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Scapulaseius asiaticus (Evans) and *S. reptans* (Blommers) (Mesostigmata: Phytoseiidae): one or two species?

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Original research

ABSTRACT

We compare published morphometric measurements of females and males of *Scapulaseius asiaticus* (Evans) and *S. reptans* (Blommers) collected in various countries, with new measurements and character states of type specimens of both species and additional material. The aim is to establish definitively whether the two species are synonyms or not. This paper follows the doubt on the taxonomic status of the former and the hypothesis of conspecificity of the two species formulated by both authors in previous papers concerning Mauritius phytoseiid fauna. Setal and shield measurements were highly similar between species. In addition, other morphological characters previously used to separate these taxa, such as the position of setae *R1*, showed a wide intraspecific variability, and largely overlapped between populations previously identified as S. asiaticus vs S. reptans. We conclude that the two forms are conspecific and, therefore, *S. reptans* is herein designated a junior synonym of *S. asiaticus*.

Keywords survey; collection; predators; taxonomy; systematics; synonymy

Introduction

Mites of the family Phytoseiidae are famous for their predatory behaviours on phytophagous mites and small insects on cultivated plants and wild vegetation. Several species are commercialised for the control of pest organisms in agricultural open fields and, above all, in protected crops all around the world (McMurtry and Croft 1997, McMurtry *et al.* 2013, Knapp *et al.* 2018). This family is widespread around the world, present on all inhabited continents and consists presently of 2,521 valid species belonging to 95 genera, 15 tribes and three sub-families (Chant and McMurtry 2007, Demite *et al.* 2021).

Biodiversity surveys in poorly investigated areas is still an urgent need and might result in the discovery of additional species potentially useful for biological control as well as having more information on the biodiversity of these areas and on taxonomy of species discovered. Most of the Indian Ocean constitutes one of the world's biodiversity hotspots (Myers 1988, Myers *et al.* 2000). Knowledge of the phytoseiid diversity in these areas may contribute to future establishment of conservation programs as well as biocontrol agents.

Mascareignes Archipelago is composed of three main islands: La Réunion, Mauritius and Rodrigues, all located in the East of Madagascar. Comoros Archipelago is composed of four main Islands: Mayotte, Anjouan, Mohéli and Grande Comore, located in the Northwest of Madagascar.

Ferragut and Baumann (2019) have investigated the Mauritian fauna of Phytoseiidae in April 2018. All main Islands of the two Archipelagos (except La Réunion which was investigated before, see Kreiter *et al.* 2020c) were investigated from October 25th to December

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12th, 2018. Results of Phytoseiidae records during this survey were already published in seven papers: Kreiter and Abo-Shnaf 2020a & b for **Rodrigues** and **Mauritius** (in addition for Mauritius, see Kreiter *et al.* 2018a); Kreiter *et al.* 2020a, 2021b, c & d for **Mayotte**, **Anjouan**, **Mohéli**, and **Grande Comore** (in addition for Grande Comore, see Kreiter *et al.* 2018b), and Kreiter *et al.* (submitted) for description of six new species and six newly collected unknown males, respectively.

During these surveys in Mascareignes, two of the common species were *Scapulaseius asiaticus* (Evans) and *S. reptans* (Blommers). Authors have mentioned that these two species are morphologically very close (Ferragut and Baumann 2019; Kreiter and Abo-Shnaf 2020b).

The objective of this paper is to test the hypothesis of synonymy between these two species of the genus *Scapulaseius*, suspected by Ferragut and Baumann (2019) and Kreiter and Abo-Shnaf (2020b) after surveys in Mauritius Island.

Material and methods

The material examined comes from several surveys conducted by the senior author and from the type specimens of both species borrowed from the respective collections.

Surveys were done in La Réunion Island in 2016-2017 (see Kreiter *et al.* 2020c), in Vietnam in 2017 (Kreiter *et al.* 2020b), in Mauritius Island in 2017 (see Kreiter *et al.* 2018a) and in 2018 (see Ferragut and Baumann 2019 and Kreiter and Abo-Shnaf 2020b). Specimens were collected from cultivated and wild plants in several locations. Mites were directly collected on leaves with a fine brush or by beating the plants and collecting the mites in a black plastic rectangular saucer 45 x 30 cm (Ref. STR 45, BHR, 71370 Saint-Germain-du-Plain, France), depending on the plant investigated:

- large leaves of shrubs and trees with the direct collection method or by beating;
- very small leaves, spiny shrubs, trees and herbaceous plants with the beating method.

We transferred the mites with a brush into small plastic vials containing 1.5 ml of 70% ethanol. The mites were then all slide-mounted in Hoyer's medium (Walter and Krantz 2009), the slides were dried at 45-50°C for at least two weeks and then all examined and identified using a phase and interferential contrast microscope (DMLB, Leica Microsystèmes SAS, Nanterre, France). We used a graded eyepiece for measuring characters of specimens (Leica, see above).

Moreover, the following type and additional material have been borrowed and studied:

- The holotype, two paratype females and one paratype male of ***Scapulaseius asiaticus* (Evans)**, from the reference collection of the National History Museum (NHM), Department of Life Sciences (Entomology), Cromwell Road, London SW7 5BD, United Kingdom;
- The holotype, four paratype females, two paratype males, 17 additional female and four additional male specimens as additional material of ***Scapulaseius reptans* (Blommers)**, housed in the mites reference collection of the Naturalis Biodiversity Center, Darwinweg 2, 2333 CR Leiden, The Netherlands.

