TDK THESIS

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Molecular and morphological analysis of tropical jumping spiders of the genus Maltecora Simon, 1909.

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List of Abbreviations

Table 1: List of abbreviations.

Morphological Abbreviations			
AAB	Anterior apophyseal branch	**PEB**	Posterior epigynal border
AB	Apophyseal bump	**PLE**	Posterior lateral eyes
AME	Anterior media eyes	**PME**	Posterior median eyes
CD	Copulatory duct	**RES**	Sperm reservoir
CO	Copulatory openings	**RH**	Retrolateral tibial apophysis holder
CY	Cymbium	**RTA**	Retrolateral tibial apophysis
EM	Embolus	**S**	Spermatheca
EP	Epigynal pocket	**TE**	Tegulum
PAB	Posterior apophyseal branch	**TI**	Tibia

The nomenclature of morphological terms follows mainly Szűts (Wesołowska and Szűts, 2021), but the discovery of new morphological features of the specimens, especially on the copulatory organs, requires new terms and a quick explanation of these terms. The male copulatory organ's retrolateral apophysis, the RTA, has two characteristic processes, called the anterior apophyseal branch (AAB) and posterior apophyseal branch (PAB) (Fig. 1.), and their shape is characteristic between different species. The female copulatory organ, the

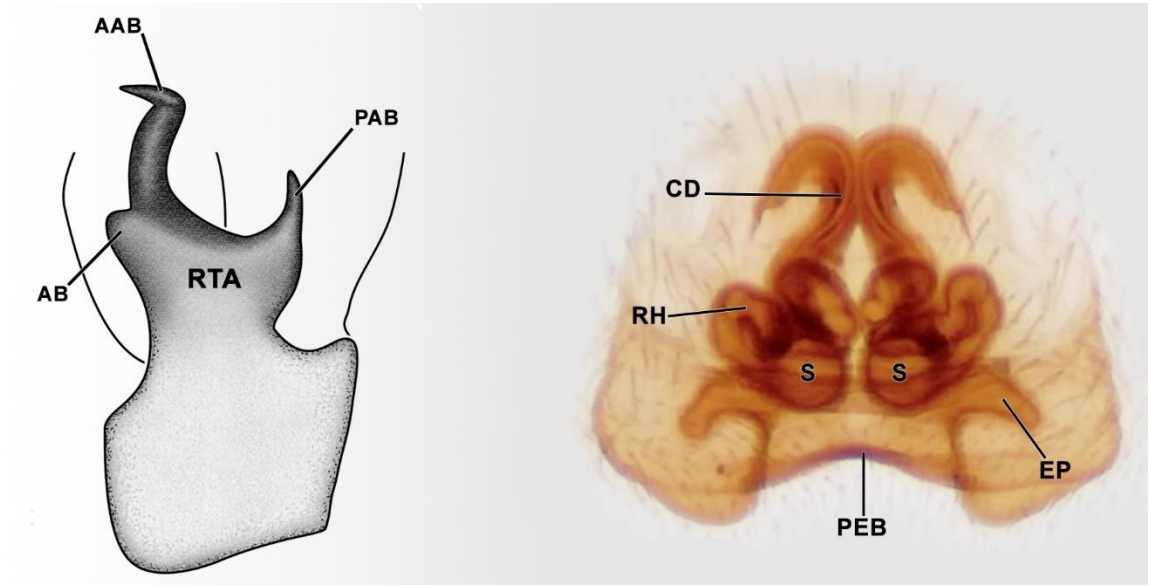

Figure 1: Explanation of the terms used to describe the male palp and female vulva.

vulva consists of a pair of copulatory openings (CO), copulatory ducts (CD) leading to the spermatheca (S). A more-or-less retangular area, epigynal pocket (EP). The RTA of the male is hold onto place by the retrolateral tibial apophysis holder (RH). All the vulva structures are located above the posterior epigynal border (PEB).

Introduction

Spiders as generalist terrestrial invertebrate predators are using a plethora of hunting tactics are one of the most skilful arthropod predators (Nentwig, 2012). As dominant arthropod inhabitants of every terrestrial ecosystem, consuming about 800 million tons of insects (Nyffeler and Birkhofer, 2017) they have an important role in keeping insect populations stable (Nyffeler et al., 1994). In addition to their natural control-role, spiders are often beneficial to industrial agriculture since they provide an eco-friendly solution for insect pest control (Norma-Rashid et al., 2014). With 50 000 species known today, spiders are the second largest order of Arachnida (Gloor et al., 2017). One-eighth of this diversity belongs to a single family, the Salticidae (Maddison, 2015), showing their great evolutionary success. Salticidae, also known as jumping spiders, are the most speciose spider group due to their excellent vision (Harland et al., 2012 and references theirein). The retina of their principal eyes consists of four layers and matches the resolution of the human eye (Harland et al., 2012). This excellent eyesight not only helped salticids to succeed, but has given a new system which determines their life history (Su et al., 2007).This resulted in enhanced perception of their environment and much more sophisticated behaviour than previously thought (Prete, 2004). In many cases, it is proven that some of the retinal layers have pigments sensitive to light in the ultraviolet spectrum (Li and Lim, 2005). This lead often to dimorphic bright coloured species (LI et al., 2008), which implies sexual selection leading to speciation (Masta and Maddison, 2002). The genus *Maltecora* is a jumping spider with brightly coloured males, that can be only found in the Afrotropical islands of São Tomé and Príncipe. Thus, studying those could help us to get glimpses to jumping spider evolution.

The islands of São Tomé and Príncipe are characterised by a the high level of endemic species and biodiversity density (Jones, 1994). The volcanic islands of the Gulf of Guinea are about 13 and 31 m.y old (Lee et al., 1994), thus provides a wide array of suitable models to study biodiversity and evolution of islands. To give a perspective, the iconic Galapagos archipelago is about maximum 5 m.y old (Bailey, 1976). It has been suggested that biodiversity is lower in newly formed islands (Craven et al., 2019). Considering also the age of the islands, it is not surprising that these islands have not only a higher diversity, but a wider selection of taxa from which new species emerged by speciation (Prigent et al., 2020). Geographical isolation provided in the case of oceanic islands is one of the most common ways for speciation to occur (Mayr, 1947). Despite the high level of biodiversity, individuals

on the islands do not thrive since they are often exposed to stressors. Alien species are significant threats to native inhabitants, declining their populations (Dutton, 1994). However, deforestation and habitat modification by humans are the main reasons which drive species to extinction (Dutton, 1994). The ecological importance of the São Tomé and Príncipe is supported by numerous studies regarding birds (Peet and Atkinson, 1994), mammals (Glenn and Bensen, 2013), reptiles (Ceríaco et al., 2018) and amphibians (Bell et al., 2015) of the islands . Anyhow, less attention is given to arthropods, and in particular, arachnids. Only a few endemics are known like the tarantula *Hysterocrates scepticus* and *Maltecora*. In a series of expeditions California Academy of Sciences crew has collected a larger invertebrate material from where several specimens have been tentatively identified as *Maltecora*. During my studies I tried to identify those specimens and gather DNA evidence to place *Maltecora* on the jumping spider evolutionary tree.

Aims

- The primary aim of my project was to identify the specimens collected recently in São Tomé and Príncipe and sort them into morphospecies. Illustrating those morphospecies by the characters they differ, and finding names for those. In the likely case the morphospecies has not been known to the scientific literature, then establishing new names for them. The genus is rather poorly known (based on 6 specimens of which only one was a female). I aimed to find these missing females in the material and try to match them with the males using DNA barcodes (658 bp long COI sequences) and morphology.
- Phylogenetic placement of the genus: As *Maltecora* relationships were unclear so far in the literature, it has been marked as *incertae sedis* (Latin for uncertain placement) in Maddison (2015). Therefore, two molecular markers were targeted (28S and COI) to infer molecular phylogeny of the genus and possible relatives. The genus shows similarities to the tribe Chrysillini (Simon, 1901), where bright coloured genera are common, thus we targeted that tribe in a separate analysis. However, a wider range of similar taxa has been selected from more tribes, which have reflective hairs and colour patterns, to test most of the potential relatives.

Materials and Methods

Material Examined

The examined material was collected by the California Academy of Sciences during a series of expeditions to São Tomé and Príncipe organized by Robert Drewes.

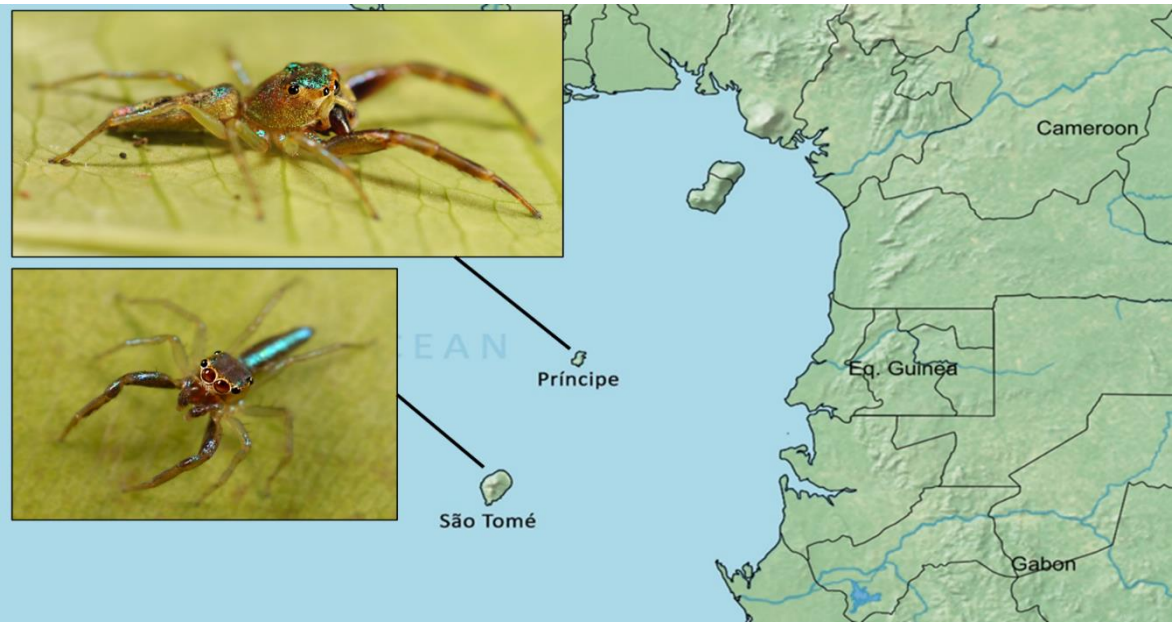

Figure 2: Geographic location of the islands and living specimens of *Maltecora*.

Morphological Methods

The specimens were stored in 1.5ml vials containing 96% isopropyl alcohol for preservation. The specimens were identified and examined using a dissection microscope (NIKON SB800). Specimens have been studied in petri dishes with sand submerged in alcohol and were fixed by the sand granules. Digital images were taken with a Nikon D300S, and a TrueChrome Metrics digital camera mounted on a Nikon Eclipse E200 compound microscope. Male palps were detached from the body and examined submerged in transparent hand sanitizer at higher magnifications. The female genitalia were dissected by the supervisor, cleaned with commercial pancreatin enzymes (NeoPanPurr™), and examined in Methyl Salicylate. All digital images are stacked multifocal images, composed from source images at sequential focal length, using Helicon Focus 7 software (Helicon Soft Ltd.). Digital drawings of male palps and female epigynes were made using Adobe Photoshop CC 2015. All measurements are given in millimetres.

Molecular Methods

DNA Extraction:

The extraction of the DNA was carried out using the DNeasy Tissue Kit according to the instructions given by the manufacturer. DNA was extracted from spiders' legs and not from the abdomen or the cephalothorax. This was done in order to avoid any potential foreign DNA fragments not originating from the spider but belonging to its prey. One or two legs, depending on the size, have been removed from the spider's body and used for DNA extraction. The remaining body parts were kept and used for morphological analysis since they provide higher morphological significance for taxonomic identification.

Amplification and Purification:

The PCR mixture was prepared by combining 2 μL of the extracted DNA template, 5 μL of 10X Taq Buffer, 4 μL of MgCl2, 1 μL of dNTPs, 0.6 μL of forward and reverse primers, 0.4 μL of Taq polymerase, and 37 μL Millipore Quality purified water, making up a total of 50 μL of PCR mixture volume. PCR was carried out on a "machine model" PCR System. An initialisation step was performed for 2 minutes at 94°C to activate the Taq polymerase. The initialisation step was followed by 35 cycles of denaturation, also at 94°C, with each cycle lasting 30 seconds. Then a 30 second annealing step was executed at 50°C for the COI gene or at 55°C for the 28S gene. Lastly, the machine carried out an elongation step for 10 minutes at a temperature of 72°C. The primers used for the PCR are shown in Table 2. Different sized fragments in DNA amplicons were visualised by gel electrophoresis. For the visualisation of the PCR amplicons, 5 μL of each DNA product was mixed with 1 μL of SAP (Shrimp Alkaline Phosphatase, 1 u/μL, Fermentas), 2 μL of 10× SAP buffer (Fermentas), 1.5 μL of E. coli ExoI (20 u/μL, Fermentas) and 2 μL of 10 × ExoI buffer (Fermentas). The mixtures were loaded into the wells of 1% agarose gel and an electric current was applied across the gel for 30 minutes. The gel was viewed under UV light, which allowed us to observe the fluorescent bands. The DNA from the extracted gel was purified using the Ultrafree-DA gel extraction kit (Millipore, Billerica, Massachusetts). For the extraction and purification, the manufacturer's commercial instructions were followed. The sequencing for the purified PCR products was carried out in Godollo, Hungary. From there, Sanger chromatogram files were obtained for which the purified DNA products were sequenced only in one direction.

