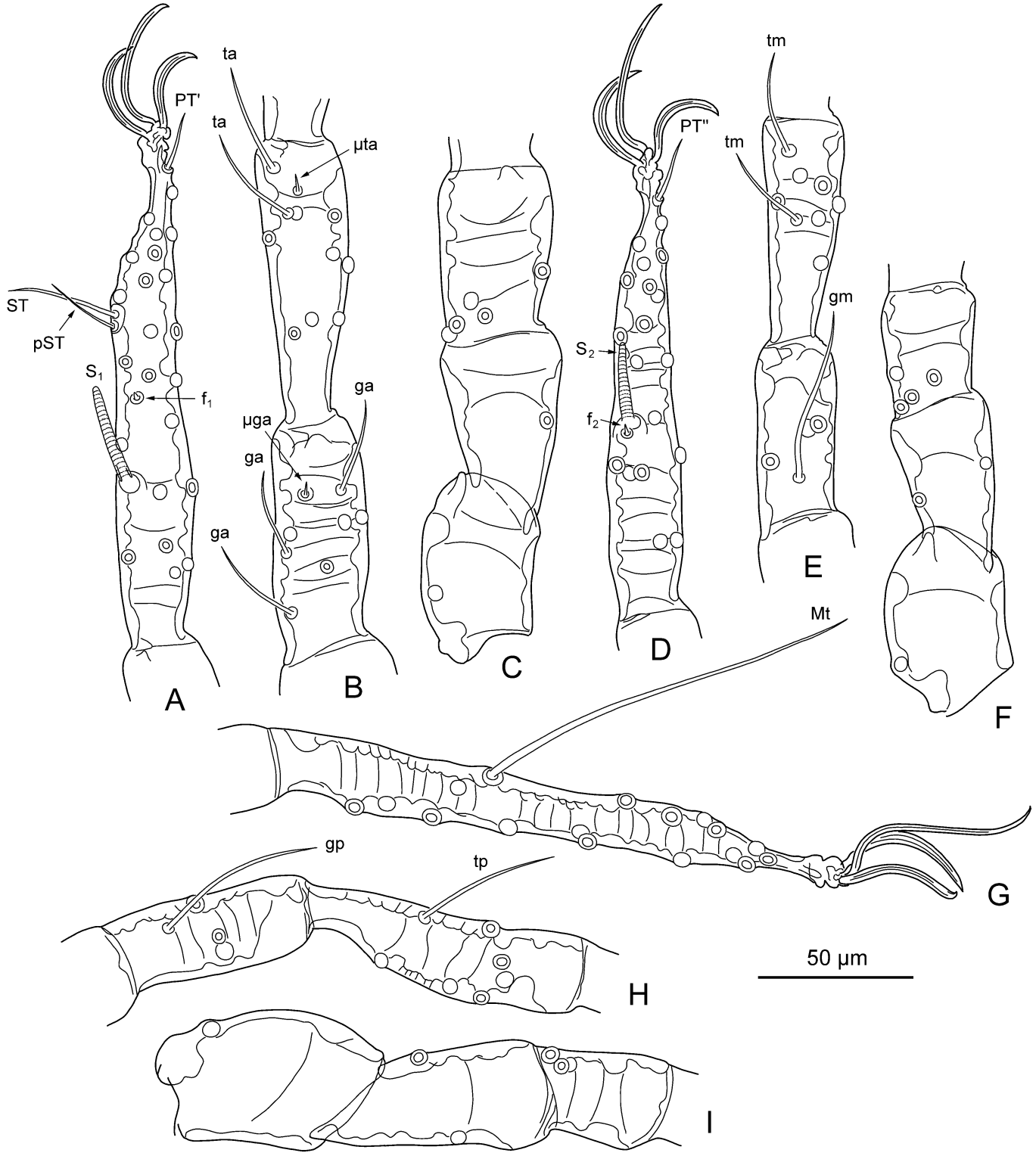

Figure 4 *Neacariscus* (*Whartonacarus*) *andamanensis* Stekolnikov, **n. sp.**, holotype: A – leg I tarsus; B – leg I genu and tibia; C – leg I trochanter, basifemur, and telofemur; D – leg II tarsus; E – leg II genu and tibia; F – leg II trochanter, basifemur, and telofemur; G – leg III tarsus; H – leg III genu and tibia; I – leg III trochanter, basifemur, and telofemur. Abbreviations: f_1 – microtarsala I (ε); f_2 – microtarsala II (ε); ga – genuala I (σ); gm – genuala II (σ); gp – genuala III (σ); Mt – mastitarsala; pST – parasubterminala (z); PT′ – pretarsala I (ζ); PT" – pretarsala II (ζ); S_1 – leg tarsala I (ω); S_2 – leg tarsala II (ω); ST – subterminala (ζ); ta – tibiala I (φ); tm – tibiala II (φ); tp – tibiala III (φ); μga – microgenuala (κ); μta – microtibiala (κ). Scale bar: 50 μm.

with ca. four branches in distal part.

Legs (Figure 4) — All legs 7-segmented (with divided femur), with one pair of claws and claw-like empodium; leg tarsi with multiple sclerite bars. Leg I: coxa with one branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, three genualae (σ), microgenuala (κ); tibia 8B, 2 distal tibialae (φ) in tandem, microtibiala (κ); tarsus 22B, tarsala (ω), famulus (ε) distal to tarsala, subterminala (ζ), nude parasubterminala (z), pretarsala (ζ). Leg II: coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala (σ); tibia 6B, two tibialae (φ) in tandem; tarsus 18B, tarsala II (ω), famulus (ε) behind tarsala, pretarsala (ζ). Leg III: coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, long genuala (σ); tibia 6B, long tibiala (φ); tarsus 16B, mastitarsala in middle part of segment.

Table 3 Morphometric (AW–dmt, μm) and meristic (DS–NDV) traits of *Neacariscus* (*Whartonacarus*) *shiraii* (Sasa, Kano & Obata, 1952) and *Neacariscus* (*Whartonacarus*) *andamanensis* Stekolnikov, **n. sp**. Abbreviations: AW – distance between anterolateral scutal setae; PW – distance between posterolateral scutal setae; SB – distance between sensillary (trichobothrial) bases; ASB – distance from the level of sensillary bases to extreme anterior margin of scutum; PSB – distance from the level of sensillary bases to extreme posterior margin of scutum; SD – length of scutum (ASB + PSB); P-PL – distance from the level of posterolateral scutal setae (PL) to extreme posterior margin of scutum; AP – distance between antero- and posterolateral scutal seta on one side; AM – length of anteromedian scutal seta; AL – length of anterolateral scutal setae; PL – length of posterolateral scutal setae; S – length of sensilla (trichobothria); H – length of humeral setae; D_{min} – length of the shortest dorsal idiosomal seta; D_{max} – length of the longest dorsal idiosomal seta; V_{min} – length of the shortest ventral idiosomal seta; V_{max} – length of the longest ventral idiosomal seta; pa – length of leg I (including coxa, excluding claws); pm – length of leg II (including coxa, excluding claws); pp – length of leg III (including coxa, excluding claws); Ip – sum of leg lengths (pa + pm + pp); TaIIIL – length of leg tarsus III; TaIIIW – width of leg tarsus III; dmt – distance between the base of leg III tarsus and base of mastitarsala; DS – number of dorsal idiosomal setae (excluding scutal); V – number of ventral idiosomal setae (excluding coxal and sternal); NDV = DS + V.

	Neacariscus shiraii				*Neacariscus andamanensis* **n. sp.** (n = 7)		
	ZIN 17981	ZIN 17982	Holotype*	Specimen from Guam**	Range	Mean	Holotype
AW	84	74	81	80	77-81	78	77
PW	95	88	89	92	86-95	91	90
SB	29	29	30	28	25-30	28	28
ASB	36	36	35	33	39-42	40	40
PSB	21	20	20	19	23-27	25	25
SD	57	56	55	52	63-66	65	65
P-PL	13	11	-	-	14-20	17	18
AP	37	34	33	32	35-44	40	41
AM	45	54	61	-	45-50	47	45
AL	56	49	50	46	45-51	50	50
PL	92	83	82	84	55-83	72	76
S	-	-	82	90	87-92	89	90
H	104	103	93	64	81-94	86	94
D_{min}	63	67	-	54	56-68	60	59
D_{max}	88	88	70	72	68-77	74	76
V_{min}	49	49	38	40	35-41	38	41
V_{max}	79	81	-	60	61-70	64	63
pa	533	513	-	480	558-581	572	574
pm	472	455	-	416	497-515	509	508
pp	545	518	-	485	580-607	589	583
Ip	1550	1487	-	1381	1642-1697	1670	1665
TaIIIL	162	160	-	-	178-189	181	182
TaIIIW	22	22	-	-	22-23	22	23
dmt	74	74	-	-	64-81	72	76
DS	80	77	92	84	42-49	45	44
V	85	85	98	96	64-84	70	74
NDV	165	162	190	180	107-133	115	118

Notes: * – after original description, cited by Vercammen-Grandjean and Langston (1976); ** – slide NAMRU 2-697, after the same work.

Type material

Larval holotype (ZIN 17980, BTRA045) ex *Calidris tenuirostris*, THAILAND, Trang province, Koh Libong, 7.243892°N, 99.451315°E, 16 March 2021, coll. S. Koosakulnirand; four paratypes (ZIN 17983 – 17986) ex four *Calidris tenuirostris*, THAILAND, Trang province, Samran Beach, 7.209399°N, 99.557854°E, 19 March 2022, coll. S. Koosakulnirand.