Chant and McMurtry's (1994, 2007) concepts of the taxonomy of the family Phytoseiidae and the world catalogue database of Demite *et al.* (2014, 2021) were used for identification and for distribution and information on descriptions and re-descriptions, respectively. The setal nomenclature system adopted was that of Lindquist and Evans (1965) and Lindquist (1994) as adapted by Rowell *et al.* (1978) and Chant and Yoshida-Shaul (1992) for the dorsum and by Chant and Yoshida-Shaul (1991) for the venter. Pore (= solenostome) and poroid (= lyrifissure) notations are that of Athias-Henriot (1975). Macrosetal notation (***Sge*** = genual macroseta; ***Sti***

= tibial macroseta; ***St*** = tarsal macroseta) are that of Muma and Denmark (1970). Numbers of teeth on the fixed and movable cheliceral digits do not include the respective apical teeth. Setae not referred to in results section should be considered as absent. All measurements are given in micrometres (µm) and presented with the mean in bold followed by the range in parenthesis. Classification of plants follows the APG IV classification of 2016 (ex. Byng *et al.* 2018).

Specimens of each species are deposited in the mite collections of Montpellier SupAgro conserved in UMR CBGP INRA/IRD/CIRAD/IA-SupAgro/University of Montpellier.

The following abbreviations are used in Tables 1 and 2 for morphological characters: **dsl** = dorsal shield length just anteriad of *j1* to just posteriad of *J5* in the middle line; **Dsw (*s4* level)** = dorsal shield width at setae *s4* level; **Perit. Reaching**: peritreme reaching the level of; gd: number of solenostomes; **PP-DS fusion at.** = Level of the fusion between peritremal plate and dorsal shield; **DS gd**: nature of solenostomes present on the dorsal shield; ***Z4* ser or not**, ***Z5* ser. or not** = *Z4*, *Z5* serrated or not serrated; **gensl** = genital shield length; **gensw post. cor.** = genital shield width posteriorly; **lisl** = Largest inguinal sigilla (= "metapodal plate″) length; **lisw** = Largest inguinal sigilla (= "metapodal plate″) width; **sisl** = smallest inguinal sigilla (= "metapodal plate″) length; **sisw** = smallest inguinal sigilla (= "metapodal plate″) width; **vsl** = ventrianal shield length; ***gv3* - *gv3*** = distance between solenostomes *gv3* on the ventrianal shield; **vsw *ZV2* & vsw anus** = ventrianal shield width at *ZV2* level and at paranal setae level; ***JV5* ser. or not** = *JV5* serrated or not; **Shape of MS**: shape of macrosetae; **scl.**: calyx length; **scw** = calyx widest width; **Fdl** = fixed digit length; **Mdl** = movable digit length; **Nb teeth Fd** = number of teeth on the fixed digit; **Nb teeth Md** = number of teeth on the movable digit; **Shaft** = length of the shaft of spermatodactyl; **toe** = length of the toe, the branch of spermatodactyl; **BCA** = Biological control agents; **aasl** = altitude above sea level; **imm.**: immature.

The following abbreviations are used in this paper for institutions: **CBGP** = Centre de Biologie pour la Gestion des Populations; **CIRAD** = Centre International de Recherche Agronomique pour le Développement; **IA** = Institut Agro; **INRAE** = Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement; **IRD** = Institut de Recherche pour le Développement; **MSA** = Montpellier SupAgro, France; **UMR** = Unité Mixte de Recherche.

Results and discussion

Taxonomy, biological characteristics and biogeography

Tribe Typhlodromipsini Chant & McMurtry

Typhlodromipsini Chant & McMurtry 2005: 318.

Genus *Scapulaseius* Karg & Oomen-Kalsbeek

Scapulaseius Karg & Oomen-Kalsbeek 1987: 132; Chant & McMurtry 2005: 331, 2007: 65.

Scapulaseius asiaticus (Evans)

Typhlodromus asiaticus Evans 1953: 461.
Typhlodromus (*Amblyseius*) *asiaticus,* Chant 1959: 80.
Amblyseius (*Typhlodromopsis*) *asiaticus,* Muma 1961: 289.
Amblyseius (*Amblyseius*) *asiaticus,* Ehara 1966: 20; Ehara & Bhandhufalck 1977: 58.
Amblyseius asiaticus, Carmona 1968: 280; Gupta, 1975: 32.
Amblyseius (*Neoseiulus*) *asiaticus,* Ehara 2002: 127.
Typhlodromips asiaticus, Moraes *et al.* 1986: 137, 2004b: 207.
Scapulaseius asiaticus, Chant & McMurtry 2005: 335, 2007: 67.
Scapulaseius linearis Corpuz & Rimando 1966: 125 (synonymy according to Schicha & Corpuz-Raros 1992).

Scapulaseius siaki Ehara & Lee 1971: 64 (synonymy according to Ehara & Bhandhufalck 1977).

According to the genus concept by Chant and McMurtry (2005), this species belongs to the *asiaticus* species group of the genus *Scapulaseius* as setae *R1* are inserted on the lateral margin of the dorsal shield of the adult female. The species group comprises 24 species. Species of the genus *Scapulaseius* are supposed to belong to the life-type III (McMurtry and Croft 1997; McMurtry *et al.* 2013), i.e. a polyphagous generalist predator. Evans (1953) has indicated that the specimens collected were feeding in colonies of tetranychid mites. Despite these qualitative observations on the group, the biology of *S. asiaticus* itself remains totally unknown. The material examined had been collected in Java Island, Indonesia (Evans 1953), in Mauritius Island (Kreiter and Abo-Shnaf 2020b; Ferragut and Baumann 2019) and in Vietnam (Kreiter *et al.* 2020b).

World distribution Angola, China, Cyprus, Hong Kong, India, Indonesia, Malaysia, Mauritius Island, Philippines, Singapore, Sri Lanka, Thailand, Vietnam.