Phylogenetic analysis

Taxon Selection:

I have chosen most of the taxa for this study based on the similarity in general morphology and the copulatory organs of the specimens. Notably, these are quite similar to those that belong to the tribe Chrysillini Simon (1909). These similarities include the bump on the tegulum at 90 degrees clockwise from the base of the embolus. Additionally, they have thin and delicate legs, and some have a shiny appearance, which is a typical characteristic of most of the Chrysillines. Examples of Chrysillini genera where the males display shiny colorations are numerous: *Chrysilla*, *Cosmophasis*, *Epocilla*, *Heliophanus*, *Mexcala*, *Natta*, *Orsima*, *Phintella, Phintelloides, Proszynskia, Rudakius* and *Siler* are only a few examples. However, since the possibility of superficial similarity could not have been ruled out, more distantly related genera were used, such as shiny members of Plexippini, Viciriini, Euophryini, Dendryphantini, and Aelurillini, based on their pervasive similar appearance to *Maltecora*. Accordingly, three phylogenetic analyses have been carried out:

1. A great variety of Chrysillines were accompanied by various others, with a more distinct outgroup genera from the related tribes such as Hasarini and Nannenini.
2. A variety of non Chrysillini genera with shiny males.
3. A more restricted Chrysillini taxon selection.

Since the COI is best used in species level analyses (Maddison, 2018), not for generic placement, we accompanied three more unpublished Chrysillini samples to monitor our results' consistency. These are indicated on the phylogenetic tree (Fig.18) as *Wesolowskana sp*., Chrysillini sp. and *Afraflacilla* sp.

Table 2: Mitochondrial and nuclear primers that have been used for DNA amplification during PCR.

Gene	Primer Sequence
Mitochondrial COI	LCO1490: 5'-GGTCAACAAATCATAAAGATATTGG-3' (Folmer et al., 1994) HCO2198: 5'-TAAACTTCAGGGTGACCAAAAAATCA-3' (Folmer et al., 1994)
Nuclear 28S	28S "O": 5'-GAAACTGCTCAAAGGTAAACG G-3' (Hedin and Maddison, 2001) 28S "C": 5'-GGTTCGATTAGTCTTTCGCC-3' (Hedin and Maddison, 2001)

The complete selection of taxa used for the phylogenetic analysis is listed in Table 3. *Eris militaris* (Hentz, 1845) was used to root the phylogenetic tree.

Table 3: Specimens used for the for molecular phylogeny.

Chrysillini			
Species or Genera	**COI**	**Species or Genera**	**COI**
Afrafracilla sp.	Unpublished code	*Okinawicius tokarensis*	AB924445
Chrysilla lauta	KY888772	*Orienticius vulpes*	AB924446
Chrysilla volupe	KY888762	*Orienticius vulpes*	JN817279.1
Chrysillini sp.	Unpublished code	*Phintella arenicolor*	JN817285.1
Cosmophasis lami	KX052392.1	*Phintella sp.*	KY587568
Cosmophasis sp.	KY888769.1	*Phintella vittata*	MK155006.1
Cosmophasis sp.	KY888776.1	*Phintelloides alborea*	KY888766.1
Epocilla Pakhtunkhwa	MK154848	*Phintelloides brunne*	KY888754.1
Epocilla sirohi	GACS5981-19	*Phintelloides flavoviri*	KY888752.1
Festucula sp.	ETKS516-13	*Phintelloides jesudasi*	KY888753.1
Festucula sp.	ETKS517-13	*Proszynnskia diatreta*	KY888774.1
Hakka himeshimensis	JN817278.1	*Psenuc dependens*	KBGPS216-18
Helicius chikunii	AB924449.1	*Psenuc dependens*	KBGPS224-18
Heliophanus auratus	KX536838.1	*Pseudicius admirandus*	KY587589.1
Heliophanus cupreus	KY270452.1	*Pseudicius admirandus*	MK154781.1
Heliophanus dampfi	KY269733.1	*Pseudicius africanus*	KBGPS120-18
Heliophanus dubius	KY270155.1	*Pseudicius encarpatus*	KX537215
Heliophanus flavipes	KY268922.1	*Pseudicius sp.*	GBMND34426-21
Heliophanus tribulosus	MT607775.1	*Pseudicius sp.*	SPIZA478-21
Helvetia aff. zonata	AY297394.1	*Pseudicius sp.*	ETKII622-12
Icius hamatus	MH673866	*Rudakius ludhianaensis*	JN306290
Icius insolidus	SPIZA538-21	*Rudakius ludhianaensis*	KY587588
Icius sp.	MN521110	*Rudakius ludhianaensis*	JN306245.1
Icius subinermis	KX039217.1	*Siler cupreus*	JN817270.1
Maltecora chrysochlora	Unpublished code	*Siler ruber*	LC485231
Menemerus sp.	KY888755.1	*Tasa nipponica*	AB924443.1
Mexcala elegans	MH673867	*Wesolowskana sp.*	Unpublished code
Mexcala sp.	KMPRV427-19		
Aelurillini			
Species or Genera	**COI**	**Species or Genera**	**COI**
Malloneta guineensis	JX145709.1	*Tarne dives*	JX145721.1
Dendryphantini			
Species or Genera	**COI**	**Species or Genera**	**COI**
Eris militaris	KX781794.1	*Eris militaris*	KP654831
Euophryini			
Species or Genera	**COI**	**Species or Genera**	**COI**
Omoedus orbiculatus	KC615792.1	*Sidusa sp.*	KC615770.1
Omoedus papuanus	KC615790.1	*Thiania latibola*	KC615750.1
Pystria ephippigera	MT671536.1	*Zenodorus microphthalmos*	DQ531816.1
Hasarini			
Species or Genera	**COI**	**Species or Genera**	**COI**
Bristowia gandhii	KY888778.1	*Habrocestum hantaneensis*	KY888765.1
Echelus sp.	KM033222.1	*Hasarius adansoni*	KY888756.1
Nannenini		**Viciriini**	
Species or Genera	**COI**	**Species or Genera**	**COI**
Idastrandia orientalis	EU815608.1	*Viciria praemandibularis*	MT672323.1
Leptorchestini			
Species or Genera	**COI**	**Species or Genera**	**COI**
Leptorchestes berolinensis	KX039227.1	*Yllenus arenarius*	JX145685.1
Plexippini			
Species or Genera	**COI**	**Species or Genera**	**COI**
Epeus sp.	MT671516.1	*Telamonia dimidiate*	MK154928.1
Additional Salticidae			
Species or Genera	**COI**	**Species or Genera**	**COI**
Salticidae sp.	KMPFI114-19	*Salticidae sp.*	ETKII489-12
Salticidae sp.	KMPKN211-19	*Salticidae sp.*	KMPDG2553-19
Salticidae sp.	ETKS299-13	*Salticidae sp.*	GMSAO305-13

Multiple sequence alignment:

Received Sanger chromatogram files were assembled with PreGap4 and Gap4 part of the Staden Package (Staden et al., 1999). Forward and reverse sequences were joined in Gap4 and minor base errors were corrected according to the consensus sequence provided by the software. Before the phylogenetic analysis was carried out and prior to the construction of the phylogenetic tree, all the COI sequences selected were aligned with MAFFT online version 7 (Katoh and Standley, 2013). Due to the small data size the L-INS-i refinement method (Katoh et al., 2005) was used for the alignment.

Phylogenetic tree construction:

The Maximum Likehood (ML) method was used for the phylogenetic analysis. Mega X (Kumar et al., 2018) was used to build the phylogenetic tree. The software suggested the GTR-G-I (general time reversible with gamma distribution) model of ML analysis of the COI gene. Then the phylogenetic tree was constructed accordingly by using 250 bootstrap replicates for clade support. A cladogram was obtained which was rooted on *Eris militaris* (Hentz, 1845).

Results

In total, 42 specimens have been processed, 95 digital images and 27 digital drawings have been made. The specimens have been sorted out into five morphospecies (represented by both sexes) based on their body size, and copulatory organs. Two from Princípe and three from Sao Tomé. All the previously known *Maltecora* species: M. *janthina* Simon, 1909 (Sao Tomé), *M. divina* Simon, 1909 and *M. chrysochlora* Simon, 1909 (both from Princípe) have been found, with the latest two matching females being newly recorded. The female previously believed to be *M. janthina* is now assigned to *M. nulnomad sp.n.* Two new species are also described, *Maltecora wawesa sp.n.* and *Maltecora nulnomad sp.n*. from Sao Tomé. Among the 12 samples selected for DNA analysis, only one has given any results of COI PCR and none for 28S. This specimen was a *M. chrysochlora* male from Princípe. To check for possible procedure errors on my end, all the samples have been processed by my supervisor, Dr. Krisztián Szabó, and the same results were obtained. The failure of the samples might be due to the quality of the preservative alcohol used when the samples were collected.

Taxonomy:

***Maltecora* Simon, 1909**

Diagnosis: Brightly coloured males can be identified by the bent and branched RTA (Figure 1). Accompanying the forward branch (AAB) (i.e., *M. wawesa* and *M. nulnomad*) the hind branch (PAB) could be enlarged or like in the three previously known species (*M. janthina*, *M. divina* and *M. chrysochlora*) the AB, which is normally just a "bump" in the newly discovered ones. Female could be recognized by the well-developed apophysis holder (RH) of the posterior part (PEB) of the epigynum (Figure 1).

Description: Small to medium size, brightly coloured jumping spiders with the males being slightly larger than the females. They have light reflecting setae usually dorsally on the prosoma and median abdomen, which emphasizes their shiny appearance (Figure 4). Usually, female arachnids are less colourful but *Maltecora* females often display bright patterns like in the case of *M. janthina* and *M. divina*. Males have elongated abdomens which are narrower than the prosoma (Fig. 3D, 6C, 9C, 12C, 15C). Male palps are equipped with long, thin and angled embolus and have iconic double branching RTAs. Females have abdomens wider than the prosoma usually with banded or spotted patterns (Figure 4C-E, 7C-E, 13C-E, 16C-E).

Distribution: Species of the genus are found in the islands of São Tomé and Príncipe only. *M. divina* and *M. chrysochlora* are only found in Príncipe whereas *M. janthina* and *M. wawesa* are only found in São Tomé. *M. nulnomad* was found in both islands.

***Maltecora janthina* Simon, 1909 — type species**

Figs. 3A-E, 4A-E, 5A-C

Material examined: 1♂ (YIANNO_64), São Tomé and Príncipe, Island of São Tomé, Angolares, disturbed urban environment singled on bush, 66m alt., 0°08'04.9"N 6°39'01.0"E, hand collection, 19th of April 2013. 1♀ (YIANNO_57) São Tomé and Príncipe, Island of São Tomé, Obô Natural Park de São Tomé, along Do Fugido Trail off of the Pico São Tomé Trail toward Morro Provaz near creek originating from Lagôa Amelia, 1235m alt, 0°17'22.0"N 6°36'20.0"E, hand collection, 4th of May 2013.

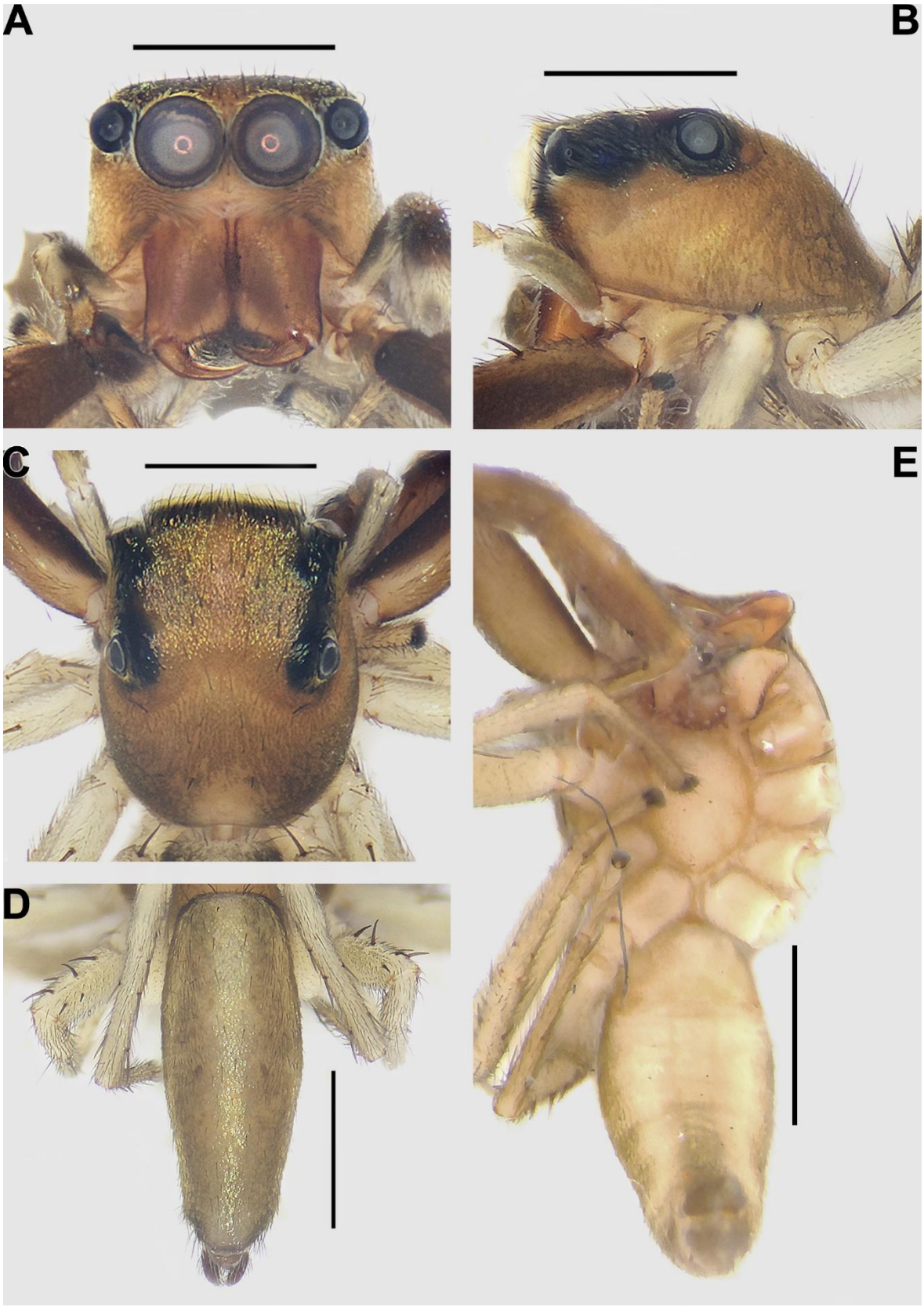

Figure 3: *Maltecora janthina* male 64 habitus images **(A-E)**. **(A)** Cephalothorax frontal aspect, **(B)** Cephalothorax lateral aspect, **(C)** Cephalothorax dorsal aspect, **(D)** Opisthosoma dorsal aspect, **(E)** Habitus ventral aspect. **Scale bars:** 1mm.