Additional material

Three larvae (ZIN 17976 – 17978) ex two *Calidris tenuirostris* and one *Charadrius lechenaultii*, THAILAND, Satun province, Thung Sabo, 7.042112°N, 99.671153°E, 14 March 2021, coll. S. Koosakulnirand.

Two larvae (UoL) ex one *Calidris tenuirostris*, THAILAND, Trang province, Koh Libong, 7.243892°N, 99.451315°E, 16 March 2021, coll. S. Koosakulnirand (same data as for holotype); nine larvae (UoL) ex four *C. tenuirostris* (6) and two *Xenus cinereus* (3), THAILAND, Trang province, Samran Beach, 7.209399°N, 99.557854°E, 19 March 2022, coll. S. Koosakulnirand; one larva (UoL) ex *Calidris ruficollis*, THAILAND, Trang province, Samran Beach, 7.201348°N, 99.562105°E, 15 March 2021, coll. S. Koosakulnirand; six larvae (UoL) ex three *C. tenuirostris*, THAILAND, Satun province, Thung Sabo, 7.042112°N, 99.671153°E, 14 March 2021, coll. S. Koosakulnirand.

Etymology

The species epithet *andamanensis* refers to the Andaman Sea, on the shore of which the type locality is situated.

Differential diagnosis

The new species is similar to *Neacariscus* (*Whartonacarus*) *shiraii* but differs from it in exhibiting fewer idiosomal setae (DS = 42 – 49 vs. 77 – 92; NDV = 107 – 133 vs. 162 – 190); the rows of dorsal idiosomal setae are unpaired (only a few additional setae are present posterior to the central part of 1st row); in its longer scutum with more prominent posterior margin (ASB = 39 – 42 vs. 33 – 36, PSB = 23 – 27 vs. 19 – 21, SD = 63 – 66 vs. 52 – 57, and P-PL = 14 – 20 vs. 11 – 13); and in longer legs (Ip = 1642 – 1697 vs. 1381 – 1550 and TaIIIL = 178 – 189 vs. 160 – 162).

Neacariscus (*Whartonacarus*) *shiraii* (Sasa, Kano & Obata, 1952)

(Figs 2F – G, 3B)

Diagnosis — SIF = 7BS-N-2-3111.1000; fPp = B/N/NNN; fCx = 1.1.1; fSt = 2.4; PL > AL ≥ AM (PL > AM > AL); fD = 2H-23-24(20)-18(19)-13(11)-(0 – 2); DS = 77 – 92; V = 85 – 98; NDV = 162 – 190; Ip = 1381 – 1550; eyes 2 + 2, very large; flagelliform sensilla (trichobothria) with few branches in distal part; sensillary bases anterior to level of PL; solenidion (ω) of palpal tarsus long and slender; leg tarsi with multiple sclerite bars. Standard measurements are given in Table 3.

Distribution and hosts — This species was described from Tokyo (Japan), ex *Pluvialis dominica* (syn.: *Charadrius dominicus*). Later it was recorded on Heron Isl. (Australia, Queensland), ex *Limosa lapponica* (L.) (Charadriiformes: Scolopacidae); on Guam, ex *P. dominica*; on Okinawa Isl. (Japan), ex *Sterna dougalli* Montagu (Charadriiformes: Laridae); and in Mexico (Sonora), ex *Haematopus palliatus* Temminck (Charadriiformes: Haematopodidae) (Vercammen-Grandjean & Langston 1976). Here it is for the first time recorded in Thailand and on *Xenus cinereus*.

Material examined — Two larvae (ZIN 17981, 17982) ex two *Xenus cinereus*, THAILAND, Trang province, Samran Beach, 7.209399°N, 99.557854°E, 19 March 2022, coll. S. Koosakulnirand.

Remarks — The form of *N.* (*W.*) *shiraii* from Mexico, with DS = 44 and V = 44 (Loomis 1966; Mertins *et al.* 2009), probably belongs to some other species.

Neacariscus (*Whartonacarus*) *sulae* (Oudemans, 1910)

(Fig. 1D)

Diagnosis — SIF = 7BS-N-2-3111.1000; fPp = B/N/NNN; fCx = 1.1.1; fSt = 2.2; PL ≫ AL = AM; fD = 2H-10-10-6-2-2; DS = 32 – 36; V = 50 – 65; NDV = 86 – 101; Ip = 1181 – 1206; eyes 2 + 2, of moderate size; flagelliform sensilla (trichobothria) with short branches in distal part; sensillary bases anterior to level of PL; solenidion (ω) of palpal tarsus long and slender. Standard measurements are given in Table 4.

Distribution and hosts — This species was described from a single specimen (holotype) collected in an unknown locality of West Africa, ex *Morus capensis* (Lichtenstein) (syn.: *Sula capensis*) (Suliformes: Sulidae). Zumpt (1961) referred to the host as *Morus bassanus* (L.). Here it is for the first time recorded in Asia and on *Pluvialis squatarola*.

Material examined — Two larvae (ZIN 17962, 18168) ex *Pluvialis squatarola*, THAILAND, Trang province, Koh Libong, 7.243892°N, 99.451315°E, 16 March 2021, coll. S. Koosakulnirand.

Remarks — The species was initially described briefly (Oudemans 1910): a fully illustrated redescription was published two years later (Oudemans 1912). Fuller (1952) and Vercammen-Grandjean & Langston (1976) also examined and redescribed the holotype. According to the latter authors, the fD of the holotype is 2H-8-8-8-4-4-2, which seems different from the fD in our material (2H-10-10-6-2-2). However, a comparison of the drawing made by Oudemans (1912, fig. A1) with our specimens shows that the divergence could be caused by a different mode of preparation and, probably, unequal levels of mite engorgement.

Table 4 Morphometric (AW – dmt, μm) and meristic (DS – NDV) traits of *Neacariscus* (*Whartonacarus*) *sulae* (Oudemans, 1910). Abbreviations as in Table 3.

	ZIN 17962	ZIN 18168	Holotype*
AW	83	86	88
PW	99	97	104
SB	37	34	40
ASB	34	35	32
PSB	20	21	20
SD	54	56	52
P-PL	-	16	-
AP	33	34	32
AM	-	36	ca. 35
AL	-	52	38
PL	85	88	83
H	99	-	94
D_{min}	-	68	60
D_{max}	-	85	92
V_{min}	-	38	42
V_{max}	-	59	60
pa	391	405	386
pm	365	380	355
pp	425	421	404
Ip	1181	1206	1145
TaIIIL	115	121	-
TaIIIW	20	20	-
dmt	-	35	-
DS	36	32	36
V	65	56	50
NDV	101	88	86

Note: * – after Vercammen-Grandjean and Langston (1976).

Fuller (1952) described the ventral palpal tibial seta of the holotype as branched, which agrees with the drawing made by Oudemans (1912, fig. A4). However, Vercammen-Grandjean & Langston (1976) drew and described this seta as nude, as in our material. The scutum on their drawing (pl. 282) bears multiple transverse striae, which were not mentioned by Oudemans (1912) and Fuller (1952). They are also absent in our specimens. Therefore, our material may represent a new species close to *N. sulae*. Additional collections in Africa and one more re-examination of the *N. sulae* holotype would be desirable to reach a conclusion.

Genus *Toritrombicula* Sasa, Hayashi & Kawashima, 1953

Type species — *Trombicula* (*Toritrombicula*) *hasegawai* Sasa, Hayashi & Kawashima, 1953, by original designation.

Diagnosis — SIF = 7B-N(B)-3-2111.0000; fPp = B/B/NNN or B/B/NNB; fCx = 1.1.1; fSt = 2.2; scutum subrectangular, without prominent anterolateral shoulders, with puncta; flagelliform sensilla (trichobothria) branched in distal part; eyes 2 + 2, anterior pair often very large; solenidion (ω) of palpal tarsus rod-like; parasubterminala (z) branched.

Toritrombicula densipiliata (Walch, 1922)

Distribution and hosts — Indonesia, Malaysia, Papua New Guinea, Philippines, Taiwan, Thailand, ex 21 bird species (Stekolnikov 2021a). *Arachnothera longirostra*, *Batrachostomus stellatus*, *Cacomantis sepulcralis*, *Copsychus malabaricus*, *Cyanoptila cyanomelana*, *Cyornis tickelliae*, *Ficedula dumetoria*, *Geokichla sibirica*, *Lanius tigrinus*, *Larvivora cyane*, *Malacocincla abbotti*, *Pellorneum malaccense*, *Malacocincla sepiaria*, *Malacopteron cinereum*, *Malacopteron magnum*, *Mixornis bornensis*, *Turdinus macrodactylus*, *Pellorneum capistratum*, *Pellorneum ruficeps*, *Cyornis brunneatus*, *Cyanoderma erythropterum*, *Stachyris maculata*, *Terpsiphone atrocaudata*, *Tricholestes criniger*, and *Turdus obscurus* are new host species.

Material examined — Two larvae (ZIN 18002, 18003) ex *Geokichla citrina* and *Geokichla sibirica*, THAILAND, Rayong province, Koh Mun Nai, 12.612384°N, 101.687574°E, 10 March 2021, coll. S. Koosakulnirand; one larva (ZIN 17935) ex *Mixornis bornensis*, MALAYSIA, Sarawak State, Sematan Pueh village, 1.831126°N, 109.708966°E, 23 March 2022, coll. P. Rajasegaran.