Specimens examined 33 ♀♀, 6 ♂♂ and 2 imm. in total. **INDONESIA** (3 ♀♀ and 1 ♂): **Bogor** (Java) (aasl 265 m on average, 6°21′36″ S, 106°28′48″ E), 1 ♀ (**holotype, slide n° 1952-10-10.1**), 1 ♂ (**paratype male, slide n°1952-10-10-2)** and 1 ♀ (**paratype, slide n° 1952-10-10.3**) on *Gossypium hirsutum* L. (Malvaceae), XI/1951; **MALAYSIA**: **Kuala Lumpur** (aasl 66 m on average, 101°41′36″ E, 3°8′27″ N), 1 ♀ (**paratype, slide n° 1952-10-10.4**) on an unknown host plant (collected by A. Newsam), 1952; **MAURITIUS** (23 ♀♀ and 5 ♂♂): **Côte d'Or**, Village (aasl 443 m, 57°32′21″ E, 20°15′26″ S), 2 ♀♀ on *Clibadium surinamense* L. (Asteraceae), 28/X/2018; **Curepipe**, Trou aux cerfs (aasl 593 m, 57°30′47″ E, 20°19′04″ S), 1 ♀ on *Rubus apetalus* Poiret (Rosaceae), 29/X/2018; **Mare aux Vacoas** (aasl 572 m, 57°29′59″ E, 20°21′40″ S), 11 ♀♀ on *Tibouchina heteromalla* Cogniaux (Melastomataceae) and 2 ♀♀ on *Litsea monopetala* (Roxburgh) Person (Lauraceae), 30/X/2018; **Quartier Militaire** (aasl 472 m, 57°36′05″ E, 20°19′11″ S), 1 ♀ on *Clidemia hirta* (L.) D. Don (Melastomataceae), 1/XI/2018; **Curepipe**, Bld Pasteur (aasl 510 m, 57°31′45″ E, 20°19′21″ S), 1 ♀ on *Ageratum conyzoides* L. (Asteraceae), 4/XI/2018; **Curepipe**, Anderson street (aasl 560 m, 57°31′52″ E, 20°19′11″ S), 5 ♀♀ and 3 ♂♂ on *Erigeron canadensis* (L.) Cronquist (Asteraceae) and 3 ♀♀ and 2 ♂♂ on *Sonchus oleraceus* L. (Asteraceae), 4/XI/2018; **Mare aux Vacoas** (aasl 581 m, 57°29′31″ E, 20°22′05″ S), 1 ♀ on *Ludwigia octovalvis* (Jacquemin) P.H.Raven (Onagraceae), 5/XI/2018; **VIETNAM** (7 ♀♀ and 2 imm.): **Ma**, in P1 plot (aasl 63 m, 105°1′28″ E, 21°45′53″ N), 1 ♀ on *Chromolaena odorata* (L.) King and Robinson (Asteraceae), 9/V/2017; **Muoi**, in P7 plot (aasl 66 m, 104°38′22″ E, 21°54′51″ N), 1 ♀ on *Crassocephalum crepidioides* (Bentham) Moore (Asteraceae), 16/V/2017; in P9 plot (aasl 66 m, 104°38′18″ E, 21°54′46″ N), 1 ♀ on an unknown plant support, 18/V/2017; in P11 plot (aasl 66 m, 104°38′14″ E, 21°54′30″ N), 1 imm. on *C. odorata* (Asteraceae), 31/V/2017; in P15 plot (aasl 66 m, 104°38′46″ E, 21°54′56″ N), 1 ♀ on *C. odorata* (Asteraceae), 31/V/2017; in P8 plot (aasl 66 m, 104°38′9″ E, 21°54′46″ N), 2 ♀♀ and 1 imm. on *Xanthium strumarium* L. (Asteraceae), 2/VI/2017; in P13 plot (aasl 66 m, 104°38′46″ E, 21°54′50″ N), 1 ♀ on *X. strumarium* (Asteraceae), 29/VII/2017.

Scapulaseius reptans (Blommers)

Amblyseius (*Amblyseius*) *reptans* Blommers 1974: 145.
Typhlodromips reptans, Moraes *et al.* 1986: 146; Moraes *et al.* 2004b: 222.
Scapulaseius reptans, Chant & McMurtry 2005: 335; Chant & McMurtry 2007: 68.

Scapulaseius reptans appears to belong to the *ficilocus* species group of the genus *Scapulaseius* as the setae *R1* are inserted on lateral integument of adult female and not on dorsal shield (Chant and McMurtry 2005). This species group contains 40 species.

This species is mentioned only from the Indian Ocean area, Madagascar (Blommers 1974), La Réunion (Quilici *et al.* 2000) and recently Mauritius (Kreiter *et al.* 2018a). Species of this genus *Scapulaseius* are supposed to be of type III (McMurtry and Croft 1997; McMurtry *et*

al. 2013), i.e. polyphagous generalist predators. However, the biology of *S. reptans* remains unknown.

World distribution La Réunion Island, Madagascar, Mauritius Island.

Specimens examined 26 ♀♀ and 9 ♂♂ in total. **LA RÉUNION ISLAND** (2 ♀♀, 1 ♂ and 1 imm.): **Ravine Langevin,** Grand-Galet Waterfall (aasl 850 m, 55°21′33″ E, 21°17′47″ S), 1 ♀ and 1 ♂ on *Desmodium incanum* De Candolle (Fabaceae), 11/12/2016; **Petite Île**, Piton Bloc, Yébo Luguy farm (aasl 973 m, 55°34′64″ E, 21°18′64″ S), 1 ♀ and 1 imm. on *Lantana camara* L. (Verbenaceae), 9/1/2017. **MADAGASCAR** (22 ♀♀ and 7 ♂♂): **Tamatave city**, 1 ♀ (**holotype**), 4 ♀♀ and 3 ♂♂ (**paratypes**), and 8 ♀♀ and 4 ♂♂ (**additional material**) on *Psidium guajava* L. (Myrtaceae), 28/VII/1972; **Tamatave Ivoloina**, 3 ♀♀ (**additional material**) on *Rubus* sp., 25/VII/1972, 1 ♀ (**additional material**) on *Pueraria phaseoloides* (= *javanica*) (Roxburgh) Bentham (Fabaceae), 1/VIII/1972; 3 ♀♀ (**additional material**) on *Passiflora foetida* L. (Passifloraceae), 5/VII/1972 (2 ♀♀) and 24/VII/1972 (1 ♀), 2 ♀♀ (**additional material**) on *Phaseolus lunatus* L. (Fabaceae), 11/II/1972. **MAURITIUS ISLAND** (2 ♀♀ and 1 ♂): **Chamouny** (aasl 128 m, 57°27′58.00″ E, 20°28′55.99″ S), 2 ♀♀ and 1 ♂ on an unknown host plant, 21/IX/2017.