Figure 4: *Maltecora janthina* female 57 habitus images and epigynum **(A-E)**. **(A)** Cephalothorax frontal aspect, **(B)** Epigynum, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect, **(E)** Habitus lateral aspect. **Scale bar (A):** 1mm, **Scale bar (B):** 0.5mm, **Scale bar (C-E):** 2mm.

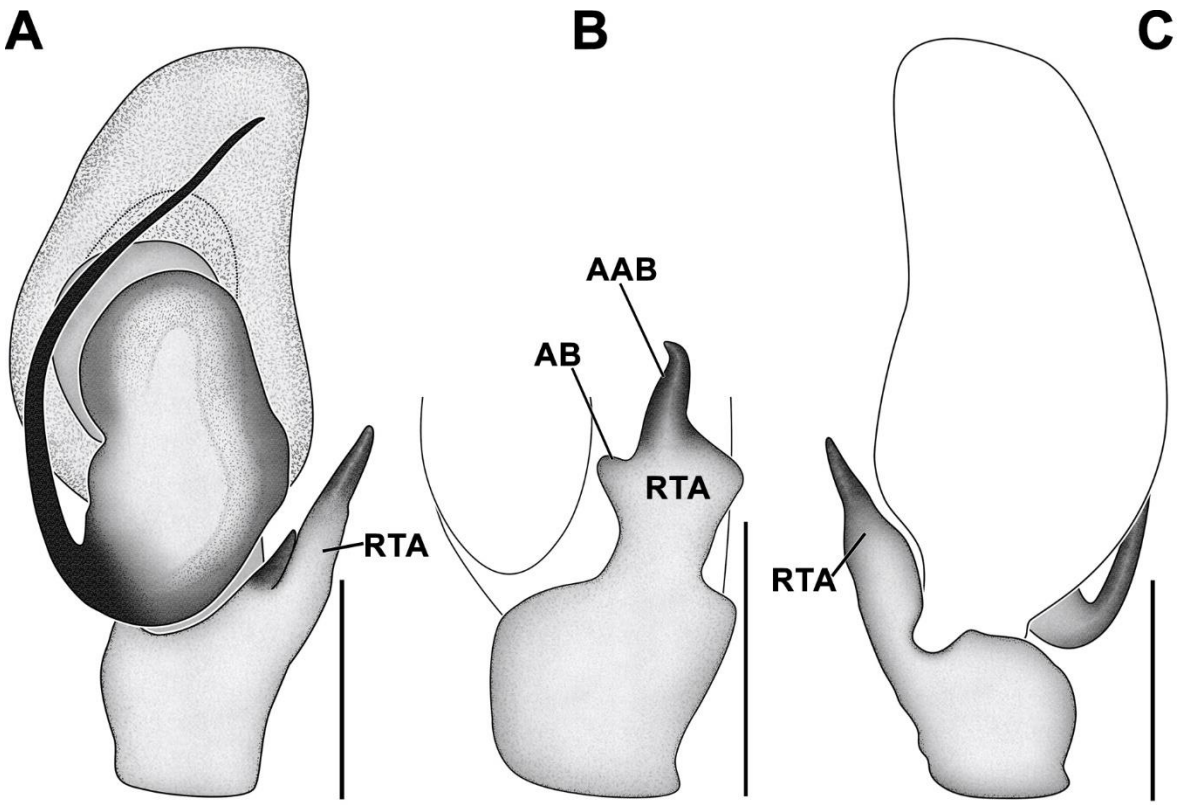

Figure 5: *Maltecora janthina* male 64 palp drawings **(A-C)**. **(A)** ventral view, **(B)** retrolateral view of the RTA, **(C)** dorsal view. **Scale bars:** 0.3mm

Diagnosis: Males have colourful setae (Figure 3C-D) on the dorsal side of the abdomen and prosoma while females exhibit a lightly spotted pattern (Fig. 4). Males are recognised by the AAB which is the tallest and most prominent branch of the RTA. Additionally, the AB appears to be the largest between all the species (Figure 5B). The epigynum is characterised by shallow EP while RH are relatively long and arched over the PEB. CD are very long (Figure 4B).

Description: Male (Figure 3A-D). Dark brown narrow clypeus. Prosoma is also dark brown and much broader than the abdomen. There is a great amount of light reflecting setae on dorsally between the eyes on the prosoma and around the anterior median and lateral eyes (Figure 3C,D). Prosoma is 2.13mm in length and 1.60mm wide at PLE level. Abdomen is 2.43mm in length and 0.89mm wide at the widest point. Total length is 4.38mm. The prosoma is shorter but wider than the abdomen (Figure 3C). PLE and PME are surrounded by darker pigmentation. Chelicerae have slightly brighter colour than the prosoma and are delicate. Sternum is yellow and oval in shape. Legs are brightly coloured and thin, except the first pair which is brown and wider in diameter. Black spikes are noted across the length of the legs. Dorsum contains a median band with bright hairs along the whole length of the

abdomen. as the prosoma with a median band bordered by darker brown bands which cover only one third of the dorsal abdomen. Ventrum has no significant pattern and is the same colour as the sternum (Fig. 3E). Spinnerets are black. Palp is light brown, with the dorsal area of the CY being darker and the ventral being brighter. EM is slender and very long. RTA is half the size of the TI. AAB is branch of the RTA. PAB is absent but AB lies under the AAB and very prominent. The tip of the AAB turns facing the ventral side of the palp. RES is visible throughout the TE (Fig.5A-C). Female (Figure 4A-E). Overall has a lighter colour than the male. Prosoma is yellowish brown and about the same width as the abdomen. Prosoma is 1.60mm in length and 1.09mm wide at PLE level. Abdomen is 2.06mm in length and 1.06mm wide at the widest point. Total length is 9.94mm. PME and PLE are surrounded by darker pigmentation. Chelicerae are yellow and small. Posterior margin of the prosoma is slightly rounded. Sternum is yellow, oval and extremely large (Fig.4D). Dorsum is yellow and consists of 3 pairs of light brown spots which extend to the lateral side of the abdomen. The spots are similar to those of *M. divina* but are not as dark. Ventrum has a darker median band covering two thirds of the length of the abdomen. Spinnerets are yellow. Epigynum is lightly sclerotised. S is small and oval. PEB bends inwards (Fig.4B).

Distribution: *Maltecora janthina* has been found on the island of São Tomé only.

***Maltecora divina* Simon, 1909**

Figs 6A-D, 7A-E, 8A-C

Material examined: 1♂ (YIANNO_66), São Tomé and Príncipe, Island of Príncipe, Bella Vista, Slopes along the Rio Papagaio (Papagaio River) about 2km south of the village of Bella Vista above Santo Antonio, beyond the end of the road (now abandoned) about 200m above the dam, 154m alt., 1°36'11.5"N 7°24'22.0"E, hand collection, 23rd of April 2013. 1♂ (YIANNO_68), São Tomé and Príncipe, Island of Príncipe, Porto Real, Along dirt road from São Joaquim toward Porto Real, 187m alt., 1°37'14.0"N 7°23'05.0"E, hand collection, 23rd of April 2013. 1♂ and 1♀ (YIANNO_56), São Tomé and Príncipe, Island of Príncipe, São Joaquim, Along 3-way road junction between Santa Trindade and Montalegre, 150m alt., 1°37'40.0"N 7°23'39.0"E, hand collection, 23rd of April 2013. 1♂ (YIANNO_81), São Tomé and Príncipe, Island of Príncipe, Sundy, along unimproved dirt road from Sundy to Praia, 154m alt., 1°36'11.5"N 7°24'22.0"E, hand collection, 21st of April 2013.

Figure 6*: Maltecora divina* male 66 habitus images **(A-D)**. **(A)** Cephalothorax frontal aspect, **(B)** Cephalothorax lateral aspect, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect. **Scale bars:** 2mm.

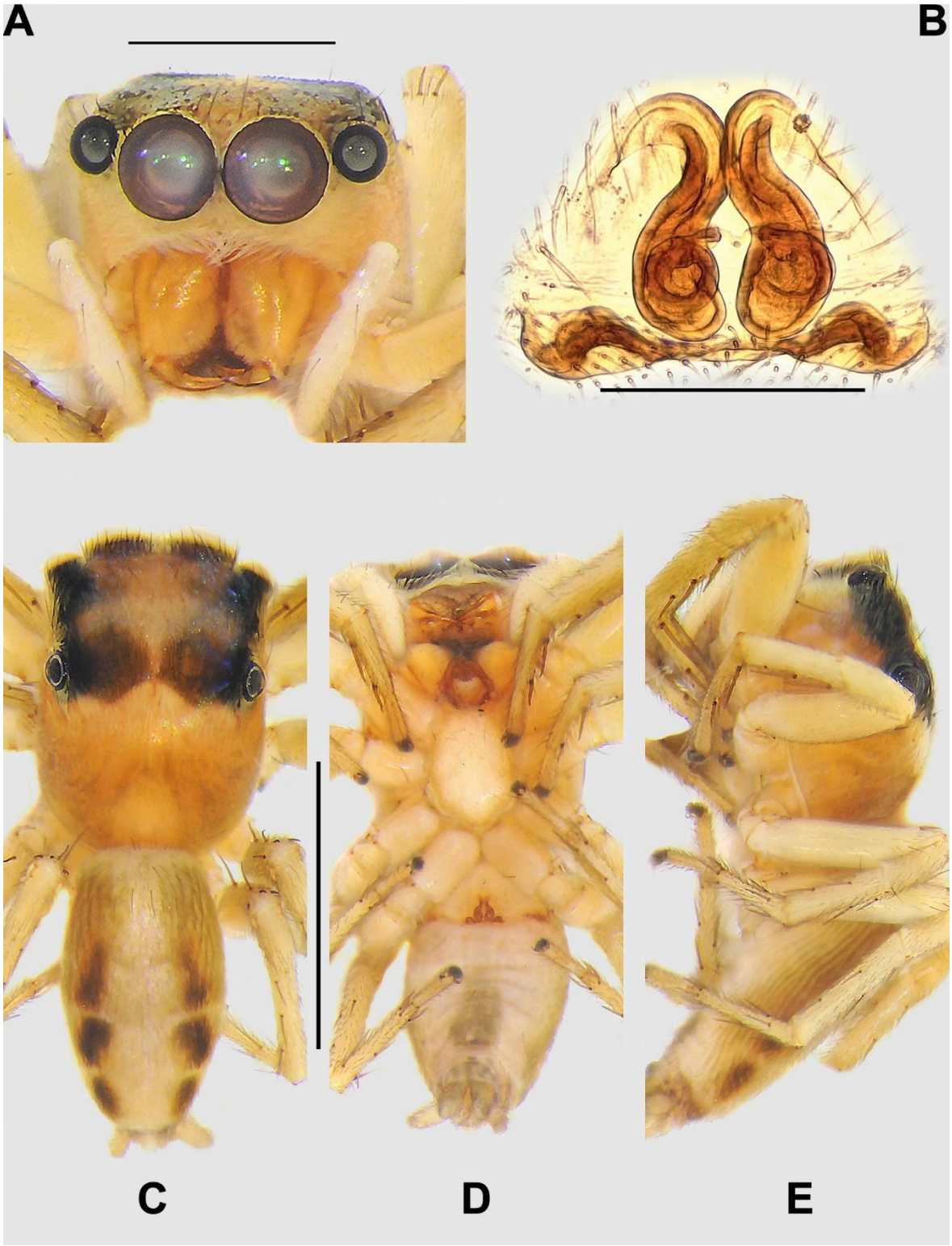

Figure 7: *Maltecora divina* female 1 habitus images and epigynum **(A-E)**. **(A)** Cephalothorax frontal aspect, **(B)** Epigynum, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect, **(E)** Habitus lateral aspect. **Scale bar (A):** 1mm, **Scale bar (B):** 0.2mm, **Scale bar (C-E):** 2mm.