Five larvae (UM) ex one *Pellorneum ruficeps* (1), one *Cyornis tickelliae* (1), two *Larvivora cyane* (2), and one *Malacocincla abbotti* (1), MALAYSIA, Kedah State, Langkawi Isl., Gunung Machinchang, 6.429010°N, 99.729852°E, 16 – 17 March 2022, coll. P. Rajasegaran; 41 larvae (UM) ex one *Pellorneum nigrocapitatum* (1), one *Calyptomena viridis* (1), one *Ficedula dumetoria* (3), one *Macronus ptilosus* (2), one *Pellorneum malaccense* (2), one *Malacocincla sepiaria* (1), one *Malacopteron cinereum* (2), one *Malacopteron magnum* (1), one *Turdinus macrodactylus* (1), five *Philentoma pyrhoptera* (11), two *Stachyris maculata* (2), three *Stachyris poliocephala* (12), and one *Terpsiphone atrocaudata* (1), MALAYSIA, Pahang State, Krau Wildlife Reserve, 3.596982°N, 102.183190°E, 16 – 20 February 2021, coll. P. Rajasegaran; 30 larvae (UM) ex two *Actenoides concretus* (3), one *Arachnothera longirostra* (1), one *Batrachostomus stellatus* (1), five *Copsychus malabaricus* (11), one *Lanius tigrinus* (1), two *Larvivora cyane* (2), three *Philentoma pyrhoptera* (4), and two *Cyornis brunneatus* (6), MALAYSIA, Perak State, Behrang Forest Reserve, 3.732175°N ,101.578552°E, 19 – 24 September 2022, coll. P. Rajasegaran; two larvae (UM) ex *Anthipes solitaris* and *Turdus obscurus*, MALAYSIA, Perak State, Larut Hill, 4.867858°N, 100.779824°E, 9 – 11 March 2022, coll. P. Rajasegaran; four larvae (UM) ex *Calyptomena viridis*, *Copsychus malabaricus*, *Cyanoptila cyanomelana*, and *Philentoma pyrhoptera*, MALAYSIA, Sarawak State, Gunung Gading National Park, Lundu, 1.692098°N, 109.845157°E, 23 – 26 March 2022, coll. P. Rajasegaran; one larva (UM) ex *Mixornis bornensis*, MALAYSIA, Sarawak State, Sematan Pueh village, 1.831126°N, 109.708966°E, 23 March 2022, coll. P. Rajasegaran; one larva (UM) ex *Cacomantis sepulcralis* and two larvae (UM) ex one *Tricholestes criniger*, MALAYSIA, Selangor State, Ulu Gombak Forest Reserve, 3.325987°N, 101.752747°E, 10 – 12 February

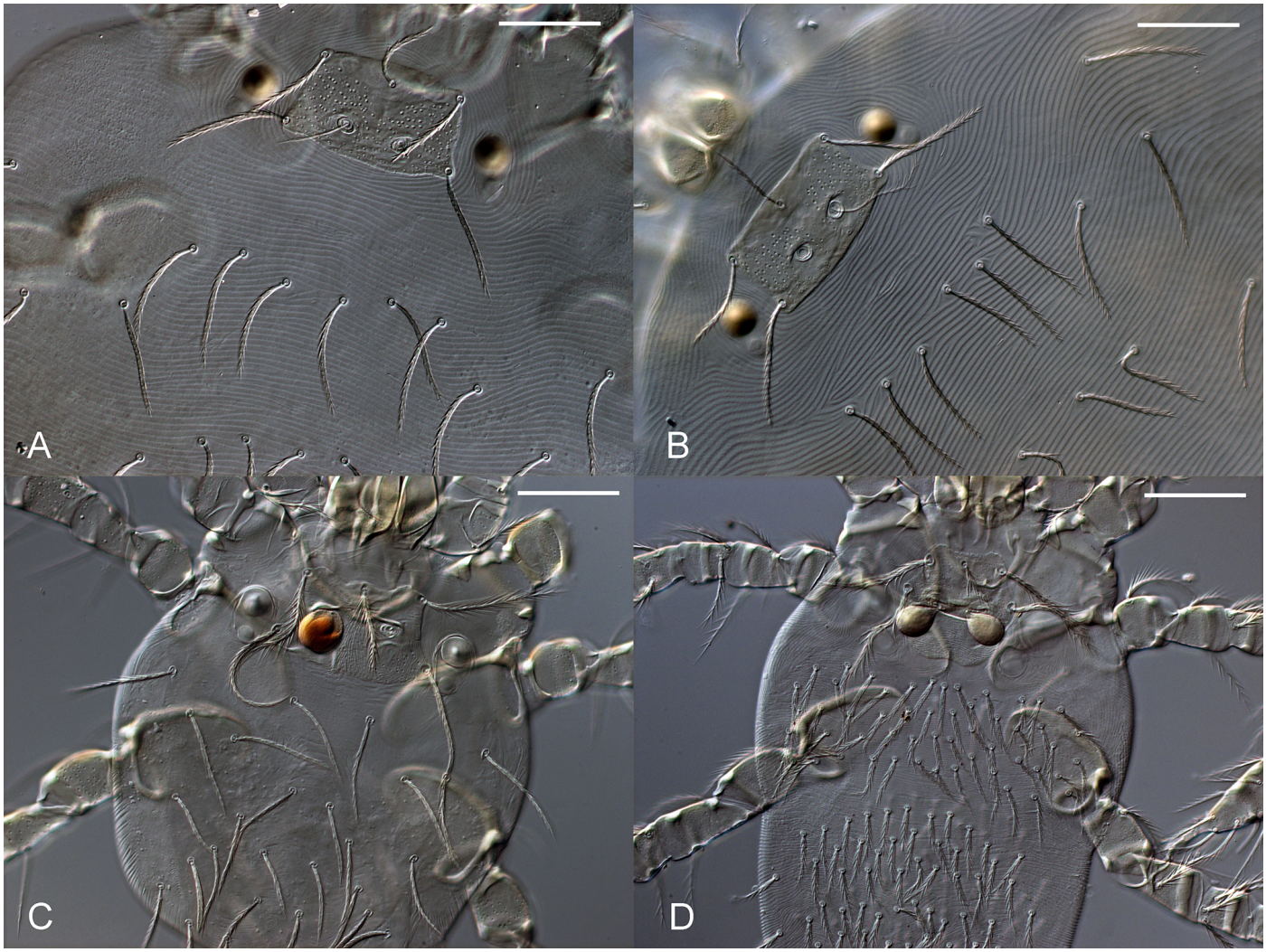

Figure 5 *Toritrombicula kirhocephales* Goff, 1982: A – specimen ZIN 18009, anterior dorsal aspect of idiosoma. *Toritrombicula uphami* Nadchatram, 1967: B – specimen ZIN 18169, anterior dorsal aspect of idiosoma. *Neoschoengastia longipes* Nadchatram, 1967: C – specimen ZIN 17947, dorsal aspect of idiosoma. *Schoengastia archaea* (Taufflieb, 1960): D – specimen ZIN 17967, dorsal aspect of idiosoma.

2021, coll. P. Rajasegaran; seven larvae (UM) ex four *Larvivora cyane* (4), two *Philentoma pyrhoptera* (2), and one *Stachyris poliocephala* (1), MALAYSIA, Terengganu State, Pasir Raja Forest Reserve, 4.790517°N, 102.996835°E, 22 – 27 October 2021, coll. P. Rajasegaran; 33 larvae (UM) ex 11 *Copsychus malabaricus*, MALAYSIA, Terengganu State, Redang Isl., 5.780867°N, 103.006183°E, 8 – 13 October 2022, coll. P. Rajasegaran.

Toritrombicula kirhocephales Goff, 1982

(Fig. 5A)

Diagnosis — SIF = 7B-N-3-2111.0000; fPp = B/B/NNN; fCx = 1.1.1; fSt = 2.2; PL > AL > AM; fD = 2H-10(11)-8(10)-(6 – 8)-4-2; DS = 32 – 37; V = 26 – 34; NDV = 58 – 68; Ip = 1026 – 1246; eyes 2 + 2, of moderate size; flagelliform sensilla (trichobothria) with short branches in distal part; sensillary bases anterior to level of PL. Standard measurements are given in Table 5.

Distribution and hosts — This species was described ex *Pitohui kirhocephalus* (R.P. Lesson & Garnot) (Passeriformes: Oriolidae) from Papua New Guinea (East Sepik province).

Here it is for the first time recorded in Asia (Thailand) and on all hosts mentioned below.

Material examined — Six larvae (ZIN 18004 – 18009) ex one *Larvivora cyane* (1), two *Pachycephala cinerea* (2), one *Pycnonotus conradi* (1), and one *Phylloscopus tenellipes* (2), THAILAND, Rayong province, Koh Mun Nai, 12.612384°N, 101.687574°E, 9 – 11 March 2021, coll. S. Koosakulnirand; one larva (ZIN 18010) ex *L. cyane*, THAILAND, Kanchanaburi province, W Mahidol University Campus, 14.13111°N, 99.14863°E, 10 December 2021, coll. S. Koosakulnirand; two larvae (ZIN 18011, 18012) ex *Ficedula albicilla* and *Pycnonotus conradi*, THAILAND, Kanchanaburi province, 5 km NW Mahidol University Campus, 14.15452°N, 99.12069°E, 13 December 2021, coll. S. Koosakulnirand.

19 larvae (UoL) from same localities, same and additional host individuals of the same species plus one larva (UoL) ex *Cyornis tickelliae*, THAILAND, Kanchanaburi province, W Mahidol University Campus, 14.13111°N, 99.14863°E, 10 December 2021, coll. S. Koosakulnirand; one larva (UoL) ex *Pycnonotus aurigaster*, THAILAND, Kanchanaburi province, 5 km NW Mahidol University Campus, 14.15452°N, 99.12069°E, 13 December 2021, coll. S. Koosakulnirand.