Discussion on the possible synonymy

Scapulaseius asiaticus was described by Evans (1953) under the name *Typhlodromus asiaticus* from specimens collected in Java Island, Indonesia, on cotton *Gossypium hirsutum* L. (Malvaceae) as indicated on slides of the type material. One female was added from Malaysia, Kwala Lumpur, to this type material (Evans 1953).

The closely related *Scapulaseius reptans* (Blommers) was described by Blommers in 1974 from Tamatave (Madagascar) under the name *Amblyseius* (*Amblyseius*) *reptans* from specimens collected on *Psidium guajava* L. (Myrtaceae).

Examination of specimens previously collected

Overall character measurements of females (Table 1) and males (Table 2) collected in various locations (by senior author) are compatible between populations, irrespective of whether they were previously identified as S. asiatcius or S. reptans. Consequently, the morphometrics strongly suggest synonymy.

There are however some discrepancies between our observations and previous descriptions of the two species. In the two descriptions, it is said that:

- dorsal shield is reticulated in the description of *S. reptans* in the anterior lateral margins and on all the posterior part of the dorsal shield except the central area. Reticulations were not included in the original description of *S. asiaticus* by Evans (1953), but were illustrated by Ehara and Bhandhulfalck (1977) and by Ferragut and Baumann (2019, using a photograph, their plate 1D);

- Ehara and Bhandhulfalck (1977) pointed out that seta *R1* is inserted on a lateral projection of the dorsal shield, a feature that Ferragut and Baumann (2019) disagreed on. *Scapulaseius reptans* is morphologically very close to *S. asiaticus*, but with setae *R1* indicated by the author as located off the dorsal shield in the description (Blommers 1974). Taking this trait into consideration as an apomorphic character, Chant and McMurtry (2005) placed the two species within different groups, *S. asiaticus* in the *asiaticus* species group characterized by having *R1* on the dorsal shield and *S. reptans* in the *ficilocus* species group with species bearing *R1* on the lateral integument. However, in *S. asiaticus* the position of this seta is variable even among individuals of the same population. Ehara and Bhandhufalck (1977) were the first to mention this variability. Ferragut and Baumann (2019) examined 19 females from Mauritius with the following results: eleven females (58%) had both *R1* setae on the dorsal shield, four females (26%) had one setae of the pair on

a lateral projection of the shield and the other on the soft integument, and three females (16%) had both setae *R1* on the lateral integument. Although the majority of specimens have both or one seta on the dorsal shield, 16%, having both R1 on the soft integument, is not a negligible proportion;

- A peculiar trait in *S. asiaticus* not mentioned by previous authors and especially by Blom-

Table 1 Previously published adult females character measurements of *Scapulaseius asiaticus* and *S. reptans* compared to character measurements of adult female types and additional material of both species (localities in alphabetic order followed by the number of specimens measured between brackets).