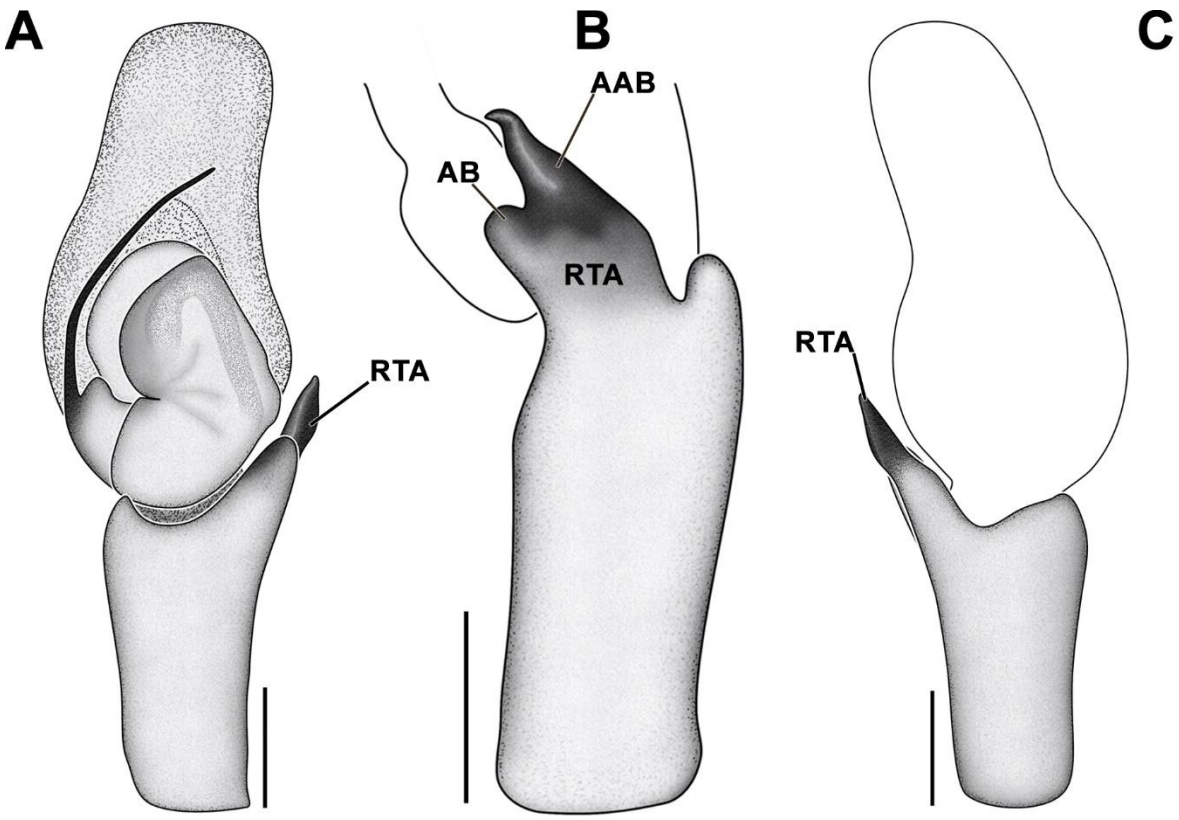

Figure 8: *Maltecora divina* male 66 palp drawings **(A-C)**. **(A)** ventral view, **(B)** retrolateral view of the RTA, **(C)** dorsal view. **Scale bars:** 0.3mm

Diagnosis: Males and females have a white coloured moustache formed by a layer of lightly coloured setae between the chelicera and the AME. The RTA of the male palps has two branches. A tall and pointy AAB and a shorter smooth AB.

Description: Male (Fig. 6A-D). Clypeus is dark brown. Shiny hairs are visible dorsally on the prosoma between the eyes. Prosoma is 2.80mm in length and 2.54mm wide at PLE level. The abdomen is 3.18mm in length and 1.37mm wide at the widest point. Total length is 6.02mm. Prosoma is much wider than the abdomen. When seen dorsally its shape is oval and almost circular. PME are surrounded by darker pigmentation and in between them there is a lighter colour cross like mark (Fig. 6C). Chelicerae are very large and extending laterally away from the midline (Fig. 6A-D). They have the same colour as the prosoma and are accompanied by a layer of whitish setae resembling a white moustache between them and the AME. Sternum is yellow and oval in shape (Fig. 6D). All legs are brightly coloured and thin, except the first pair which is darker and wider. Black spikes are noted across the length of the legs. The tip tarsal segments of the legs where the claws are located is black. Dorsum contains a brown marking covering almost the whole dorsal abdomen. The marking displays a double rhomboid shape (Fig. 6C). Ventrum has no significant pattern and is the same

colour as the sternum (Fig. DC). Spinnerets are light brown. Palp is light brown, with the CY being darker in middle. EM is thin and long. RTA is a third of the size of the TI and has a very similar structure to M. divina. AAB is the tallest and most pointy branch where the shorter AB lies below it and has a smooth end (Fig. 8A-C). ABB is darker and highly sclerotised where AB colour is lighter. RES is visible throughout the TE. A bump is present on the tegulum around 90 degrees clockwise from the base of the embolus like in the case of *M. chrysochlora* but here is smaller. Female (Fig. 7 A-E). Overall has a lighter colour than the male. Prosoma is yellowish brown and slightly larger in length and width than the abdomen. Prosoma is 2.14mm in length and 1.53mm wide at PLE level. Abdomen is 1.82mm in length and 1.15mm wide at the widest point. Total length is 4.18mm. PME and PLE are surrounded by darker pigmentation but the colour fades between the eyes dorsally on the carapace (Fig 7C). Chelicerae are yellow and small. The same whitish moustache is presented on the female as well but it is less prominent. Sternum is yellow and oval in shape (Fig. 7D). Dorsum is yellow and consists of 3 pairs of light brown elongated spots, in between the spots on the midline of the abdomen the colour is lighter. Ventrum has a slightly darker elongated spot close to the posterior end of the abdomen. Spinnerets are yellow. Epigynum is highly sclerotised. S is large and oval. PEB bends inwards (Fig. 7B).

Distribution: *Maltecora divina* has been found on the island of Príncipe only.

***Maltecora chrysochlora* Simon, 1909**

Figs 9A-D, 10A-E, 11A-C

Material examined: 1♂ (YIANNO_70), São Tomé and Príncipe, Island of Príncipe, along dirt road from Gaspar to Sundy after bridge crossing of Ribeira Ize, 191m alt., 1°39'32.0"N 7°23'14.0"E, hand collection, 22nd of April 2013. 1♀ (YIANNO_23), São Tomé and Príncipe, Island of Príncipe, Sundy, along the road to Sundy, 191m alt., 1°39'35.3"N 7°23'12.9"E, hand collection, 22nd of April 2013. 1♂ (salt_33), São Tomé and Príncipe, Island of Príncipe, Auga Doctor, degraded forest north of Santo Antonio de Príncipe on road to airport, 157m alt., 1°39'17.7"N 7°24'57.8"E, hand collection, 19th of April 2001. 1♀ and 1♂ (YIANNO_83), São Tomé and Príncipe, Island of Príncipe, Sundy, along unimproved dirt road from Sundy to Praia Sundy, 157m alt., 1°40'16.0"N 7°23'10.0"E, hand collection, 22nd of April 2013.

Diagnosis: Males are small with smaller palps. Palps have RTAs consisting of two branches which split less deeply than in other species (Fig. 11). Also, the embolus appears shorter than the others. Females appear to have the darkest colouration of the prosoma while their abdomen is brightly coloured with minimal markings (Fig. 10C-E). The RH is the least deep (Fig. 10B).

Description: Male (Fig 9A-D, 11A-C). Clypeus is dark brown, like the prosoma and the abdomen. The prosoma is wider than the abdomen (Fig. 9C). Some shiny hairs are visible dorsally on the prosoma between the eyes, but mainly along the abdomen. The abdomen is narrow and elongated (Fig. 9C,D). Prosoma is 1.93mm in length and 1.42mm wide at PLE level. The abdomen is 2.54mm in length and 0.93mm wide at the widest point. The total length is 4.53mm. PLE and PME are surrounded by darker pigmentation. Chelicerae are small and brown (Fig. A). Sternum is light brown and oval in shape (Fig. 9D). All the legs are brightly coloured and thin. The first pair is darker and bigger than the others. Black spikes are noted across the length of the legs. The dorsum contains two darker longitudinal bands and between them reflective setae are found (Fig. 9C). The ventrum has no significant pattern and it is slightly lighter in colour than the dorsal abdomen. Spinnerets are black (Fig. 9D). Palp is orange brown and contains a lot of shiny scales with the CY being darker in the middle. EM is thin but not as long as the other species. RTA is a third of the size of the TI and consists of two small branches which split less deeply than in the other species. AAB is the tallest and most pointy branch AB is the shortest (Fig. 11C). Both branches are highly sclerotised. RES is mainly visible at the top of the TE. There is a bump on the tegulum around 90 degrees clockwise from the base of the embolus (Fig. 11A). Female (Fig. 10A-E). Overall, it has a lighter colour than the male. Prosoma is yellowish brown and slightly larger in length and width than the abdomen (Fig. 10A-E). Prosoma is 1.92mm in length and 1.39mm wide at PLE level. The abdomen is 2.14mm in length and 1.28mm wide at its widest point. The total length is 4.08mm. PME and PLE are surrounded by darker pigmentation but the colour fades between the eyes dorsally on the carapace. Chelicerae are orange and small (Fig. 10A). Sternum is yellow and oval in shape (Fig. 10D). Dorsum is yellow and smooth with no pattern. The ventrum has a slightly darker stripe which expands along the length of the abdomen (Fig. 10D). Spinnerets are brown (Fig. 10A-E). The epigynum is not as much sclerotised. S is both large and oval. PEB bends inwards (Fig. 10B).

Distribution: *Maltecora chrysochlora* has been found on the island of Príncipe only.

Figure 9: *Maltecora chrysochlora* male habitus images **(A-D)**. **(A)** Cephalothorax frontal aspect, **(B)** Cephalothorax lateral aspect, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect. **Scale bars (A,B):** 1mm, **Scale bars (C,D):** 2mm.

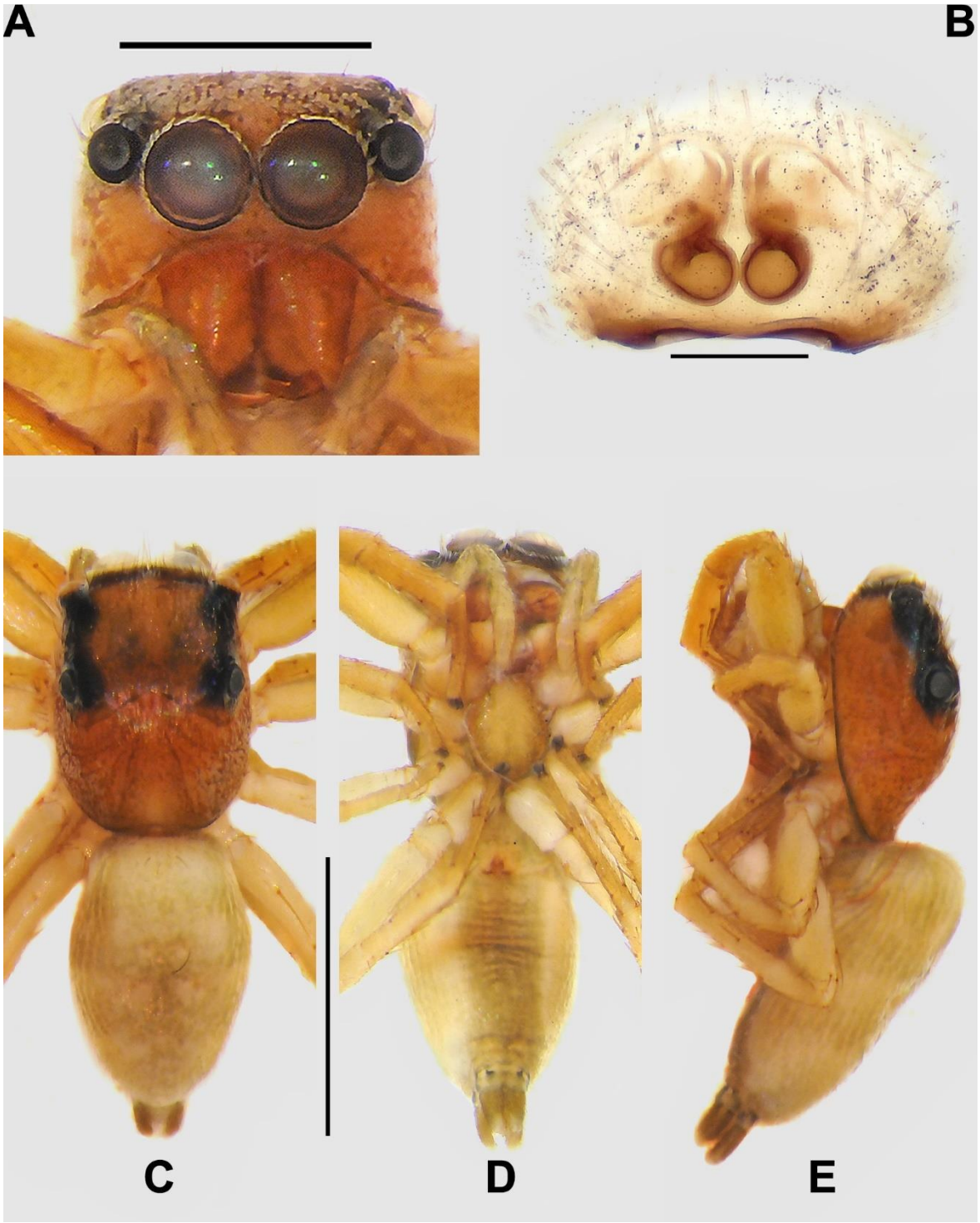

Figure 10: *Maltecora chrysochlora* female 83 habitus images and epigynum **(A-E)**. **(A)** Cephalothorax frontal aspect, **(B)** Epigynum, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect, **(E)** Habitus lateral aspect. **Scale bar (A):** 1mm, **Scale bar (B):** 0.1mm, **Scale bar (C-E):** 2mm.