Remarks — Our specimens deviate from the original description (Goff 1982) in more numerous idiosomal setae (fD = 2H-10(11)-8(10)-8(7)-4-2 vs. 2H-10-8-6-4-2, DS = 34 – 37 vs. 32, V = 31 – 34 vs. 26, NDV = 65 – 68 vs. 58) and slightly longer legs (Ip = 1145 – 1246 vs. 1026 – 1045, TaIIIL = 112 – 121 vs. 98). We estimate this difference as a case of intraspecific variation.

Toritrombicula kirhocephales differs from *T. densipiliata* in exhibiting fewer idiosomal setae (two humeral setae vs. four; 1st posthumeral row simple vs. double; DS = 34 – 37 vs. 50 –

Table 5 Morphometric (AW – TaIIIW, μm) and meristic (DS – NDV) traits of *Toritrombicula kirhocephales* Goff, 1982 (n = 5). Abbreviations as in Table 3.

	Range	Mean	Type series, range*
AW	65-74	70	69-77
PW	79-90	84	84-89
SB	22-27	25	25-28
ASB	32-36	34	27-33
PSB	16-18	17	16-18
SD	49-54	51	-
P-PL	9-14	11	-
AP	32-40	35	31-33
AM	38-43	41	43-45
AL	46-51	48	41-52
PL	54-71	65	51-58
H	50-64	57	54-64
D_{min}	32-36	34	37
D_{max}	54-68	61	54
V_{min}	32-33	33	29
V_{max}	54-56	55	47
pa	396-443	416	355-361
pm	333-365	347	309-316
pp	405-437	416	362-368
Ip	1145-1246	1186	1026-1045
TaIIIL	112-121	115	98
TaIIIW	18-20	19	18
DS	34-37	35	32
V	31-34	32	26
NDV	65-68	67	58

Note: * – After Goff (1982).

65; NDV = 58 – 65 vs. about 104) (Goff 1982; Nadchatram 1967b; Vercammen-Grandjean & Langston 1976).

Toritrombicula uphami Nadchatram, 1967

(Fig. 5B)

Distribution and hosts — Described ex *Pitta sordida* (Statius Müller) (Passeriformes: Pittidae) in Malaysia. *Cyornis tickelliae*, *Enicurus ruficapillus*, and *Pellorneum nigrocapitatum* are new host species.

Material examined — Two larvae (ZIN 18172, 18173) ex *Enicurus ruficapillus* and *Pellorneum nigrocapitatum*, MALAYSIA, Terengganu State, Pasir Raja Forest Reserve, 4.790517°N, 102.996835°E, 24 October 2021, coll. P. Rajasegaran; one larva (ZIN 18169) ex *Cyornis tickelliae*, MALAYSIA, Kedah State, Langkawi Isl., Gunung Machinchang, 6.429010°N, 99.729852°E, 15 March 2022, coll. P. Rajasegaran.

Genus *Neoschoengastia* Ewing, 1929

Type species — *Schoengastia americana* Hirst, 1921, by original designation.

Diagnosis — SIF = 7B(7BS)-B-3-(2–3)111.0(1)000; cheliceral blade with tricuspid cap; scutum trapezoidal, with anterolateral shoulders, covered by puncta and cuticular striations around sensillary bases, with almost straight, concave or bilobate posterior margin; sensillary bases far anterior to PL; usually AL > PL; sensilla pyriform or globose, covered with setules; eyes 2 + 2; parasubterminala (*z*) branched; onychotriches frequently present.

Neoschoengastia longipes Nadchatram, 1967

(Fig. 5C)

Diagnosis — SIF = 7BS-B-3-3111.0000; fPp = B/B/BNB; fCx = 1.1.3; fSt = 2.2; AL ≥ PL > AM; fD = 2H-6-6-4-6-4-2 (6-6-4-4-6, 6-6-6-6-4, and other similar variants); Ip = 1140 – 1294; DS = 28 – 31; V = 19 – 25; NDV = 50 – 54; onychotriches present on claws and empodium. Standard measurements are given in Table 6.

Distribution and hosts — THAILAND, ex 14 bird species (Stekolnikov 2021a). *Alcedo atthis*, *Calliope calliope*, *Larvivora cyane*, and *Otus sunia* are new host species.

Material examined — Two larvae (ZIN 17946, 17947) ex *Alcedo atthis* and *Larvivora cyane*, THAILAND, Rayong province, Koh Mun Nai, 12.612384°N, 101.687574°E, 9 March 2021, coll. S. Koosakulnirand; six larvae (ZIN 17948 – 17953) ex four *Copsychus malabaricus* (4), *Cyornis tickelliae* (1), and *L. cyane* (1), THAILAND, Kanchanaburi province, SW Mahidol University Campus, 14.11806°N, 99.15253°E, 8 – 9 December 2021, coll. S. Koosakulnirand; one larva (ZIN 17954) ex *C. malabaricus*, THAILAND, Kanchanaburi province, W Mahidol University Campus, 14.13111°N, 99.14863°E, 10 December 2021, coll. S. Koosakulnirand.

A great many (42) larvae (UoL) from the same localities, same and additional individuals of the same host species, plus 13 larvae ex four *C. malabaricus* (7), two *C. tickelliae* (2), and three *L. cyane* (4), THAILAND, Kanchanaburi province, W Mahidol University Campus, 14.134225°N, 99.1374365°E, 11 December 2021, coll. S. Koosakulnirand; nine larvae (UoL) ex two *Calliope calliope* (4), one *L. cyane* (3), and one *Otus sunia* (2), THAILAND, Kanchanaburi province, NW Mahidol University Campus, 14.154772°N, 99.1193296°E, 12 December 2021, coll. S. Koosakulnirand.

Remarks — *Neoschoengastia longipes* belongs to the group of species close to *N. americana*, which is characterized by the presence of three setae on coxa III (fCx = 1.1.3). Nadchatram (1967a) compared *N. longipes* with *Neoschoengastia entomyza* Womersley, 1952 and *Neoschoengastia thomasi* (Radford, 1946). The main difference between *N. longipes* plus *N. thomasi* and *N. americana* is the presence of six setae in the first posthumeral row vs. eight. Our material on *N. longipes* also differs from two specimens of *N. americana* collected in Paraguay (Stekolnikov *et al.* 2022) by NDV = 50 – 54 vs. 61 – 62, AP = 34 – 41 vs. 28 – 31,

and AL = 59 – 74 vs. 47. The difference by AL and, to a lesser extent, by AP agrees with the morphometric data on *N. americana* provided by Domrow (1974). However, the mean values of measurements from Malaysian specimens identified as *N. americana* by Domrow & Nadchatram (1960) differed from ours. In addition, the specimens examined by Domrow & Nadchatram (1960) were characterized by the presence of two additional sternal setae (fSt = 2.4. vs. 2.2). Probably, they belong to a new and still undescribed species. *Neoschoengastia entomyza*, a species described from Australia, was synonymized with *N. americana* by Domrow (1974), but we believe that these two taxa require a more detailed comparison. Thus, the presence of *N. americana* outside the American continent remains questionable.

Neoschoengastia thomasi was described incompletely, without characters of gnathosoma and legs (Radford 1946). According to the redescription prepared by Nadchatram (1967a) on the base of the type specimen deposited in the British Museum (Natural History), London (currently, Natural History Museum), *N. thomasi* differs from *N. americana* and *N. longipes* by the branched lateral palpal tibial seta (fPp = B/B/BbB vs. B/B/BNB). The redescription was illustrated with a drawing of the scutum lacking all setae except for one AL and one PL (Nadchatram 1967a, fig. 17). Surprisingly, the cuticular striations in the medial part of the scutum were drawn as transverse, whereas they are longitudinal in all above species. As noted by Domrow and Lester (1985), this drawing rather corresponds to *Neoschoengastia struthidia* Womersley, 1952. Fernandes and Kulkarni (2003) based their redescription of *N. thomasi* on existing literature. Unfortunately, the size of the *N. thomasi* type series and the place of

Table 6 Morphometric (AW – TaIIIW, µm) and meristic (DS – NDV) traits of *Neoschoengastia longipes* Nadchatram, 1967 (n = 8). Abbreviations as in Table 3.

	Range	Mean	Original description*
AW	46-58	53	51, 53
PW	62-90	77	80, 86
SB	26-35	30	32, 31
ASB	20-27	23	21, 23
PSB	24-29	26	24, 26
SD	44-56	49	-
P-PL	7-16	10	-
AP	34-41	38	34, 33
AM	35-43	38	31, 35
AL	59-74	65	69, 68
PL	54-70	59	59, 57
S (length)	38-38	38	36, 34
S (width)	20-22	21	19, 19
H	48-58	52	49
D_{min}	27-34	29	-
D_{max}	49-56	52	44-46
V_{min}	25-28	26	-
V_{max}	31-41	36	30-34
pa	403-437	421	410-460
pm	360-398	373	357-370
pp	425-461	441	380-400
Ip	1197-1294	1234	1140-1230
TaIIIL	122-139	131	140
TaIIIW	14-18	16	14
DS	28-31	30	30
V	19-25	22	-
NDV	50-54	52	-

Note: * – Holotype and mean of 11 specimens; single unspecified value or range for some characters; after Nadchatram (1967).

deposition of other type specimens is unknown. Therefore, it remains a dubious species.

Among our *N. longipes* material, three measured specimens (ZIN 17951, 17953, 17954) from *Copsychus malabaricus* collected 9 – 10 December 2021 differ from five other measured specimens by a lesser NDV (50 vs. 53 – 54) smaller scutum (AW = 46 – 50 vs. 51 – 58; SB = 26 – 28 vs. 29 – 35; SD = 44 – 47 vs. 49 – 56), and shorter legs (Ip = 1197 – 1210 vs 1222 – 1294; TaIIIL = 122 – 128 vs. 131 – 139). We provisionally consider this as a case of intraspecific variability.