Characters	*Scapulaseius asiaticus* (Evans)								*Scapulaseius reptans* (Blommers)		
	India (10)	**Indonesia-Malaysia** (3) Holo- & Paratypes	**Mauritius 1** (9)	**Mauritius 2** (12)	**Sri Lanka** (1)	**Thailand 1** (1?)	**Thailand 2** (8)	**Vietnam** (7)	**La Réunion Island** (2)	**Madagascar** (22) Holotype, 4 paratypes & 17 addit. mat.	**Mauritius** (2)
Dsl	309 (305–313)	**319** (308–338)	311 (304–315)	310 (293–325)	287	330	301 (283–318)	306 (293–313)	321 (308–335)	**310** (275–333)	303–305
Dsw (*s4* level)	193 (188–198)	**184** (173–200)	191 (182–199)	174 (145–205)	182	230	200 (181–222)	179 (170–188)	210 (198–223)	**187** (163–203)	185–188
Perit. reaching	*j1*	***j1***	*j1*	*j1*	–	–	–	*j1*	*j1*	***j1***	*j1*
PP-DS fusion at.	–	***j3***	*j3*	*j3*	–	–	–	*j3*	*j3*	***j3***	*j3*
DS *gd*	1, 2, 4, 5, 6, 8, 9	**1, 2, 4, 5, 6, 8, 9**	1, 2, 4, 5, 6, 8, 9	1, 2, 4, 5, 6, 8, 9	-	-	-	1, 2, 4, 5, 6, 8, 9	1, 2, 4, 5, 6, 8, 9	**1, 2, 4, 5, 6, 8, 9**	1, 2, 4, 5, 6, 8, 9
j1	21 (19–24)	**22** (20–24)	22 (20–24)	23 (18–25)	19	20	21 (19–23)	21 (18–23)	23 (20–25)	**22** (20–23)	23
j3	19 (17–21)	**15**	17 (15–20)	22 (20–23)	13	18	15 (10–16)	14 (13–15)	25	**20** (15–25)	20–23
j4	10 (8–11)	**9** (8–10)	5	8 (8–9)	8	7	8 (7–10)	8	10	**9** (8–12)	8
j5	10 (8–11)	**8** (8–9)	5	8 (8–9)	8	7	8 (6–10)	8 (6–8)	9 (8–10)	**9** (8–11)	8
j6	13 (11–14)	**11** (10–13)	8 (7–9)	11 (9–13)	9	8	10 (9–12)	9 (8–10)	13 (13–13)	**11** (9–13)	10
J2	12 (11–13)	**12** (10–13)	9 (7–9)	13 (10–15)	9	9	11 (10–12)	9 (8–10)	13 (13–13)	**12** (10–14)	8 – 9
J5	8 (8–9)	**8**	8 (7–8)	8 (8–10)	6	6	8 (7–8)	8 (8–9)	9 (8–10)	**8** (8–9)	8
r3	15 (15–16)	**16** (15–16)	14 (13–14)	19 (18–20)	12	14	13 (11–15)	13 (13–15)	23 (18–28)	**16** (15–18)	18
R1	12 (10–13)	**12** (11–12)	11 (10–12)	13 (11–15)	14	16	16 (14–17)	10 (9–13)	14 (13–15)	**11** (9–13)	13
s4	25 (20–30)	**21** (19–25)	23 (22–25)	27 (25–31)	17	21	21 (18–23)	18 (16–20)	33	**27** (23–33)	28
S2	18 (17–19)	**16** (15–18)	18 (15–20)	22 (19–26)	13	15	16 (13–18)	15 (13–18)	24 (23–25)	**20** (16–25)	22–25
S4	16 (16–17)	**14** (13–15)	15 (13–17)	19 (16–20)	12	13	14 (11–15)	12 (10–13)	20	**18** (14–22)	18–23
S5	15 (14–16)	**14** (14–15)	14 (13–15)	17 (15–20)	11	13	14 (12–19)	13 (10–15)	20 (18–23)	**16** (13–21)	18–20
z2	17 (15–18)	**14** (14–15)	15 (13–16)	18 (15–20)	11	13	14 (13–15)	12 (10–15)	21 (20–23)	**19** (15–23)	18–20
z4	19 (18–20)	**17** (15–18)	18 (16–19)	20 (18–23)	11	11	11 (7–13)	13 (10–15)	25 (25–25)	**19** (15–28)	23
z5	11 (10–12)	**9** (9–10)	7 (6–9)	10 (8–12)	7	9	9 (8–11)	8 (7–10)	10	**9** (8–10)	8
Z1	11 (9–12)	**10**	9 (8–9)	12 (9–13)	–	11	11 (10–12)	10 (7–13)	13	**11** (9–13)	10
Z4 **ser. or not**	49 (47–52) ser.	**52** (45–56) **ser.**	47 (44–52) ser.	54 (49–58) ser.	45	51	52 (49–58)	50 (47–55) ser.	61 (60–63) ser.	**51** (46–59) **ser.**	56–63 ser.
Z5 **ser. or not**	76 (73–79), ser.	**77** (75–79), **ser.**	73 (65–77), ser.	77 (74–84), ser.	68	73	74 (70–83)	77 (75–80) ser.	79 (75 – 83) ser.	**75** (73–80) **ser.**	72–75 ser.