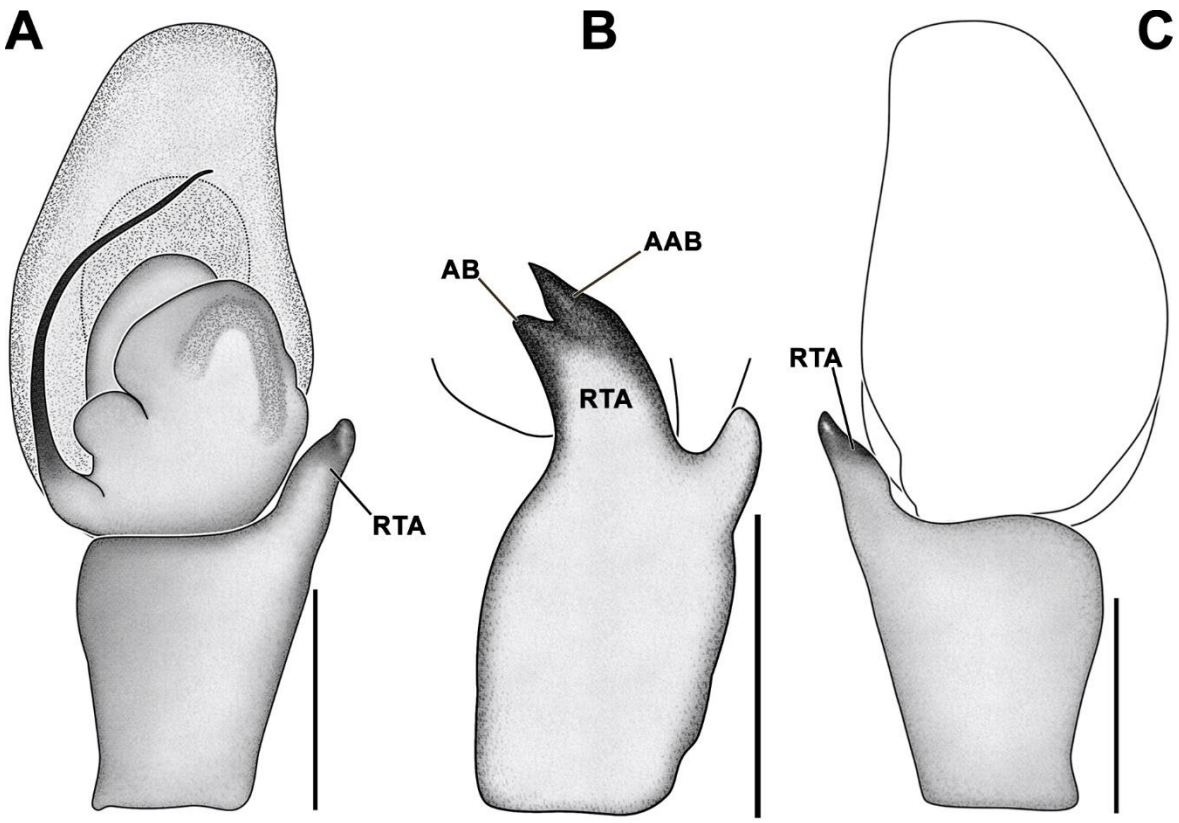

Figure 11: *Maltecora chrysochlora* palp drawings **(A-C)**. **(A)** ventral view, **(B)** retrolateral view of the RTA, **(C)** dorsal view. **Scale bars:** 0.3mm.

***Maltecora nulnomad* sp. n.**

Figs: 12A-D, 13A-E, 14A-C

Material examined: 2♂ (YIANNO_65, YIANNO_61), São Tomé and Príncipe, Island of São Tomé, Parque Nacional Óbó, forest near radio tower 1.63 arir km WSW Bom Successo, 1325m alt., 0°16'34.0"N 6°36'20.0"E, hand collection, 9th of April 2001. 1♂ (YIANNO_69), São Tomé and Príncipe, Island of São Tomé, Obô Natural Park de São Tomé, along Do Fugido Trail off of the Pico São Tomé Trail toward Morro Provaz near creek originating from Lagôa Amelia, 1213m alt., 0°17'39.0"N 6°36'01.0"E, hand collection, 5th of May 2013. 2♂ and 1♀ (YIANNO_63), São Tomé and Príncipe, Island of São Tomé, Augustino Neto, Rio de Oro Plantation, 221m alt., 0°21'55.7"N 6°38'41.7"E, hand collection, 13th of April 2001. 1♂ (SALT_54), São Tomé and Príncipe, Island of São Tomé, Parque Nacional Óbó, forest at Lagoa Amelia, 1451m alt., 0°16'48.0"N 6°35'29.0"E, hand collection, 14th of April 2001. 1♂ (YIANNO_12), São Tomé and Príncipe, Island of Príncipe, Obô Natural Park de Príncipe, slopes above the Rio Papagaio on old trail toward Pico Papagaio at junction trail

between Bela Vista and Santa Joaquina, 242m alt., 1°36'37.0"N 7°24'03.0"E, hand collection, 21st of April 2013. 2♀ (YIANNO_57), São Tomé and Príncipe, Island of São Tomé, Parque Nacional Óbó, next to trail toward Morro Provaz in watershed below Lagôa Amelia, 1235m alt., 0°17'22.0"N 6°36'20.0"E, hand collection, 4th of May 2013.

Diagnosis: Males can be recognized by the presence of the PAB, which is thin and relative short (Fig.14A-C). This makes the palp similar to that of *M. wawesa* but AAB is thicker while PAB appears thinner and slender. AB is also much more prominent (Fig. 14A-C). Females have a deep epigynal pocket, and the RH are relatively short (Fig. 13B).

Etymology: The species epithet has been derived from the three Latin words *nullum nomen adhuc*, meaning no name yet.

Description: Male (Fig. 12A-D). Large salticid, the largest of the genus. The bright colours are not present, but a brownish colouration. Yellowish brown clypeus. Prosoma is also yellowish brown and broader than the abdomen (Fig. 12C-D). Prosoma is 3mm in length and 2.32mm wide at PLE level. Abdomen is 4.30mm in length and 1.34mm wide at the widest point. Total length is 8.56mm. PLE and PME are surrounded by darker pigmentation (Fig. 12A-C). Lateral side of the prosoma is smooth with no pattern. Chelicerae are bright yellow, large and extend slightly forward (Fig. 12A, C, D). Posterior margin of the prosoma is slightly concave. Sternum is yellow and oval in shape. Dorsum has a yellow median band bordered by brown bands which cover the whole length of the abdomen. Ventrum has a brown median band also extending from the anterior to posterior end of the abdomen (Fig. 12C). Spinnerets are yellow. Palp colour appears to be yellow throughout with the TE and dorsoproximal area of the CY being slightly darker. EM is slender and long. RTA is half the size of the TE and TI. AAB is thicker and taller than PAB, its tip twists laterally and heavily sclerotised (Fig. 14A-C). PAB points directly upwards, has a lighter colour and less sclerotization. AB under the AAB is greatly prominent. RES is visible throughout the TE. Female (Fig.13A-E). Clypeus colour same as the male. Prosoma is yellowish brown and broader than the abdomen. Prosoma is 2.50mm in length and 1.86mm wide at PLE level. Abdomen is 2.43mm in length and 1.48mm wide at the widest point. Total length is 5.11mm. The area dorsally on the prosoma, between PME and PLE is brown and the PME and PLE are surrounded by even darker pigmentation (Fig. 13A, C, E). Lateral side of the prosoma is smooth with no pattern. Chelicerae are light brown and large (Fig. 13A). Posterior margin of the prosoma is slightly concave. Sternum is yellow and oval in shape (Fig. 13D).

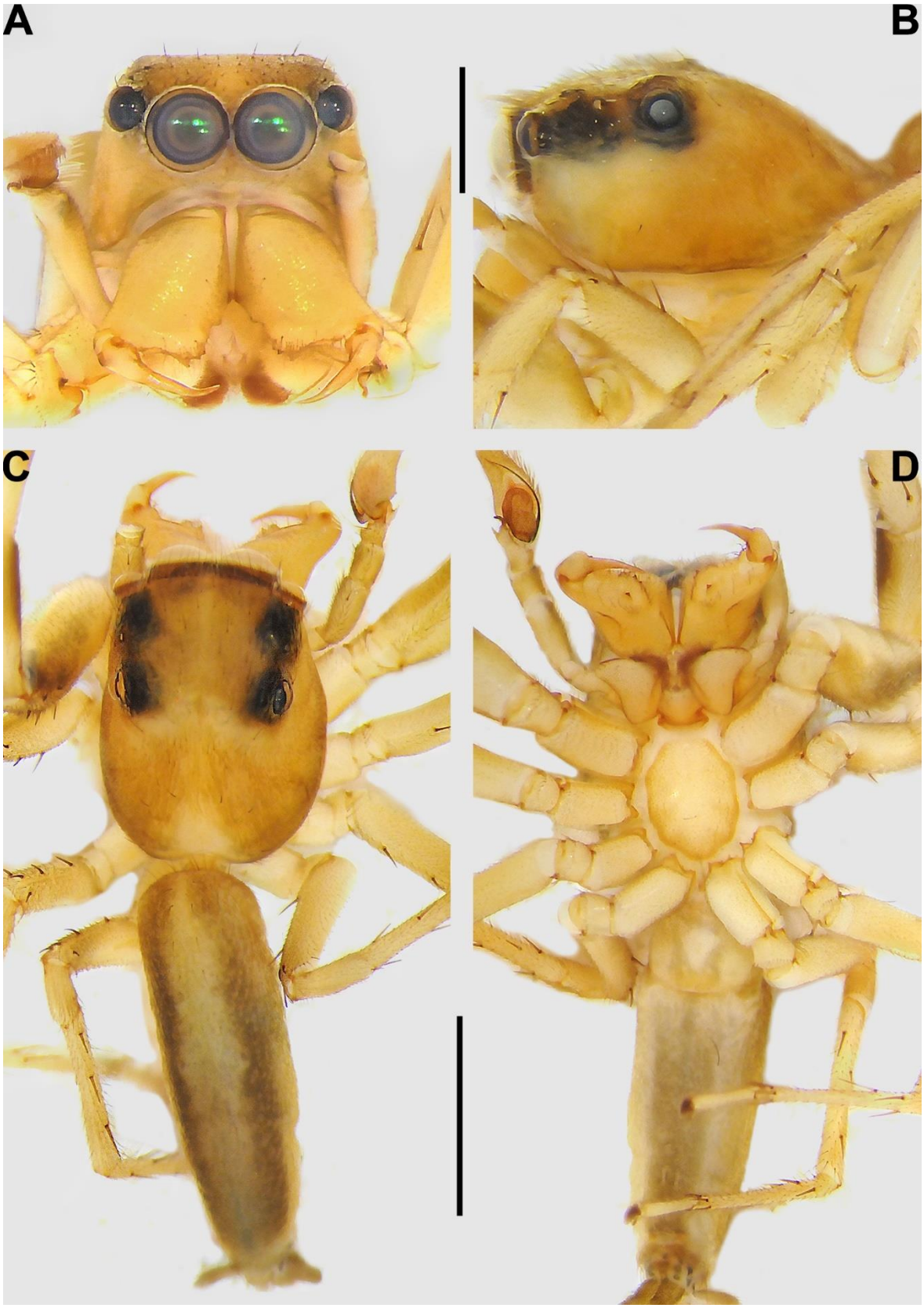

Figure 12: *Maltecora nulnomad* male 69 habitus images **(A-D)**. **(A)** Cephalothorax frontal aspect, **(B)** Cephalothorax lateral aspect, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect. **Scale bars (A,B):** 1mm, **Scale bars (C,D):** 2mm.

Dorsum has a median light colour band that extends up to two thirds of the total length of the abdomen (Fig. 13C).. The posterior end of the dorsum has a busy spotted pattern which has a brown colour (Fig. 13C). Ventrum has a darker median band covering half the length of the abdomen. Spinnerets are yellow (Fig. 13C-D). Epigynum is highly sclerotised, and S is small and oval. PEB bends inwards. CD are twisted (Fig. 13B).

Distribution: *Maltecora nulnomad* was found in both São Tomé and Príncipe islands.