Neoschoengastia solitus Nadchatram, 1967

Distribution and hosts — Malaysia, Thailand, ex 11 bird species (Stekolnikov 2021a).

Material examined — Three larvae (ZIN 17955 – 17957) ex one *Geokichla citrina*, THAILAND, Rayong province, Koh Mun Nai, 12.612384°N, 101.687574°E, 10 March 2021, coll. S. Koosakulnirand.

Neoschoengastia gallinarum (Hatori, 1920)

Distribution and hosts — China, Malaysia, Taiwan, Vietnam, ex 24 bird species and subspecies, and from two species of rats and a hare (Stekolnikov 2021a). Here this species is for the first time reported from Thailand. *Argusianus argus*, *Lophura rufa*, and *Polyplectron inopinatum* are new hosts.

Material examined — Four larvae (ZIN 17958 – 17961) ex one *Gallus gallus domesticus*, THAILAND, Nan province, Ban Huai Muang village, 19.139995°N, 100.718956°E, 23 December 2021, coll. S. Koosakulnirand; two larvae (UM) ex one *Argusianus argus* and 14 larvae ex five *Polyplectron malacense*, MALAYSIA, Johor State, Jemaluang Wildlife Conservation Centre, 2.291356°N, 103.852966°E, 22 February 2022, coll. P. Rajasegaran; 11 larvae (UM) ex five *Gallus gallus domesticus*, MALAYSIA, Johor State, Kota Tinggi plantation, 2.030233°N, 103.866035°E, 21 – 23 June 2022, coll. P. Rajasegaran; 24 larvae (UM) ex two *Lophura rufa* (15), three *Polyplectron inopinatum* (8), and one *Polyplectron malacense* (1), MALAYSIA, Perak State, Sungkai Wildlife Conservation Centre, 4.064302°N, 101.366232°E, 9 January and 8 March 2021, coll. P. Rajasegaran; nine larvae (UM) ex seven *Gallus gallus domesticus*, MALAYSIA, Selangor State, Bestari Jaya village, 3.378008°N, 101.410224°E, 12 April 2021, coll. P. Rajasegaran.

Genus *Schoengastia* Oudemans, 1910

Type species — *Thrombidium vandersandei* Oudemans, 1905.

Diagnosis — SIF = 7BS-N-3(2)-3(2)111.(0 – 2)000; cheliceral blade serrate on its dorsal edge, with tricuspid cap; scutum usually subpentagonal, with convex posterior margin; AL > PL > AM, sensillary bases situated not far apart and close to level of PLs; sensilla globose, covered with setules; eyes 2 + 2.

Schoengastia archaea (Taufflieb, 1960)

(Fig. 5D)

Diagnosis — SIF = 7BS-N-3-2111.0000; fPp = B/B/NBB; fCx = 1.1.1; fSt = 2.2; AL ≥ PL ≫ AM; fD = (49 – 60)-(26 – 30)+(56 – 72); DS = 138 – 159; V = 89 – 100; NDV = 227 – 254; Ip = 1024 – 1127; cheliceral blade with four dorsal hooks; eyes 2 + 2, very large; scutum as long as wide, with prominent anterolateral shoulders, with greatly projected posterior margin concave in center; entire scutum covered with puncta, its half posterior to sensillary bases also covered with distinct transverse striations; sensilla (trichobothria) drop-shaped, covered with setules; sensillary bases posterior to level of PL; leg tarsi with multiple sclerite bars; S_1 in distal part of segment, f_1 behind S_1, f_2 behind S_2. Standard measurements are given in Table 7.

Distribution and hosts — This species was described from Senegal (Rufisque), ex *Sterna hirundo* L. (Charadriiformes: Laridae) (Taufflieb 1960). Here it is for the first time recorded in Asia (Thailand) and on all hosts mentioned below.

Material examined — Six larvae (ZIN 17966 – 17971) ex two *Charadrius mongolus* (2), one *Calidris ruficollis* (1), two *Calidris tenuirostris* (2), and one *Xenus cinereus* (1), THAILAND, Trang province, Samran Beach, 7.201348°N, 99.562105°E and 7.209399°N, 99.557854°E, 15 – 17 March 2021, 19 March 2022, coll. S. Koosakulnirand; four larvae (ZIN 17972 – 17975) ex three *Numenius arquata*, THAILAND, Trang province, White Dragon Spine Beach (7.2984973°N, 99.420628°E), 20 March 2022, coll. S. Koosakulnirand.

12 larvae (UoL) from the same localities, same and additional host individuals of the same species.

Remarks — This species is similar to *Schoengastia galapa* Stekolnikov, 2021 described ex marine iguana *Amblyrhynchus cristatus* Bell (Squamata: Iguanidae) from the Galápagos Islands; this similarity has not been noted before. Both species stand out among *Schoengastia* due to the numerous idiosomal setae (NDV ca. 200 or more), the presence of two genualae I (σ) vs. three or more, the presence of anterolateral shoulders of the scutum, and the presence of transverse cuticular striations on the scutum posterior to sensillary bases. Such striations do not reach the level of sensillary bases in all other species of *Schoengastia* (Stekolnikov 2021b). *Schoengastia galapa* differs from *S. archaea* by fPp = N(b)/N/NNB vs. B/B/NNB, much shorter legs (Ip = 733 – 795 vs. 1019 – 1127) without additional sclerite bars, presence of mastitarsalae, f_1 distal to S_1 vs. proximal, smaller anterior pair of eyes, fewer idiosomal setae (NDV = 197 – 206 vs. 227 – 256), and by a wider scutum (AW = 46 – 48 vs. 34 – 38, PW = 62 – 66 vs. 51 – 56).

Table 7 Morphometric (AW – TaIIIW, µm) and meristic (DS – NDV) traits of *Schoengastia archaea* (Taufflieb, 1960) (n = 7). Abbreviations as in Table 3.

	Range	Mean	Original description*
AW	34-36	35	38
PW	51-56	53	56
SB	23-25	24	23
ASB	26-29	28	24
PSB	29-31	29	33
SD	56-58	57	57
P-PL	27-34	31	-
AP	17-21	19	19
AM	23-25	25	25
AL	56-65	60	58
PL	56-61	58	61
S (length)	27-30	28	29
S (width)	14-15	15	-
D_{min}	20-22	20	25
D_{max}	28-34	32	29
V_{min}	20-24	21	22
V_{max}	24-30	27	25
pa	371-401	386	362
pm	297-329	311	299
pp	351-396	372	358
Ip	1024-1127	1069	1019
TaIIIL	101-110	105	100
TaIIIW	15-19	16	-
DS	138-159	148	160
V	89-100	94	96
NDV	227-254	241	256

Note: * – After Taufflieb (1960).

Genus *Ascoschoengastia* Ewing, 1946

Ascoschoengastia lorius (Gunther, 1939)

Distribution and hosts — Australia, China, Papua New Guinea, Thailand, Vietnam, ex nine mammal hosts and four bird species (Stekolnikov 2021a). Here this species is for the first time recorded in Malaysia and on *Meiglyptes tukki*.

Material examined — 12 larvae (UM) ex one *Meiglyptes tukki*, MALAYSIA, Pahang State, Krau Wildlife Reserve, 3.596982°N, 102.183190°E, 17 February 2021, coll. P. Rajasegaran.

Genus *Blankaartia* Oudemans, 1911

Blankaartia acuscutellaris (Walch, 1922)

Distribution and hosts — Eastern Europe, Spain, Tropical Africa, Central, South, Southeast, and East Asia, mainly on water birds, also on mammals of different orders, including humans, and two records on chameleons (Stekolnikov 2021a). *Lewinia striata* is a new host species.

Material examined — One larva (ZIN 18170) ex *Lewinia striata*, MALAYSIA, Sarawak State, Sematan Pueh village, 1.831126°N, 109.708966°E, 22 March 2022, coll. P. Rajasegaran.

One larva (UM) with the same data.

Genus *Ericotrombidium* Vercammen-Grandjean, 1966

Ericotrombidium cosmetopode (Vercammen-Grandjean & Langston, 1971)

(Fig. 6)

Diagnosis — SIF = 7BS-B-3-2111.0000; fPp = B/B/NNB; fCx = 1.1.1; fSt = 2.2; PL > AL > AM (PL > AM ≥ AL); fD = 2H-8-6-6-4-2 (8-6-6-4-4-2); DS = 28 – 32; V = 27 – 28; NDV = 55 – 60; Ip = 666 – 770; dorsal idiosomal setae tetrapectinate, with thin barbs; scutum with large puncta, with bilobate posterior margin; SB at level of PL; sensilla with cilia in medial part and ca. 13 branches in distal third; f_1 distal to S_1, f_2 distal to S_2; S_2 thin, pointed. Standard measurements are given in Table 8.

Distribution and hosts — This species was described from free larvae found in a ground hole, Malaysia, Selangor State, Ulu Langat Forest Reserve. *Pellorneum ruficeps* is the first known host of this species.

Material examined — One larva (ZIN 17937) ex *Pellorneum ruficeps*, MALAYSIA, Pahang State, Fraser's Hill, 3.725630°N, 101.716365°E, 22 October 2021, coll. P. Rajasegaran.

Remarks — As compared with the original description, our specimen has longer legs and a slightly reduced number of idiosomal setae (Table 8).