st1–st1	–	**49** (48–50)	–	51 (48–53)	–	–	–	50 (48–50)	50	**48** (46–50)	50
st2–st2	60 (60–61)	**60** (59–61)	57 (55–60)	59 (55–63)	52	–	59 (57–61)	58 (55–60)	60 (58–63)	**60** (55–65)	60
st3–st3	61 (60–62)	**65** (65–66)	–	64 (58–70)	–	–	–	61 (55–65)	66 (63–70)	**61** (58–63)	65
st1–st3	56 (56–57)	**58** (55–59)	53 (52–54)	55 (53–56)	48	–	54 (50 – 58)	53 (50–55)	56 (55–58)	**52** (50–58)	53–56
st4–st4	–	**68** (63–73)	–	60 (50–70)	–	–	–	65 (56–83)	79 (73–85)	**64** (60–70)	65–78
Gensl	–	**117** (108–125)	98 (96–101)	112 (100–125)	–	–	–	101 (90–113)	105–108	**105** (98–115)	100–105
st5–st5	57 (57–58)	**60** (54–63)	61 (55–65)	60 (55–64)	54	–	61 (58–64)	59 (55–63)	61 (60–63)	**61** (53–69)	60
Gensw post. corn.	–	**72** (68–75)	71 (60–74)	78 (60–83)	–	–	–	69 (65–80)	70–78	**73** (68–81)	78
Lisl	19 (18–20)	**17** (14–19)	–	18 (15–20)	–	–	–	16 (13–18)	20 (18–23)	**18** (20–22)	18–23
Lisw	12 (12–13)	**5** (4–5)	–	3 (2–4)	–	–	–	3 (2–5)	5	**5**	4–5
Sisl	–	**11** (10–12)	–	10 (8–13)	–	–	–	10	11 (10–13)	**12** (10–15)	10–13
Sisw	–	**2** (1–3)	–	2 (1–3)	–	–	–	2 (1–2)	2 (1–2)	**2** (2–3)	2
Vsl	102 (100–103)	**116** (105–125)	99 (95–101)	103 (93–115)	97	–	103 (97–110)	102 (95–110)	115 (115–115)	**105** (98–110)	98–100
Vsw *ZV2*	78 (78–79)	**86** (84–88)	81 (77–84)	85 (78–90)	79	–	84 (80–87)	82 (78–90)	81 (78–85)	**85** (80–91)	85–87
Vsw anus	66 (65–67)	**71** (68–73)	67 (61–74)	70 (60–74)	65	–	–	64 (50–73)	75 (75–75)	**68** (64–74)	68–70
gv3–gv3	–	**20** (18–21)	20 (16–23)	20 (19–23)	–	–	–	22 (19–25)	20–21	**21** (20–22)	20–21
JV5 **ser. or not**	27 (25–30) not	**25** (20–30) **not**	26 (22–28) not	30 (28–35) not	–	19	–	23 (20–25) not	34 (33–35) not	**28** (20–33) **not**	28 not
SgeI	–	**18** (15–20)	18 (16–19)	25 (20–30)	–	–	17 (15–20)	16 (15– 20)	24 (23–25)	**21** (18–27)	23
SgeII	–	**12** (10–13)	12 (10–13)	17 (13–20)	–	–	11 (8–13)	12 (10–15)	15	**13** (11–16)	13–15
SgeIII	–	**17** (16–18)	15 (13–17)	17 (13–25)	14	–	17 (15–18)	17 (15–19)	19 (18–20)	**17** (15–20)	18
StiII	–	**17** (15–18)	–	17 (13–23)	15	–	–	15 (13–18)	18 (15–20)	**17** (15–18)	18
SgeIV	29 (27–31)	**28** (25–30)	26 (24–29)	29 (25–33)	22	27	27 (24–30)	28 (25–30)	31 (30–33)	**28** (23–35)	28
StiIV	23 (19–26)	**22** (20–24)	20 (18–23)	24 (22–25)	18	22	22 (18–26)	22 (20–24)	28 (28–28)	**22** (19–25)	23–25
StIV	49 (47–51)	**52** (48–55)	49 (44–53)	53 (48 – 58)	45	50	49 (44–52)	50 (48–50)	59 (55–63)	**52** (47–60)	50–53
Shape of MS	Pointed	**Thick, knobbed tips**	Thick, knobbed tips	Thick, knobbed tips	–	–	–	Thick, knobbed tips	Thick, knobbed tips	Thick, knobbed tips	Thick, knobbed tips
Scl	–	**32** (23–40)	33 (29–34)	28 (25–33)	27	-	35 (29–40)	30 (28–35)	30	**39** (33–45)	30–35
Scw	–	**13** (11–14)	–	12 (8–15)	–	–	–	11 (8–18)	10	**15** (13–17)	2
Fdl, No teeth	24 (24–25), 11	**28** (27–28), **9**	26 (24–27), 9	24 (23–25), 9	–	–	22 (21–23)	25 (23–28), 9	28 (25–30), 10	**24** (20–26), **9**	25, 9
Mdl, No teeth	26 (26–27), 3	**26** (26–27), **3**	27 (25–29), 2–3	25 (23–28), 3	–	–	25 (23–25)	25 (23–28), 3	23 (20–25), 3	**26** (25–28), **3**	25, 3