Figure 13: *Maltecora nulnomad* female 57 habitus images and epigynum **(A-E). (A)** Cephalothorax frontal aspect, **(B)** Epigynum, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect, **(E)** Habitus lateral aspect. **Scale bar (A):** 1mm, **Scale bar (B):** 0.3mm, **Scale bar (C-E): 2mm**

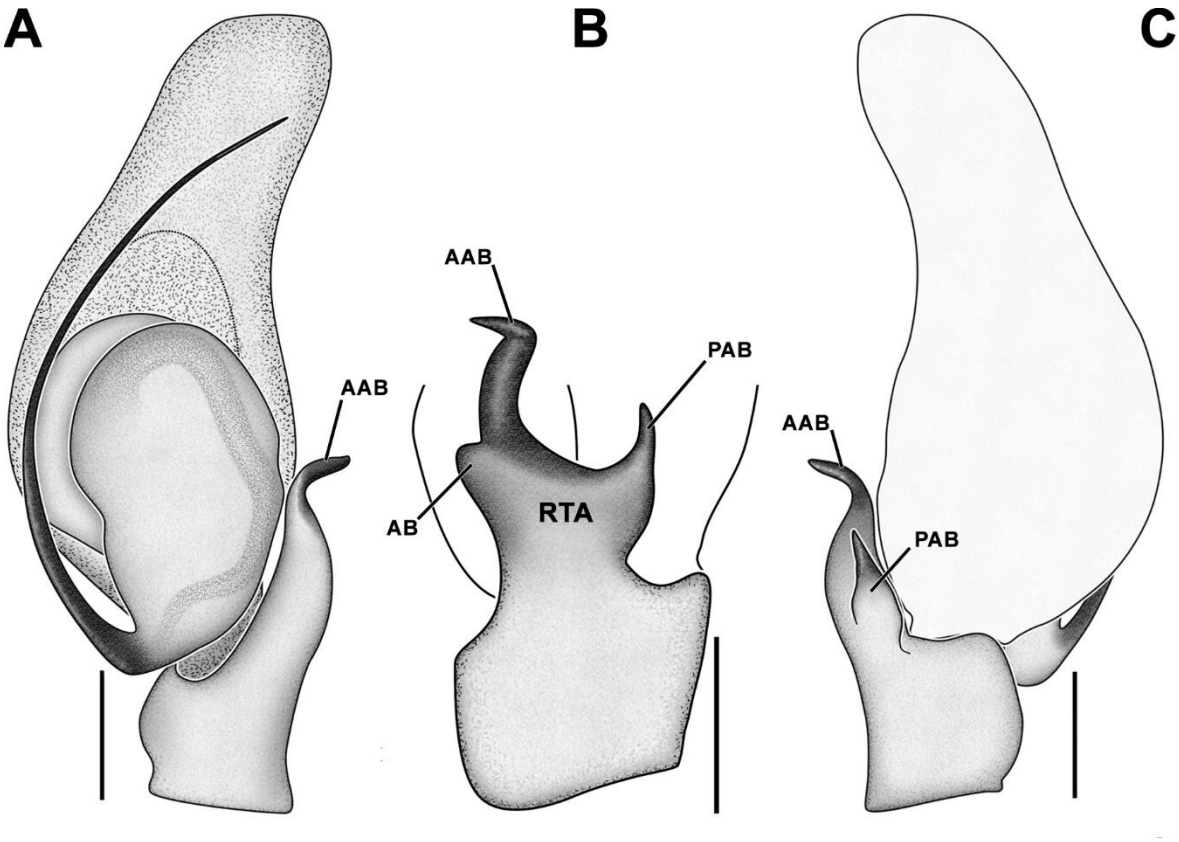

Figure 14: *Maltecora nulnomad* male 69 palp drawings **(A-C)**. **(A)** ventral view, **(B)** retrolateral view of the RTA, **(C)** dorsal view. **Scale bars:** 0.3mm.

***67, 22 Maltecora wawesa* sp. n.**

Figs: 15A-D, 16A-E, 17A-C

Material examined: 14♂ and 16 ♀, São Tomé and Príncipe, Island of Príncipe, Parque Nacional Óbó, forest near radio tower 1.63 arir km WSW Bom Successo, 1325m alt., 0°16'34.0"N 6°36'20.0"E, hand collection, 9th of April and 5th of May 2001, 5th of May 2013. 1♀ (SALT1_16), São Tomé and Príncipe, Island of São Tomé, Java Plantation, 596m alt., 0°15'43.1"N 6°39'07.4"E, hand collection, 11th of April 2001.

Diagnosis: Males are recognised from their arrowhead stamp starting from the posterior most part of the prosoma and ending midway at PLE level (Fig. 15D). Male palps have RTAs with the thickest AAB and most delicate PAB (Fig. 17A-C)**.** Female epigynums have deep EP and unique dark bands across the dorsal part of the abdomen (Fig. 16B-C).

Etymology: The species is dedicated to Wanda Wesołowska, well-known salticid taxonomist, whose work made our project possible. The species epithet is derived from first letters of her name.

Description: Male (Fig. 15 A-D). Dark brown clypeus. Prosoma is also dark brown and much broader than the abdomen. There is a front facing arrowhead like stamp on the posterior dorsal part of the prosoma (Fig. 15D). Prosoma is 2.11mm in length and 1.54mm wide at PLE level. The abdomen is 2.37mm in length and 0.96mm wide at the widest point. Total length is 4.64mm. PLE and PME are surrounded by darker pigmentation (Fig. 15B). Chelicerae have slightly brighter colour than the prosoma and are small (Fig. 15A). Sternum is yellow and oval in shape (Fig. 15D). Dorsum has the same colour as the prosoma with a median band bordered by darker brown bands which cover only one third of the dorsal abdomen (Fig. 15C). Ventrum has a brown median band also covering one third of the abdominal length (Fig. 15D). Spinnerets are black (Fig. 15C-D). Palp colour is light brown with the dorsal area of the CY being brighter. EM is slender and very long, almost touching the tip of the CY (Fig. 17A-C). RTA is really large compared to the total size of the TI (it is almost half the length of the Cymbium). AAB is thinner and taller than PAB, its tip twists laterally and it is heavily sclerotised (Fig. 17A-C). PAB points directly upwards, has a lighter colour, less sclerotization and it is very thick. AB under the AAB is existent but tiny (Fig. 17B). RES is visible throughout the TE. Female (Fig. 16A-E). Overall has a lighter colour than the male. Prosoma is yellowish brown and broader than the abdomen (Fig. 16C). Prosoma is 2.18mm in length and 1.58mm wide at PLE level. Abdomen is 3.50mm in length and 2.20mm wide at the widest point. Total length is 5.98mm. The area dorsally on the prosoma, between PME and PLE is brown and the PME and PLE are surrounded by even darker pigmentation. Chelicerae are brown and large (Fig. 16 A, E). Posterior margin of the prosoma is slightly concave (Fig. 16E). Sternum is yellow and oval in shape. Dorsum has a busy pattern consisting of 2 bands stretching all the way to the sides across the abdomen. The bands are darker than the rest of the abdomen (Fig. 16 C, E). Ventrum has a darker median band covering the whole length of the abdomen. Spinnerets are yellow (Fig. 16 C-E). Epigynum is highly sclerotised similar to *M. nulnomad*. S is small, oval and darker than the CD which appears twisted. PEB bends outwards (Fig. 16B).

Distribution: Specimens for *Maltecora wawesa* were found only in the island of São Tomé.

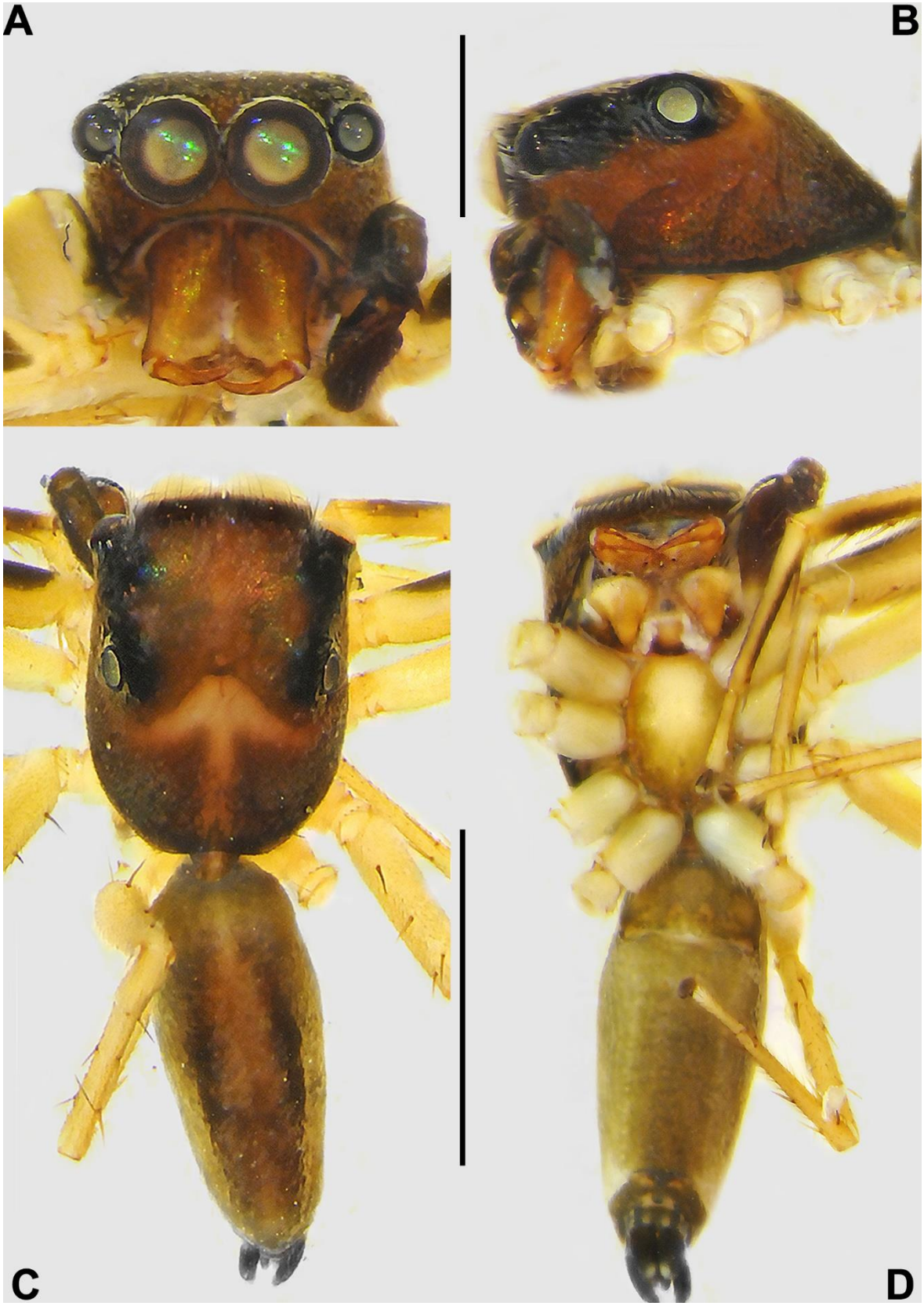

Figure 15: *Maltecora wawesa* male 22 habitus images **(A-D)**. **(A)** Cephalothorax frontal aspect, (B) Cephalothorax lateral aspect, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect. **Scale bars (A,B):** 1mm, **Scale bars (C,D):** 2mm.

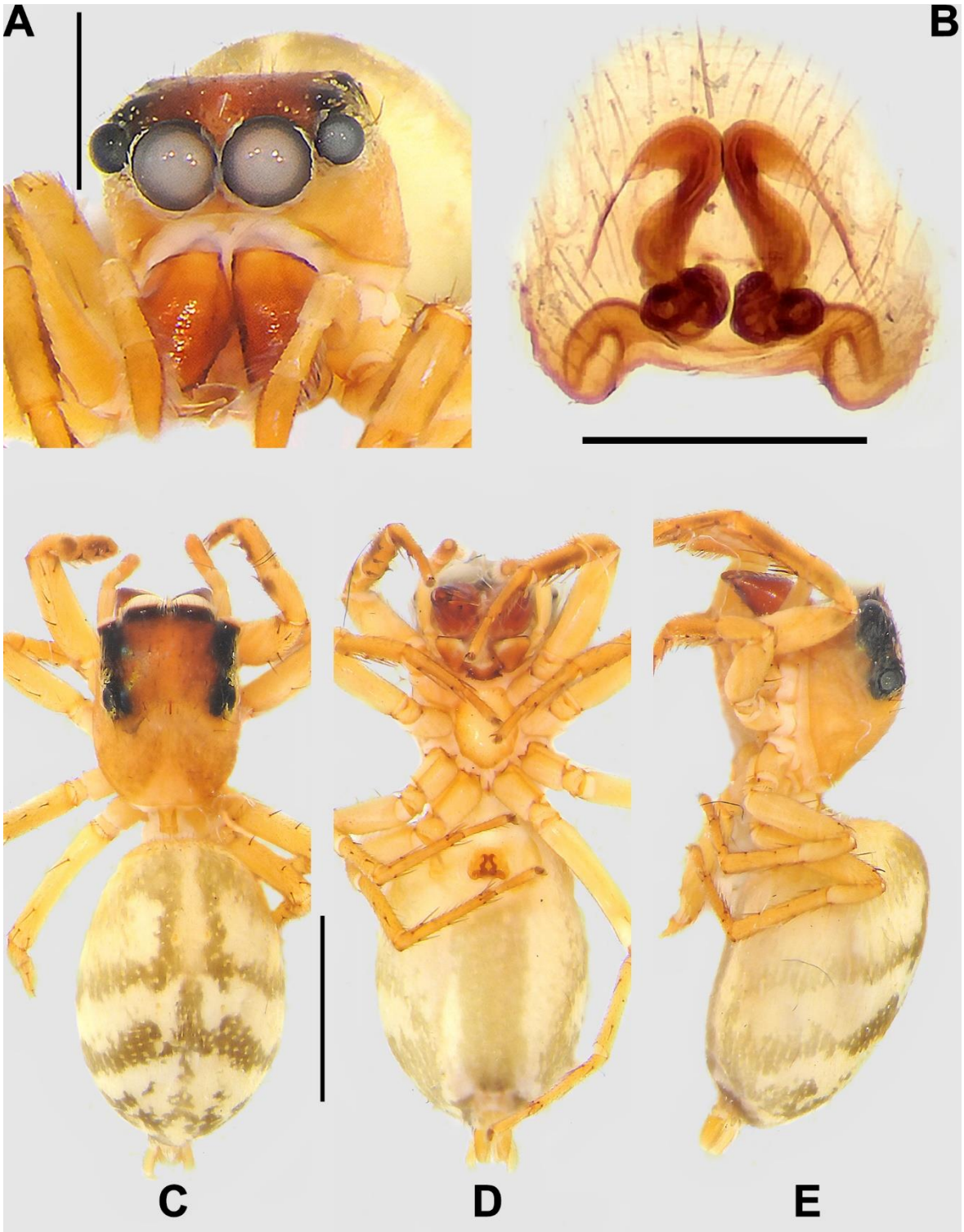

Figure 16: *Maltecora wawesa* female 75 habitus images and epigynum **(A-E)**. **(A)** Cephalothorax frontal aspect, **(B)** Epigynum, **(C)** Habitus dorsal aspect, **(D)** Habitus ventral aspect, **(E)** Habitus lateral aspect. **Scale bar (A):** 1mm, **Scale bar (B):** 0.3mm, **Scale bar (C-E):** 2mm.