Genus *Eutrombicula* Ewing, 1938

Eutrombicula wichmanni (Oudemans, 1905)

Distribution and hosts — Australia, Myanmar, Brunei, China, Guam, Indonesia, Japan, Malaysia, Papua New Guinea, Philippines, Taiwan, Thailand, Vietnam, ex many species of mammals from different orders (including humans), reptiles, and birds (Stekolnikov 2021a).

Material examined — Three larvae (ZIN 17997 – 17999) collected by the black plate technique, THAILAND, Nan province, Ban Huai Muang village, 19.140834°N, 100.718315°E, 26 December 2021, coll. Kamonchanok Bunmee; 19.1391337°N, 100.7195905°E, 25 December 2021, coll. Rawadee Kumlert; 19.1378833°N, 100.7193387°E, 27 December 2021, coll. Kamonchanok Bunmee; two larvae (ZIN 18000, 18001) ex two *Gallus gallus domesticus*, same place, 19.139652°N, 100.718019°E and 19.140026°N, 100.719794°E, 23 December 2021, coll. S. Koosakulnirand.

A great many (113) larvae (UoL) ex *Gallus gallus domesticus*, THAILAND, Nan province, Ban Huai Muang village, different collection sites, 23 – 24 December 2021, coll. S. Koosakul-

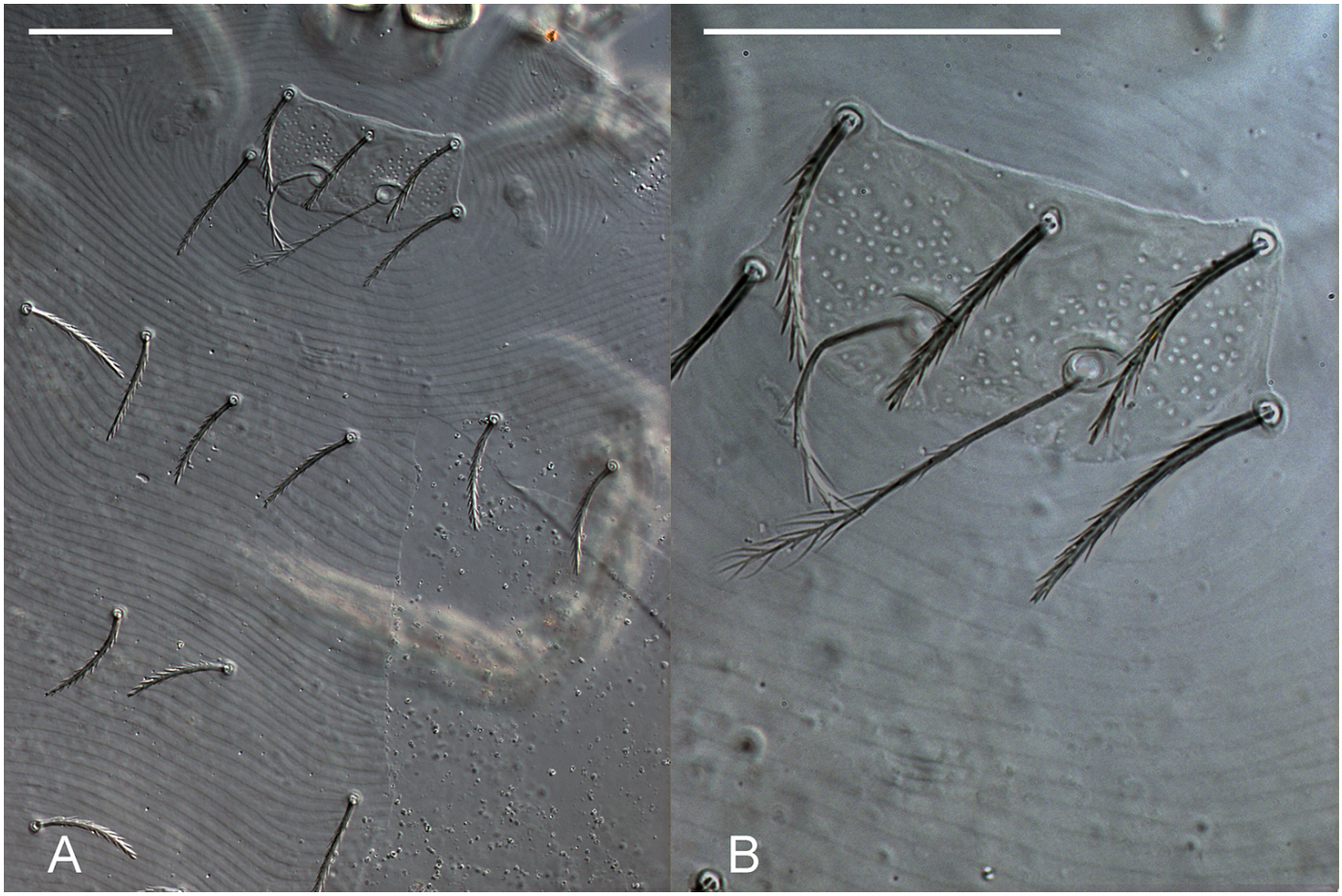

Figure 6 *Ericotrombidium cosmetopode* (Vercammen-Grandjean & Langston, 1971), specimen ZIN 17937: A –anterior dorsal aspect of idiosoma; B – scutum. Scale bars: 50 µm.

nirand; 2 larvae (UoL) ex *Gallus gallus domesticus*, THAILAND, Nan province, Ban Santisuk village, 19.131006°N, 100.698332°E, 24 December 2021, coll. S. Koosakulnirand.

Genus *Helenicula* Audy, 1954

Helenicula comata (Womersley, 1952)

Distribution and hosts —China, India, Philippines, ex *Rattus tanezumi* (Stekolnikov 2021a). Here this species is for the first time recorded in Thailand and on *Gallus gallus domesticus*.

Material examined — One larva (ZIN 17989) collected by the black plate technique, THAILAND, Nan province, Ban Huai Muang village, 19.1392019°N, 100.7199339°E, 25 December 2021, coll. Rawadee Kumlert; three larvae (ZIN 17990 – 17992) collected by the black plate technique, same place, 19.1386161°N, 100.7162079°E, 26 December 2021, coll. Kamonchanok Bunmee.

Three larvae (UoL) ex *Gallus gallus domesticus*, THAILAND, Nan province, Ban Huai Muang village, 19.139696°N, 100.720205°E, 24 December 2021, coll. S. Koosakulnirand.

Genus *Leptotrombidium* Nagayo, Miyagawa, Mitamura & Imamura, 1916

Leptotrombidium deliense (Walch, 1922)

Distribution and hosts — Australia, Cambodia, China, India, Indonesia, Laos, Malaysia, Maldive Islands, Myanmar, Nepal, Papua New Guinea, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam, ex a wide range of mammal hosts (including humans), birds, occasionally on reptiles and arthropods (Stekolnikov 2021a).

Material examined — One larva (ZIN 17936) ex *Pellorneum ruficeps*, MALAYSIA, Pahang State, Fraser's Hill, 3.725630°N, 101.716365°E, 22 October 2021, coll. P. Rajasegaran; one larva (ZIN 18171) ex *P. ruficeps*, MALAYSIA, Kedah State, Langkawi Isl., Gunung Machinchang, 6.429010°N, 99.729852°E, 16 March 2022, coll. P. Rajasegaran.

Leptotrombidium imphalum Vercammen-Grandjean & Langston, 1976

Distribution and hosts — Sri Lanka, China, India, Malaysia, Myanmar, Pakistan, Taiwan, Thailand, ex 19 species of mammals from four orders and ex one unidentified bird (Stekolnikov 2021a). *Amaurornis phoenicurus* and *Lewinia striata* are new host species.

Material examined — Two larvae (ZIN 17933, 17934) ex *Amaurornis phoenicurus* and *Lewinia striata*, MALAYSIA, Sarawak State, Sematan Pueh village, 1.831126°N, 109.708966°E, 22 March 2022, coll. P. Rajasegaran.

Leptotrombidium miculum (Traub & Audy, 1954)

Distribution and hosts — Malaysia, Thailand, ex five species of rodents (Stekolnikov 2021a). Here this species is for the first time recorded on a bird host.

Table 8 Morphometric (AW – TaIIIW, μm) and meristic (DS – NDV) traits of *Ericotrombidium cosmetopode* (Vercammen-Grandjean & Langston, 1971). Abbreviations as in Table 3.

	New specimen	Holotype*	Mean (n = 4)*
AW	60	62	62
PW	75	72	71
SB	23	23	22
ASB	28	26	26
PSB	13	12	13
SD	41	38	38
P-PL	14	-	-
AP	24	23	22
AM	33	42	39
AL	35	39	38
PL	43	47	47
S	59	64	64
H	38	42	43
D_{min}	33	38	37
D_{max}	41	46	44
V_{min}	24	32	31
V_{max}	40	44	43
pa	274	236	235
pm	234	206	206
pp	263	238	241
Ip	770	680	682
TaIIIL	74	-	-
TaIIIW	14	-	-
DS	28	32	32
V	27	28	28
NDV	55	60	60

Note: * – After Vercammen-Grandjean and Langston (1971, 1976).

Material examined — One larva (ZIN 17932) ex *Pellorneum ruficeps*, MALAYSIA, Kedah State, Langkawi Isl., Gunung Machinchang, 6.429010°N, 99.729852°E, 17 March 2022, coll. P. Rajasegaran.

Genus *Odontacarus* Ewing, 1929

Odontacarus audyi (Radford, 1946)

Distribution and hosts — India, Malaysia, Thailand, Vietnam, on 22 bird species (Stekolnikov 2021a). *Cacomantis sepulcralis*, *Cyornis tickelliae*, *Eumyias thalassinus*, *Geokichla citrina*, *Geokichla sibirica*, *Larvivora cyane*, *Philentoma pyrhoptera*, *Cyornis brunneatus*, *Stachyris nigriceps*, and *Stachyris poliocephala* are new host species.