Sources of measurements:

Scapulaseius asiaticus **– Original description Indonesia:** Evans (1953) but measured in this study by the senior author; **Mauritius 1:** Ferragut & Baumann (2019); **Mauritius 2:** Kreiter & Abo-Shnaf (2020b); **Sri Lanka:** Moraes *et al* . (2004a); **Thailand 1:** Ehara & Bhandhufalck (1977); **Thailand 2:** Oliveira *et al.* (2012); **Vietnam**: Kreiter *et al.* (2020b);

Scapulaseius reptans **– La Réunion Island:** Kreiter *et al.* (2020c); **Original description Madagascar:** Blommers (1974) but measured in this study by the senior author; **Mauritius:** Kreiter *et al.* (2018a).

– : not provided.

mers (1974) for *S. reptans* is the position of the dorsal solenostome *gd3*. Ferragut and Baumann (2019) stated that while in females of the family Phytoseiidae, this solenos-

Table 2 Previously published adult male character measurements of *Scapulaseius asiaticus* and *S. reptans* compared to character measurements of adult male paratypes and additional material of both species (localities in alphabetic order followed by the number of specimens measured between brackets).

Characters	*Scapulaseius asiaticus* (Evans)					*Scapulaseius reptans* (Blommers)		
	India (6)	**Indonesia** (1) Paratype	**Mauritius** (5)	**Thailand 1** (?)	**Thailand 2** (1)	**La Réunion Island** (1)	**Madagascar** (6) 3 paratypes & 4 additional mat.	**Mauritius** (1)
Dsl	277 (275–280)	**240**	250 (245–258)	240	237	250	**245** (240–250)	255
Dsw (*s4* level)	184 (183–185)	**185**	137 (133–143)	160	175	150	**178** (169–200)	175
Perit. reaching	*j1*	***j1***	*j1*			*j1*	***j1***	*j1*
PP-DS fusion at.	–	***J3***	*J3*			*J3*	***J3***	*J3*
DS *gd*	gd 1, 2, 4, 5, 6, 8, 9	**gd 1, 2, 4, 5, 6, 8, 9**	gd 1, 2, 4, 5, 6, 8, 9			gd 1, 2, 4, 5, 6, 8, 9	**gd 1, 2, 4, 5, 6, 8, 9**	gd 1, 2, 4, 5, 6, 8, 9
j1	18 (16–20)	**19**	20 (18–22)	17	17	15	**20** (19–21)	18
j3	25 (25–26)	**16**	19 (18–20)	18	16	20	**20** (15–23)	25
j4	8 (6–9)	**9**	8 (8–9)	7	7	10	**7** (7–8)	10
j5	9 (8–10)	**6**	8	7	8	8	**8** (7–9)	10
j6	10 (10–11)	**8**	9 (8–9)	8	8	10	**9** (9 – 10)	10
J2	12 (10–14)	**10**	10 (10–11)	9	10	13	**10** (9–10)	10
J5	7 (5–9)	**7**	7 (6–8)	6	7	5	**8**	6
r3	14 (13–15)	**14**	16 (15–18)	13	15	15	**16** (14–20)	15
R1	10 (9–11)	**10**	13 (12–14)	12	10	13	**13** (10–15)	13
s4	18 (16–20)	**20**	23 (20–26)	20	20	28	**24** (20–28)	25
S2	11 (10–12)	**15**	20 (18–23)	15	15	20	**20** (18–22)	10
S4	11 (10–12)	**14**	18 (14–20)	13	13	20	**16** (15–18)	10
S5	8 (8–9)	**13**	16 (13–18)	12	12	18	**16** (13–18)	9
z2	10 (8–12)	**15**	16 (15–18)	13	13	23	**17** (15–20)	13
z4	13 (12–14)	**15**	19 (18–19)	16	15	20	**19** (15–22)	13
z5	8 (6–10)	**6**	8 (7–9)	8	9	8	**8**	10
Z1	12 (12–13)	**9**	10 (9–10)	10	10	10	**10** (9–11)	13
***Z4* ser.**	33 (30–35)	**30 ser.**	38 (35–40)	34	35	40	**36** (33–39)	33
***Z5* ser.**	55 (53–57)	**45 ser.**	54 (53–55)	47	50	58	**53** (45–56)	50
st1-st1	–	**45**	44 (43–45)	–	–	30	**42** (34–45)	47
st2-st2	–	**53**	49 (48–50)	–	–	53	**49** (43–53)	53
st3-st3	–	**51**	47 (43–48)	–	–	50	**46** (44–49)	55
st1-st5	–	**101**	101 (100–103)	–	–	78	**99** (95–103)	105
st4-st4	–	**38**	35 (30–38)	–	–	38	**36** (35–38)	40
st5-st5	–	**30**	32 (30–35)	–	–	38	**32** (29–34)	35
Vsl	112 (110–113)	**95**	107 (100–113)	–	104	100	**110** (105–115)	113
Vsw *ZV2*	112 (110–113)	**135**	113 (108–120)	–	140	133	**138** (134–143)	135
Vsw *anus*	54 (53–55)	**68**	53 (48–60)	–	–	75	**64** (54–68)	60
gv3 –gv3	–	**16**	20 (19–23)	–	–	17	**15** (14–16)	18
JV5	–	**18 not**	19 (18–20) not	19	–	18	**20** (16–23) **not**	20
SgeI	–	**15**	19 (18–20)	–	15	25	**18** (16–23)	25
SgeII	–	**10**	13	–	8	15	**12** (9–14)	20
SgeIII	–	**20**	16 (15–18)	–	12	18	**13** (12–14)	25
StiIII	–		17 (15–18)	–	–	–	**13** (12–14)	20
SgeIV	33 (30 – 35)	**20**	21 (18–23)	19	21	25	**22** (18–25)	35
StiIV	27 (26 – 28)	**18**	20 (18–21)	17	19	23	**19** (16–22)	20
StIV	40 (38 – 43)	**39**	45 (43–48)	44	42	45	**47** (41–53)	48
Shape of MS	–	–	Thick, knobbed tips	–	–	Thick, knobbed tips	**Thick, knobbed tips**	Thick, knobbed tips
Fdl, No teeth Fd	–	**20, 8**	20 (18–20), 8	–	19	20, 8	**21** (18–23), **8**	20, 8
Mdl, No teeth Md	–	**20, 1**	20 (18–22), 1	1–	21	23, 1	**21** (20–23), **1**	23, 1
Shaft	15 (15 – 16)	**14**	16 (15–17)	–	14	15	**14** (14–15)	17
Toe or branch	–	**5**	5	–	–	5	**6** (5–7)	5

Sources of measurements:

Scapulaseius asiaticus – **India:** Karmakar & Bhowmik (2018); **Original description Indonesia:** Evans (1953) but measured in this study by the senior author; **Mauritius:** Kreiter & Abo-Shnaf (2020b); **Thailand 1:** Ehara & Bhandhufalck (1977); **Thailand 2:** Oliveira *et al.* (2012);

Scapulaseius reptans – **La Réunion:** Kreiter *et al.* (2020c); **Madagascar:** Blommers (1974); **Mauritius:** Kreiter *et al.* (2018a).

– : not provided.

tome is usually located on the peritremal plate, in *S. asiaticus*, it is on the soft lateral integument, between the peritremal and dorsal shields, posterior to setae *r3* and close to the margin of dorsal shield.

Our examination of the material collected in Mauritius and Vietnam (Kreiter *et al* 2020b) and identified as *S. asiaticus* and of the material collected in Mauritius (Kreiter *et al.* 2018a) and in La Réunion (Kreiter *et al.* 2020c) and identified as *S. reptans* along with the original descriptions of *S. asiaticus* and *S. reptans* shows that:

- Re-examination of our specimens from La Réunion (Kreiter *et al.* 2020c) and of Mauritius (Kreiter *et al.* 2018a) point out that the dorsal shields of the two species present exactly the same reticulation as drawn by Blommers (1974) for the description of *S. reptans* and in Ehara and Bhandhulfalck (1977) for the redescription of *S. asiaticus*;
- In our 27 specimens females of Mauritius (Kreiter and Abo-Shnaf 2020b), we have 21 females out of 27 (77.8%) with *R1* on the dorsal shield, four females / 27 (14.8%) with one of these setae on and the other one off shield and two females / 27 (7.4%) with setae *R1* both off shield, compared to above mentioned data of Ferragut and Baumann (2019), respectively. In specimens from Vietnam (Kreiter *et al.* 2020b), we had four females out of seven (57.1%) with *R1* on the dorsal shield, only one female / seven (14.3%) with one of these setae on and the other one off shield and two females / seven (28.6%) with setae *R1* both off shield. In the two specimens from Mauritius (Kreiter *et al.* 2018a), both specimens have *R1* on the dorsal shield, and in the two female specimens from La Réunion (Kreiter *et al.* 2020c), one specimen has both *R1* on the dorsal shield, but the other specimens have one seta on and the other one off the dorsal shield.
- solenostomes *gd3* are on integument in all our specimens from Mauritius (this study), from Vietnam (Kreiter *et al.* 2020b), but also on those from Mauritius (Kreiter *et al.* 2018a) and La Réunion (Kreiter *et al.* 2020c) previously identified as *S. reptans*.