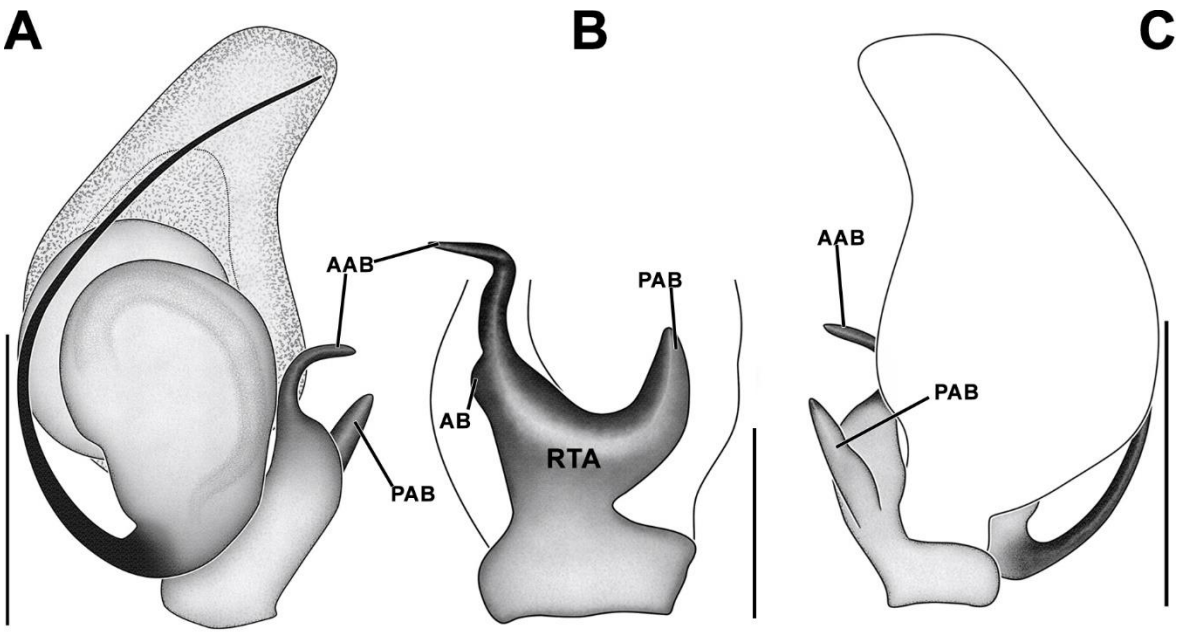

Figure 17: *Maltecora wawesa* male 22 palp drawings **(A-C)**. **(A)** ventral view, **(B)** retrolateral view of the RTA, **(C)** dorsal view. **Scale bars:** 0.3mm.

Molecular Phylogeny:

The aligned sequences for the COI gene resulted in a matrix consisting of 81 taxa and having a length of 658 bp (same length as COI). Using the taxa abovementioned in Table 3, three phylogenetic analyses were conducted. Regarding the phylogenetic placement of *Maltecora*, the results displayed by the three phylogenetic trees in Figure 18 are mostly congruent. When tested with Chrysillini and non-Chrysillini taxa, Figure 18C clearly shows that *M. chrysochlora* jumps in the Chrysillini green region and not in any of the other closely related tribes, Euophryini (marked with blue), Hasarini (marked with grey), Plexippini (marked with yellow), and Aelurillini (marked with orange). Additionally, when a more restricted Chrysillini taxon selection was used, similar results were obtained and *M. chrysochlora* is grouped together with the Chrysillines. As Figure 18B shows, despite its shiny morphological character, it appears closely related to Icius insolidus a rather dull coloured Chrysilline. Figure 18A displays taxa from a variety of genera where the males are brightly coloured and shiny. In this phylogenetic tree, *Maltecora* tends to group together with Chrysillini members even if the species do not exhibit shiny colours. Several taxa (Fig. 18, marked with a red asterisk) appeared consistently in unpredictable locations within the phylogenetic trees. This can be explained when taking into consideration that some of the specimens whose sequences were uploaded were misidentified and listed in another genus. Also, these taxa are only named up to genus level, which further questions their real identity.

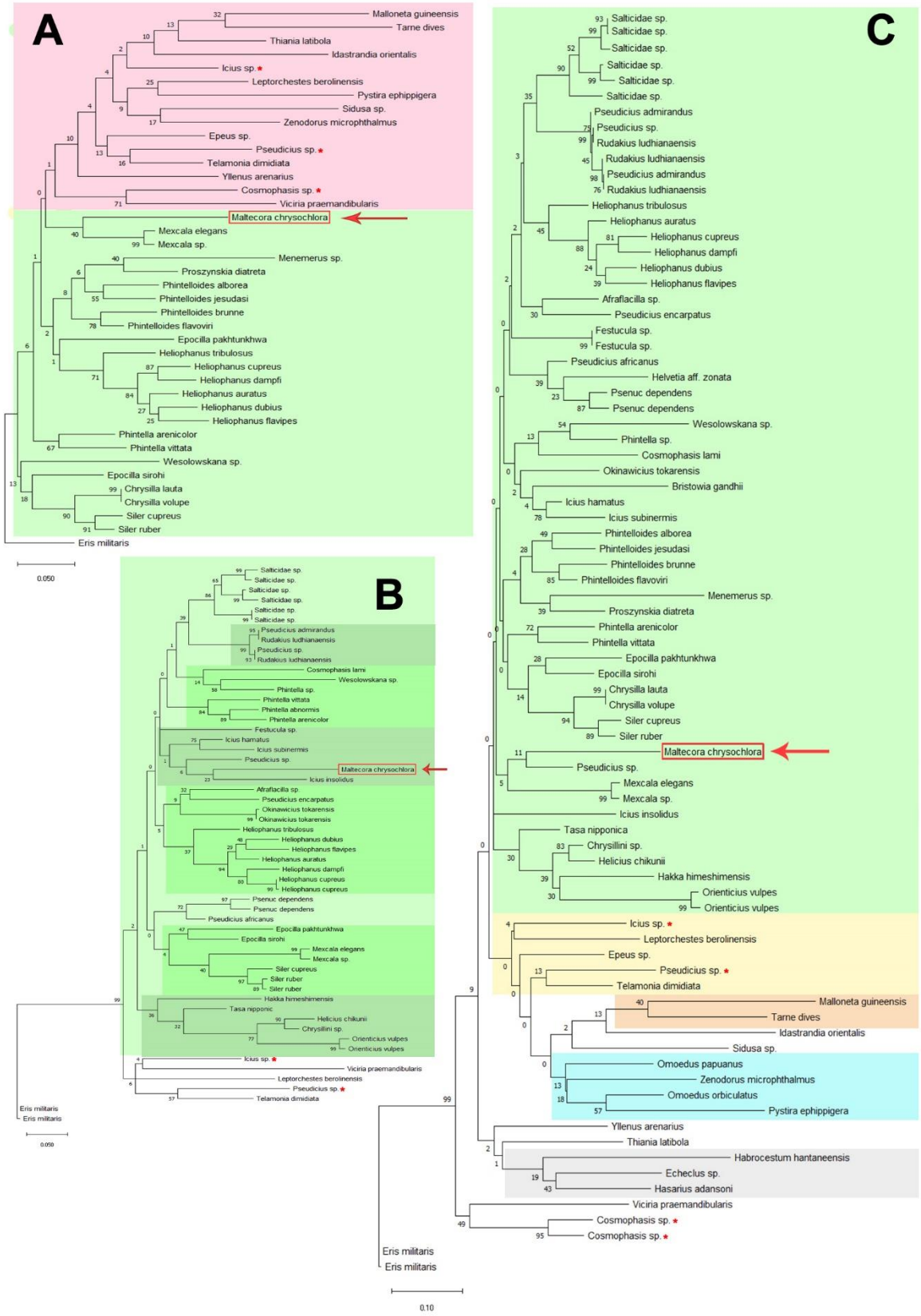

Figure 18: Phylogenetic trees. **(A)** A variety of non Chrysillini genera with shiny males, **(B)** A more restricted Chrysillini taxon selection, **(C)** Chrysillines tested with closely related tribes.

Although COI is not ideal for generic level distinctions (Maddison, 2018), the phylogenetic position of the genus in Chrysillini in all three analyses is supported without any conflicts.

Discussion

As shown on Fig. 18 B *Maltecora* seems to originate from a dark-coloured clade together with *Icius* and *Pseudicius* which have exclusively dull-coloured species (i.e., not physical colours). Taking into consideration that *Maltecora* is an island endemic, it is not surprising that some adaptive success is probably linked to the separate origin of bright colours of *Maltecora*. Sexual selection requires sexually dimorphic colour patterns (most cases: a shiny male and not a shiny female). However, *M. divina* and *M. janthina* and *M. chrysochlora* females also have shiny patterns. With that taken into account the sexual drive for the

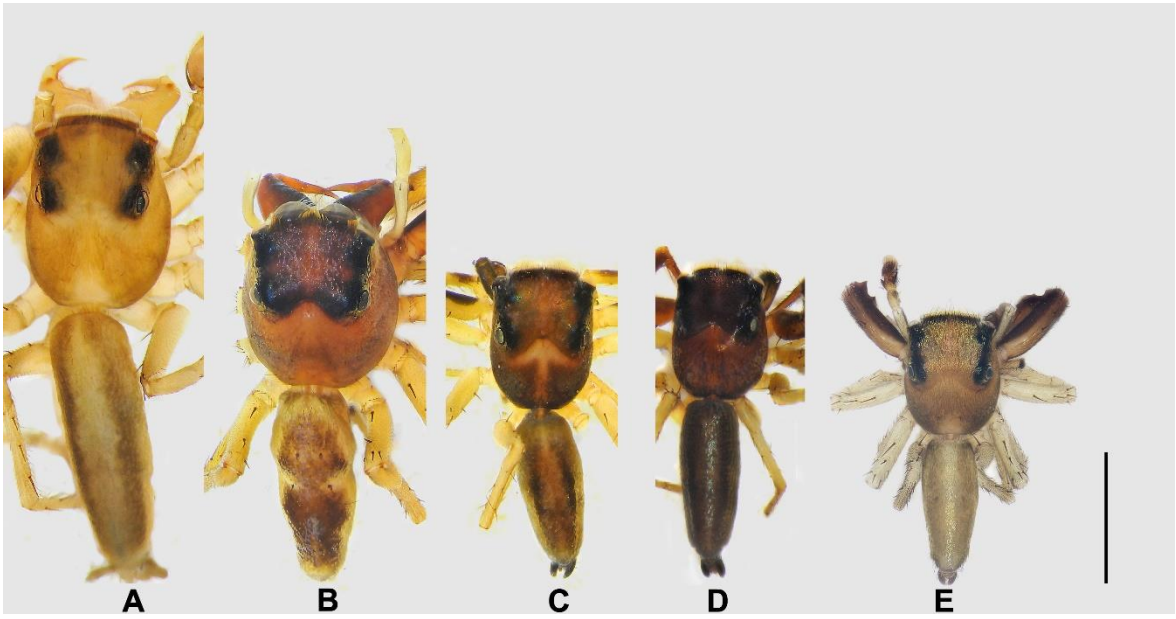

Figure 19: Comparison of male habitus sizes across *Maltecora sp.* **(A)** *M. nulnomad,* **(B)** *M. divina,* **(C)** *M. wawesa,* **(D)** *M. chrysochlora,* **(E)** *M. janthina*. **Scale bar:** 2mm.

conspicuous colour probably can be ruled out and the species' physical colours are related to a yet unknown environmental factor. This theory is further confirmed by the fact that the two new coexisting species differ in their shininess. *M. nulomad* and *M. wawesa* are coexisting in several localities and whereas *M. nulnomad* is dull and *M. wawesa* is brightly coloured (observation by T. Szűts when the specimens were alive during collection). This could imply species delimitation factors. In any case, further investigation is necessary to test any hypothesis about matching males and females.

Prior to this study, only three species of *Maltecora* were known, and only one (*M. janthina*) has been known by females. Here the overall similarity rule (allover features of males and female like the white moustache in *M. divina*), the size differences (larger males have larger females) and cooccurrence have been used as hypotheses for morphological forms as

matching sexes. With this study completed, an additional two new species have been described as members of the genus, thus in total 5 pairings have been proposed (the female of *M. janthina* has been reassigned). Among the coexistent species *M. nulnomad* has a big body, long legs, big chelicerae, small PAB, and big AAB, while *M. wawesa* with a smaller body and legs, smaller cheliceral size, smaller AAB and larger PAB shows an opposing morphological character, but these species limits remain to be tested rigorously. The two new species have the same locality (Fig. 20) but differ in morphology and RTA structures (Fig. 19A, 19C, 20). Although we haven't been able to prove it by DNA analysis, these major morphological differences between them support the results of these specimens being two different species.