Material examined — Three larvae (ZIN 17938 – 17940) ex *Geokichla citrina*, *Geokichla sibirica*, and *Larvivora cyane*, THAILAND, Rayong province, Koh Mun Nai, 12.612384°N, 101.687574°E, 10 – 11 March 2021, coll. S. Koosakulnirand; two larvae (ZIN 17941, 17943) ex *L. cyane* and *Cyornis tickelliae*, THAILAND, Kanchanaburi province, Mahidol University Campus, 14.1288777°N, 99.1611407°E, 8 – 9 December 2021, coll. S. Koosakulnirand; one larva (ZIN 17942) ex *L. cyane*, THAILAND, Kanchanaburi province, SW Mahidol University Campus, 14.11806°N, 99.15253°E, 9 December 2021, coll. S. Koosakulnirand; two larvae (ZIN 17944, 17945) ex *L. cyane* and *Copsychus malabaricus*, THAILAND, Kanchanaburi province, W Mahidol University Campus, 14.13111°N, 99.14863°E, 10 December 2021, coll. S. Koosakulnirand; one larva (ZIN 18167) ex *Gallus gallus domesticus*, THAILAND, Nan province, Ban Santisuk village, 19.131006°N, 100.698332°E, 23 December 2021, coll. S. Koosakulnirand.

Fifty-three larvae (UoL) from the same localities of Kanchanaburi province, same and additional host individuals of the same species, plus 11 larvae ex one *Copsychus saularus* (2), one *Mixornis gularis* (1), two *Pycnonotus conradi* (4), and two *Rhipidura javanica* (4), THAILAND, Kanchanaburi province, Mahidol University Campus, 14.1288777°N, 99.1611407°E, 9 December 2021, coll. S. Koosakulnirand; nine larvae (UoL) ex one *Mixornis gularis* (2), two *Pycnonotus conradi* (4), and one *Rubigula flaviventris* (3), THAILAND, Kanchanaburi province, W Mahidol University Campus, 14.13111°N, 99.14863°E, 10 December 2021, coll. S. Koosakulnirand; 53 larvae (UoL) ex three *Copsychus malabaricus* (7), four *Cyornis tickelliae* (15), four *Larvivora cyane* (15), one *Pycnonotus aurigaster* (2), four *Pycnonotus conradi* (8), and two *Pycnonotus finlaysoni* (6), THAILAND, Kanchanaburi province, W Mahidol University Campus, 14.134225°N, 99.1374365°E, 11 December 2021, coll. S. Koosakulnirand; nine larvae (UoL) ex one *Dicrurus paradiseus* (1), one *Larvivora cyane* (3), one *Calliope calliope* (3), one *Ficedula albicula* (1), and one *Pycnonotus conradi* (1), THAILAND, Kanchanaburi province, NW Mahidol University Campus, 14.154772°N, 99.1193296°E, 12 – 13 December 2021, coll. S. Koosakulnirand.

Three larvae (UM) ex *Pellorneum ruficeps*, *Geokichla citrina*, and *Larvivora cyane*, MALAYSIA, Kedah State, Langkawi Isl., Gunung Machinchang, 6.429010°N, 99.729852°E, 16 – 17 March 2022, coll. P. Rajasegaran; one larva (UM) ex *P. ruficeps*, MALAYSIA, Pahang State, Fraser's Hill, 3.725630°N, 101.716365°E, 22 October 2021, coll. P. Rajasegaran; five larvae (UM) ex *Cacomantis sepulcralis*, *Copsychus malabaricus*, *Eumyias thalassinus*, *Stachyris nigriceps*, and *Stachyris poliocephala*, MALAYSIA, Selangor State, Ulu Gombak Forest Reserve, 3.325987°N, 101.752747°E, 9 – 12 February 2021, coll. P. Rajasegaran; 16 larvae (UM) ex one *C. malabaricus* (1), four *L. cyane* (5), four *Philentoma pyrhoptera* (4), one *Cyornis brunneatus* (2), and four *S. poliocephala* (4), MALAYSIA, Terengganu State, Pasir Raja Forest Reserve, 4.790517°N, 102.996835°E, 23 – 27 October 2021, coll. P. Rajasegaran.

Genus *Parascoschoengastia* Vercammen-Grandjean, 1960

Parascoschoengastia heynemani (Nadchatram & Upham, 1966)

Distribution and hosts — China and Malaysia, ex *Halcyon pileata* (Boddaert), *Alcedo atthis bengalensis* J.F. Gmelin, *Alcedo peninsulae*, and *Alcedo meninting* Horsfield (Coraciiformes: Alcedinidae) (Stekolnikov 2021a). *Actenoides concretus* is a new host species.

Material examined — Four larvae (UM) ex one *Actenoides concretus*, MALAYSIA, Pahang State, Krau Wildlife Reserve, 3.596982°N, 102.183190°E, 18 February 2021, coll. P. Rajasegaran; four larvae (UM) ex one *Alcedo peninsulae*, MALAYSIA, Sarawak State, Gunung Gading National Park, Lundu, 1.692098°N, 109.845157°E, 22 March 2022, coll. P. Rajasegaran.

Characteristics of infestation

Thailand. In total, 754 hosts were examined; 199 (26.4%) were found parasitized by chiggers (2,340 specimens); 440 chigger specimens from 140 hosts were slide-mounted and identified (Table 1). There were 30 hosts (22%) bearing more than one chigger species, considering only those cases confirmed by the identification of slide-mounted chiggers. One individual of *Geokichla citrina* from Koh Mun Nai was parasitized by three species (*N. solitus*, *O. audyi*, and *T. densipiliata*). The pairs of co-occurring species were *N. longipes* and *O. audyi* (19 cases), *N. longipes* and *T. kirhocephales* (3), *N.* (*W.*) *andamanensis* and *S. archaea* (3), *O. audyi* and *T. kirhocephales* (2), *O. audyi* and *T. densipiliata* (1), and *E. wichmanni* and *H. comata* (1).

Malaysia. In total 777 hosts were examined; 129 (16.6%) were found parasitized by chiggers; 242 chigger specimens from 123 hosts were slide-mounted and identified (Table 2). One *Pellorneum ruficeps* from Fraser's Hill bore three species (*E. cosmetopode*, *L. deliense*, and *O. audyi*); whereas four hosts bore pairs of species—*O. audyi* and *T. densipiliata* (2), *L. miculum* and *O. audyi* (1), and *L. imphalum* and *B. acuscutellaris* (1).

Discussion

The specificity of chigger mites for different orders of birds is a trait that can be noted first of all when considering our results. Thus, our materials from Thailand demonstrate three different sets of chigger species connected with birds from different orders occurring in different habitats (Table 9). Shorebirds (order Charadriiformes) were parasitized by four species of *Neacariscus* and by *Schoengastia archaea*. Birds inhabiting forests (mainly Passeriformes) bore two species of *Neoschoengastia* (*N. longipes* and *N. solitus*), two *Toritrombicula* spp., and *Odontacarus audyi*. Domestic chickens (Galliformes) were parasitized by *Eutrombicula wichmanni*, *Neoschoengastia gallinarum*, *Helenicula comata*, and *O. audyi*. Thus, only the latter species was found on birds belonging to two of these ecological (and taxonomic) groups.

In the materials from Malaysia (Table 10), we can see that Galliformes, represented in this collection by four species of pheasants in addition to domestic chickens (Table 2), were the hosts of a sole chigger species, *Neoschoengastia gallinarum*. The chigger species composition on Passeriformes was similar to that of Thailand and included two species of *Toritrombicula* and *O. audyi*. Other recorded species were rare. Finally, *Parascoschoengastia heynemani* was found only on two species of kingfisher (Coraciiformes: Alcedinidae), in two localities from different provinces. Noteworthy is that previous records of this species were on hosts from the same family (Stekolnikov 2021a).

Since chigger mites are temporary parasites, their distribution is expected to be determined by the natural conditions of the biotopes suitable both for their free-living postlarval stages and for their hosts. However, the size of actually recorded host ranges for different chigger species can be highly variable and dependent, theoretically, on the number of host species in some localities and the modes of chigger activity; for example, preferred habitats where they lie in wait for their hosts (ground surface, grass, tree branches, etc.). These aspects of

their behavior are poorly known: however, the connection of *P. heynemani* with kingfishers suggests this chigger species is nidicolous, occupying the burrows in which kingfishers nest. Similarly, *A. lorius* larvae and post-larval stages were found together in tree-hollow nests of psittaciform birds in Queensland, Australia, indicating that the entire lifecycle of this species can be nidicolous (Shaw 2010). Such ecological habits could explain the infestation of the buff-necked woodpecker (*M. tukki*) by *A. lorius* in Malaysia, as this host species also nests in tree hollows.

The separate set of chigger species from the shorebirds in Thailand was the most unexpected discovery during our investigation. Among the five chigger species collected from the birds inhabiting the seashore of southern Thailand, *Schoengastia archaea* and *Neacariscus sulae* were previously known only from their type localities in West Africa. *Neacariscus pluvius* was previously recorded only in Oceania, and *N. shiraii* from Oceania and Japan. One species of this genus was described above as new.