Despite the confinement during the Covid-19 pandemic (2020-2021), as we were strongly suspecting that *S. reptans* is a junior synonym of *S. asiaticus*, just like Ferragut and Baumann (2019) did, we have however managed to borrow type material (and in case of *S. reptans* some additional material) of both species in 2021.

Examination of type material from both species

Results of the study of the type material of both sexes of both species (Tables 1 and 2) indicate that:

(1) Examination of respective female specimens belonging to *S. asiaticus* and *S. reptans* shows very little differences in character measurements: *j3*, *z2*, *s4*, *S2*, *S4* and *S5* are slightly longer in *S. reptans* and genital and ventrianal shields longer in *S. asiaticus* but these details have to be taken cautiously as we have only three specimens of *S. asiaticus vs.* 22 specimens of *S. reptans*. The dorsal shields of specimens of the two species present exactly the same reticulation as drawn by Blommers (1974) for the description of *S. reptans* and in Ehara and Bhandhulfalck (1977) for the redescription of *S. asiaticus*;

(2) Examination of respective male specimens belonging to *S. asiaticus* and *S. reptans* shows also very little differences in character measurements: the same setae than female, *j3*, *z2*, *s4*, *S2*, *S4* and *S5* with in addition *Z4*, *Z5, StIV* and the length of ventrianal shield are slightly longer in *S. reptans*. But these details have also to be taken very carefully as we have only one paratype specimen of *S. asiaticus vs.* 7 specimens of *S. reptans*;

(3) Examination of respective female and male specimens belonging to both species shows only very little differences with specimens previously collected and identified as one of the two species (Tables 1 and 2);

(4) While type specimen females of *S. asiaticus* have setae R1 on the dorsal shield, in type specimen females of *S. reptans*, we have 11 females out of 22 (**50%**) with *R1* on the dorsal shield, six females / 22 (**27%**) with one of these setae on and the other one off shield and five females / 22 (**20%**) with setae *R1* both off shield, compared to **58**, **26** and **16%** for Mauritius specimens (Ferragut and Baumann 2019), to **77.8%**, **14.8%** and **7.4%** for other Mauritius specimens (Kreiter and Abo-Shnaf 2020b), and to **57.1%**, **14.3%**, and **28.6%** for Vietnam specimens (Kreiter *et al.* 2020), respectively. In the two specimens from Mauritius (Kreiter *et al.* 2018a), both specimens have *R1* on the dorsal shield. And in the two female specimens from La Réunion (Kreiter *et al.* 2020c), one specimen has both *R1* on the dorsal shield, but the other specimens have one seta on and the other one off the dorsal shield.

(5) Solenostomes *gd3* are on integument in all specimens of *S. asiaticus* and all specimens *of S. reptans*;

(6) Except for specimens from India and La Réunion (Table 1), specimens of both species have the same number of teeth and the same shape of terminal tips of macrosetae;

(7) A double-blind identification by one of us with all label hidden conducted to exactly half *S. asiaticus* and half *S. reptans* using all available type and collected specimens.

Conclusion on the synonymy

Given this variability in *S. asiaticus* and *S. reptans,* we agree with Ferragut and Baumann (2019) that *S. reptans* represent a junior synonym of *S. asiaticus*. The holotype of *S. reptans* has setae *R1* on the dorsal shield, whereas many type specimens and additional specimens have setae *R1* on or off the shield, or both (asymetry) as indicated before. This character is thus quite variable, even if the majority (> 50%) of specimens of both described taxa have setae *R1* on the dorsal shield.

Setal measurements and other morphological features of the specimens collected from Indonesia, Malaysia, Madagascar, La Réunion Island, Mauritius and Vietnam agree well with both, with those of the original description and subsequent redescriptions of *S. asiaticus* by Ehara and Bhandhufalck (1977), Moraes *et al.* (2004a), Oliveira *et al.* (2012), Karmakar and Bhowmik (2018) and Ferragut and Baumann (2019); as well as with the morphological data provided in the original description and the redescriptions of *S. reptans* given by Kreiter *et al.* (2018a, 2020c).

Considering all this information and new examination of type and additional material, we can conclude that our specimens from Mauritius (Kreiter *et al.* 2018a, Kreiter and Abo-Shnaf 2020b) and from La Réunion (Kreiter *et al.* 2020c) must be all named *S. asiaticus*. Previous specimens collected in La Réunion Island (Kreiter *et al.* 2020d) and in Mauritius Island (Kreiter *et al.* 2018a, Kreiter and Abo-Shnaf 2020b) and previously identified as *S. reptans* are thus consequently belonging all to the unique valid species, *S. asiaticus*.

The logical outcome of our findings is that the division of the genus *Scapulaseius* into two species groups based on the position of setae *R1* (on vs off the shield) is not supported. We have only examined two of the species in the genus, but our observations reveal a wide variability in the placement of R1, which is evident in a reduced number of individuals and even on the same specimen. This variability does not seem to be local or restricted to a part of the geographical range of the species. Instead, we have observed the three possible patterns (*R1* on the dorsal shield, *R1* off the shield, one member of the pair on and the other one off the shield) on females collected in the extremes of the geographical area of distribution, Mauritius Island and Vietnam, and in the type series of *S. reptans* collected by Blommers in Eastern Madagascar.

Furthermore, in those females with *R1* on the shield, the insertion of these setae is marginal and small deviations in the development of the dorsal shield may lead indistinctly to one of the three patterns observed or, as Chant and McMurtry (2005) mentioned for other *Scapulaseius* species, to the setal placement on a lateral projection of the dorsal shield.

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