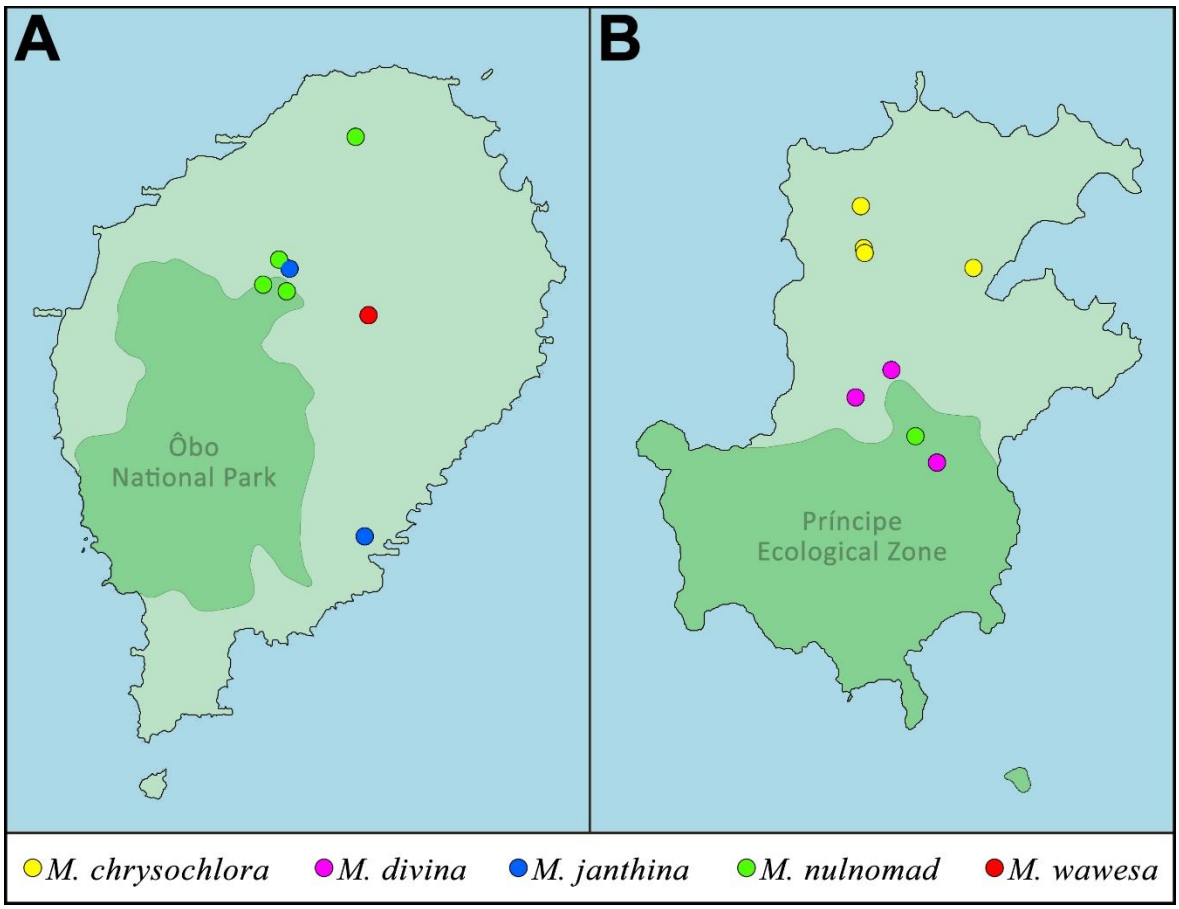

Figure 20: Topographical representation of *Maltecora sp.* collected across the Island of São Tomé **(A)**, and the Island of Príncipe **(B)**. **Note:** The two maps are not equally scaled, Single points on the maps might represent the locality of more than one specimen collected.

The geographical distribution also looks well divided (with a strange *M. nulnomad* occurrence in Princípe), and based on personal observation of T. Szűts, these species were relatively common.

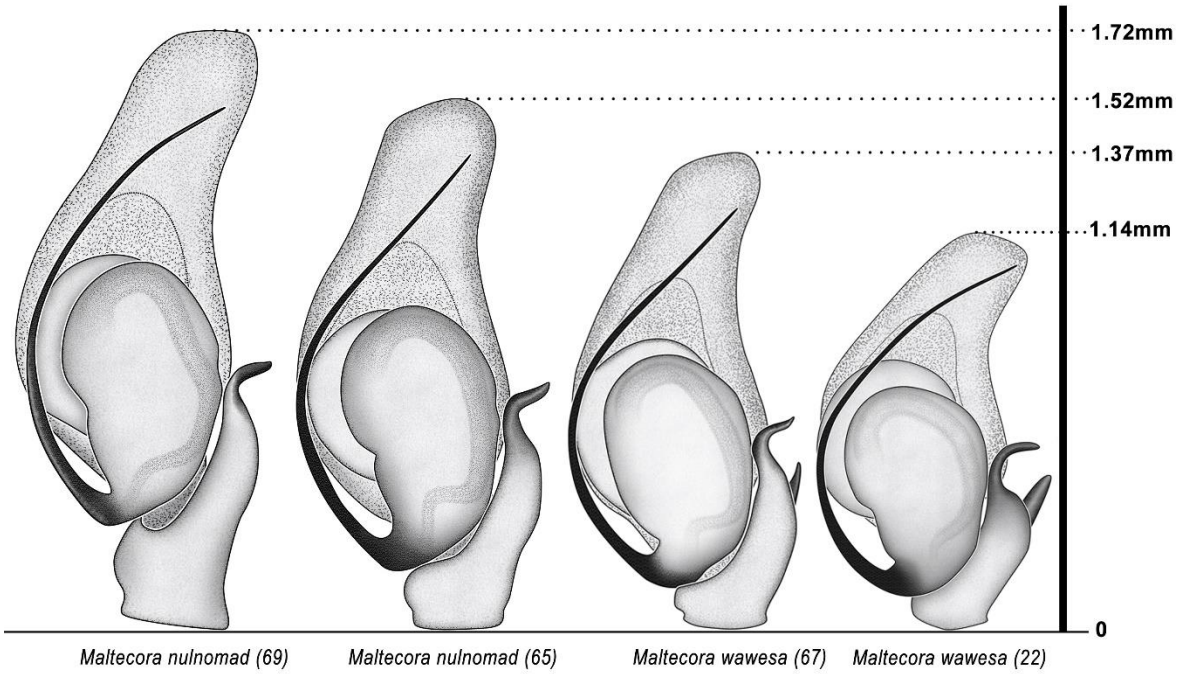

Figure 21: Male palp size comparison between *M. nulnomad* and *M. wawesa*. Corresponding species are indicated below the palps.

As we put the male palps in a consecutive row, it is evident, that the species of the two islands differ from each other by other means. *M. divina* and *M. chrysochlora* having bumps on tegulum close to the origin of the embolus, whereas the São Toméan species missing that feature. There is also a significant size difference among the species, the newly discovered have larger palpi (Fig. 21). All of these observations clearly show some current speciation processes, which should be also further investigated.

With two new species being described, this study emphasises the islands' importance in terms of biodiversity density and species endemism. Also, when dealing with biodiversity hotspots such as São Tomé and Príncipe, there is still a lot of work to be done to bring to light the unknowns of the natural world. The 2 national parks shown in Fig. 20 provide protection only for a relatively low number of species. With climate change and habitat destruction by humans, endemic species are highly threatened.

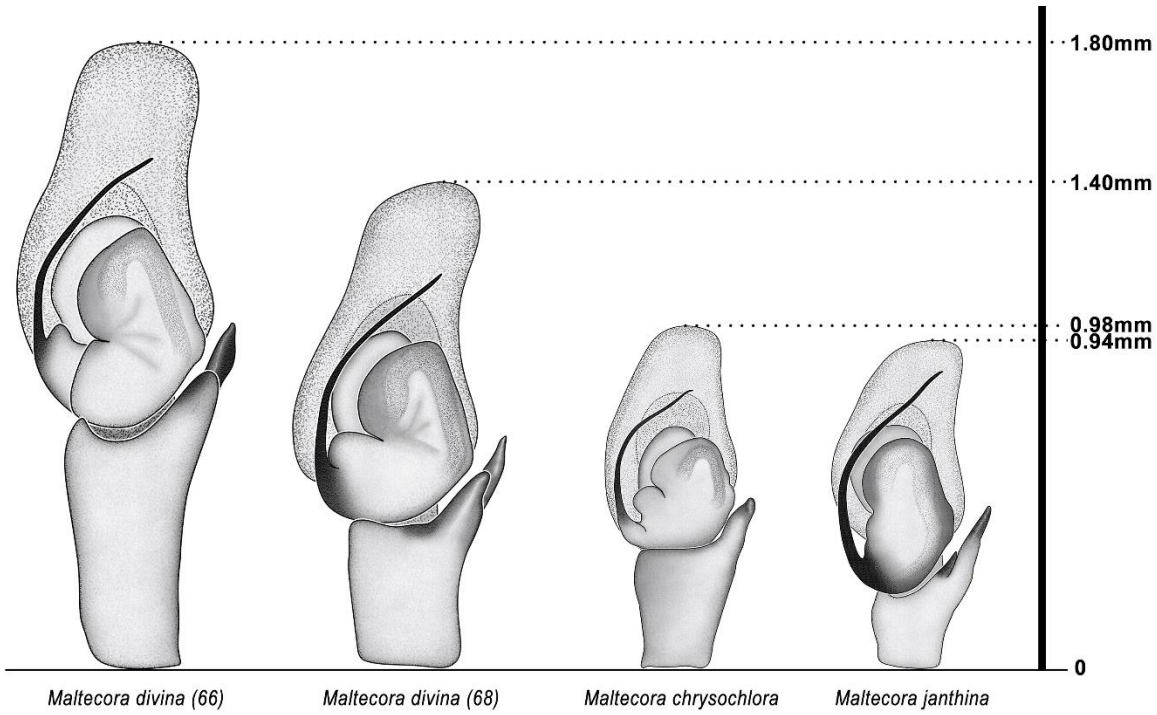

Figure 22: Male palp size comparison between M. divina, M. chrysochlora and M. janthina. Corresponding species are indicated below the palps.

Abstract

Commonly known as jumping spiders, Salticidae are distinguished from other spider groups by their superb eyesight. Spiders with such excellent visual abilities frequently have bright colours, which are often used in sexual selection. The genus *Maltecora* is such a jumping spider group, where the males have bright colours. Despite their conspicuous appearance, the genus is rather poorly known and they have only been found so far in São Tomé and Príncipe, two small volcanic islands in the Gulf of Guinea in the Atlantic Ocean. During my research, I illustrated several *Maltecora* specimens and sorted them into morphospecies. I was able to find all the three species that are already known, and two more distinct groups. These are described as species new to science. DNA extraction was conducted from the specimens. I was focusing on COI as it is often used as a DNA barcode, therefore a lot of other sequences were available. Several genera sharing similar morphological characters could be potentially related to *Maltecora*. *Chrysilla, Phintella, Mexcala, Thiania, Tarne, Omoedus* and many more. A larger dataset was collected, sequences were multiple-aligned, and a phylogenetic tree was inferred. Based on the results, it is almost certain that *Maltecora* belongs to the tribe Chrysillini. Within the there are

numerous bright-coloured groups (*Phintella, Mexcala,* etc.) and *Maltecora* nested in a dull-colour clade, suggesting a completely new origin of bright colours.

Összefoglaló

Az ugrópókként is ismert Salticidae pókcsaládot kiváló látásuk különbözteti meg a többi pókcsoporttól. A jó vizuális képességekkel rendelkező pókok gyakran élénk színekkel rendelkeznek, amelyeket sokszor a szexuális szelekcióban is használnak. A *Maltecora* genusz egy olyan ugró pókcsoport, ahol a hímek élénk színekkel rendelkeznek. Feltűnő megjelenésük ellenére a nemzetség meglehetősen gyengén ismert, és eddig csak az Atlanti-óceán Guinea-öbölijében található két kis vulkanikus szigeten, São Toméról és Prínciperől ismertek. Kutatásom során több *Maltecora* példányt illusztráltam, és morfo-fajokba válogattam őket. Megtaláltuk mindhárom eddig ismert fajt és még két különálló csoportot. Ezeket a tudomány számára új fajként írom le. A mintákból DNS -kivonást is végeztük. A COI génre koncentráltam, mivel ezt gyakran használják DNS bárkódként, ezért sok összehasonlító szekvencia is rendelkezésemre állt. Számos hasonló morfológiai karakterrel rendelkező nemzetség szóba jöhet, mint *Maltecora* rokon. A Chrysilla, Phintella, Mexcala, Thiania, Tarne, Omoedus és még számos más. Ezért egy nagyobb adatbázis gyűjtöttem össze, a szekvenciákat multiple align-nal rendeztük, és egy filogenetikai fát készítettünk. Az eredmények alapján szinte biztosra vehető, hogy a *Maltecora* a Chrysillini tribushoz tartozik. A tribuson belül számos élénk színű csoport (Phintella, Mexcala stb.) létezik. A *Maltecora* fakó színezetű kládban helyezkedik el, ami az élénk színek teljesen új eredetére utal.

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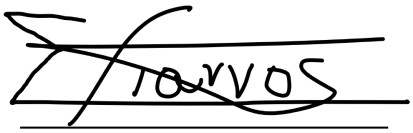

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Appendix 5. Declaration regarding TDK research paper-thesis equivalence

DECLARATION

I hereby declare that the thesis entitled *"Molecular and morphological analysis of tropical jumping spiders of the genus Maltecora Simon, 1909."*
is identical in terms of content and formal requirements to the TDK research paper submitted in 2021.

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YIANNOS SOFOCLEOUS .....

(Name of student)