According to the literature, species of the genus *Neacariscus* parasitize mainly aquatic birds (Vercammen-Grandjean and Langston 1976; Mertins *et al.* 2009). One species, *N. thompsoni*, in addition to the birds, was found on a fish-eating bat. Only two species, *N. chaetosa* and *N. nativitatis*, are known from lizards in Central and South America; while *N. shiraii* was occasionally collected on rats. However, where the collection sites of these species are known, they tend to be located in coastal areas accessible to seabirds (Mertins *et al.* 2009; Stekolnikov and González-Acuña 2015). *Schoengastia archaea* was also described from a species of Charadriiformes. We assume that the fauna of chiggers inhabiting seashores and parasitizing the birds associated with these biotopes is mostly uniform throughout the tropical zone of the world. Probably, *Schoengastia galapa*, described from the Galápagos Islands belongs to the same species complex, although it was collected only from a marine iguana (Stekolnikov 2021b). Its presence on seabirds seems probable.

Table 9 Distribution of chiggers by host orders in Thailand. Names of localities as in Table 1. Sum of the column 'Hosts' is larger than the total number of host individuals examined due to the co-parasitization of one host with different chigger species.

Host order	Hosts	Chigger species	Slides	Province	Locality	Habitat	Month
Charadriiformes	4	*Neacariscus andamanensis* **n. sp.**	9	Satun	Thung Sabo	Shore	March
Charadriiformes	3	*Schoengastia archaea*	8	Trang	Albino Dragon	Shore	March
Charadriiformes	1	*Neacariscus sulae*	2	Trang	Koh Libong	Shore	March
Charadriiformes	12	*Neacariscus andamanensis* **n. sp.**	17	Trang	Samran beach	Shore	March
Charadriiformes	2	*Neacariscus shiraii*	2	Trang	Samran beach	Shore	March
Charadriiformes	3	*Neacariscus pluvius*	3	Trang	Samran beach	Shore	March
Charadriiformes	8	*Schoengastia archaea*	14	Trang	Samran beach	Shore	March
Coraciiformes	1	*Neoschoengastia longipes*	5	Rayong	Koh Mun Nai	Island	March
Passeriformes	4	*Neoschoengastia longipes*	8	Rayong	Koh Mun Nai	Island	March
Passeriformes	1	*Neoschoengastia solitus*	3	Rayong	Koh Mun Nai	Island	March
Passeriformes	3	*Odontacarus audyi*	3	Rayong	Koh Mun Nai	Island	March
Passeriformes	2	*Toritrombicula densipiliata*	3	Rayong	Koh Mun Nai	Island	March
Passeriformes	6	*Toritrombicula kirhocephales*	17	Rayong	Koh Mun Nai	Island	March
Passeriformes	51	*Odontacarus audyi*	140	Kanchanaburi	Mahidol Univ.	Highland	December
Passeriformes	6	*Toritrombicula kirhocephales*	8	Kanchanaburi	Mahidol Univ.	Highland	December
Passeriformes	29	*Neoschoengastia longipes*	73	Kanchanaburi	Mahidol Univ.	Highland	December
Strigiformes	1	*Neoschoengastia longipes*	2	Kanchanaburi	Mahidol Univ.	Highland	December
Galliformes	29	*Eutrombicula wichmanni*	115	Nan	Huai Muang	Village	December
Galliformes	1	*Helenicula comata*	3	Nan	Huai Muang	Village	December
Galliformes	1	*Neoschoengastia gallinarum*	4	Nan	Huai Muang	Village	December
Galliformes	1	*Eutrombicula wichmanni*	2	Nan	Ban Santisuk	Village	December
Galliformes	1	*Odontacarus audyi*	1	Nan	Ban Santisuk	Village	December

Migration of birds could facilitate widespread dispersal of the bird chiggers, such as *S. archaea* and *N. sulae*. Varma (1964) discussed this possibility in detail. In part, the wide range of *Blankaartia acuscutellaris*, which extends from Southeast Asia to Western Europe and Africa, could be connected with the fact that principal hosts of this species are birds associated with wetlands (although it has been frequently collected from other hosts, including humans) (Mąkol and Korniluk 2017; Trnka *et al.* 2022). Recently, a disjunctive area of distribution, consisting of three isolated parts—Eastern Europe, Iran, and Vietnam—was established for *Neotrombicula elegans* (Shamsi *et al.* 2020). Since in Vietnam this species was found on three species of birds, including *Larvivora sibilans* (Swinhoe), which was noted as a rare vagrant in Europe (Clement and Rose 2015), these authors hypothesized that dissemination by birds could be the cause of the scattered range of *N. elegans*.

We add that alternative migration routes within the same population of birds can result in the presence of greatly disjunct wintering sites, both latitudinally and longitudinally. Thus, the wintering sites of the little ringed plovers *Charadrius dubius* Scopoli (Charadriiformes: Charadriidae) breeding in south Sweden were identified as far apart as West Africa and India

Table 10 Distribution of chiggers by host orders in Malaysia. Names of localities as in Table 2. Sum of the column 'Hosts' is larger than the total number of host individuals examined due to the co-parasitization of one host with different chigger species.

Host order	Hosts	Chigger species	Slides	Province	Locality	Month
Coraciiformes	1	*Parascoschoengastia heynemani*	4	Pahang	Krau	February
Coraciiformes	1	*Parascoschoengastia heynemani*	4	Sarawak	Gunung Gading	March
Coraciiformes	2	*Toritrombicula densipiliata*	4	Perak	Behrang	September
Cuculiformes	1	*Odontacarus audyi*	1	Selangor	Ulu Gombak	February
Cuculiformes	1	*Toritrombicula densipiliata*	1	Selangor	Ulu Gombak	February
Galliformes	6	*Neoschoengastia gallinarum*	16	Johor	Jemaluang	February
Galliformes	5	*Neoschoengastia gallinarum*	11	Johor	Kota Tinggi	June
Galliformes	6	*Neoschoengastia gallinarum*	24	Perak	Sungkai	January, March
Galliformes	7	*Neoschoengastia gallinarum*	9	Selangor	Bestari Jaya	April
Gruiformes	1	*Blankaartia acuscutellaris*	2	Sarawak	Pueh	March
Gruiformes	2	*Leptotrombidium imphalum*	2	Sarawak	Pueh	March
Passeriformes	1	*Ericotrombidium cosmetopode*	1	Pahang	Fraser's Hill	October
Passeriformes	1	*Leptotrombidium deliense*	1	Pahang	Fraser's Hill	October
Passeriformes	1	*Leptotrombidium deliense*	1	Kedah	Langkawi	March
Passeriformes	1	*Leptotrombidium miculum*	1	Kedah	Langkawi	March
Passeriformes	3	*Odontacarus audyi*	3	Kedah	Langkawi	March
Passeriformes	1	*Odontacarus audyi*	1	Pahang	Fraser's Hill	October
Passeriformes	4	*Odontacarus audyi*	4	Selangor	Ulu Gombak	February
Passeriformes	14	*Odontacarus audyi*	16	Terengganu	Pasir Raja	October
Passeriformes	5	*Toritrombicula densipiliata*	5	Kedah	Langkawi	March
Passeriformes	21	*Toritrombicula densipiliata*	41	Pahang	Krau	February
Passeriformes	14	*Toritrombicula densipiliata*	25	Perak	Behrang	September
Passeriformes	2	*Toritrombicula densipiliata*	2	Perak	Larut Hill	March
Passeriformes	4	*Toritrombicula densipiliata*	4	Sarawak	Gunung Gading	March
Passeriformes	1	*Toritrombicula densipiliata*	2	Sarawak	Sematan Pueh	March
Passeriformes	1	*Toritrombicula densipiliata*	2	Selangor	Ulu Gombak	February
Passeriformes	6	*Toritrombicula densipiliata*	6	Terengganu	Pasir Raja	October
Passeriformes	11	*Toritrombicula densipiliata*	33	Terengganu	Redang Isl.	October
Passeriformes	1	*Toritrombicula uphami*	1	Kedah	Langkawi	March
Passeriformes	2	*Toritrombicula uphami*	2	Terengganu	Pasir Raja	October
Piciformes	1	*Ascoschoengastia lorius*	12	Pahang	Krau	February
Podargiformes	1	*Toritrombicula densipiliata*	1	Perak	Behrang	September

using geolocators (Hedenström *et al.* 2013). Similarly, Terek sandpiper (*X. cinereus*), which we found to be parasitized with three *Neacariscus* spp. and *S. archaea* in Thailand, has a vast breeding range across the taiga from Finland to eastern Siberia. Its wintering grounds extend from eastern and southern Africa, the Middle East, southern Asia, and Australia, with vagrants appearing as far afield as the Americas (White *et al.* 2006). Provided that the breeding sites of some bird species are suitable to support the life cycle of chiggers (at least for part of the year), variability of migration routes could thus result in extensive meridional dissemination of chiggers over vast distances.

The chigger species composition on the Passeriformes in the study areas significantly differed from that of the seven passerine bird species examined by Kaluz *et al.* (2016) in North Vietnam. Among the 12 chigger species found by these authors, only one (*O. audyi*) was also recorded in our study. Moreover, they found no species of *Toritrombicula*, whereas we recorded three, and this genus was rather frequent in our collections (Tables 9, 10). In Thailand, we collected two species of *Neoschoengastia* from passerines whereas three other species from the same genus were reported by Kaluz *et al.* (2016). In contrast, we did not find this genus on Passeriformes in the Malaysian localities. Finally, we collected three species of *Leptotrombidium* from Passeriformes in Malaysia, but none in Thailand, while Kaluz *et al.* (2016) found six other *Leptotrombidium* species. Evidently, the fauna of bird chiggers in forest biotopes of Southeast Asia is highly variable and requires further investigations, including quantitative analysis of host-chigger networks using the data presented here, which will be the subject of a separate publication.

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