

TAXONOMY AND NOMENCLATURE

 Review of *Paraphotina* (Mantodea: Photinaidae)

 Antonio A. Agudelo^{1*} & José A. Rafael¹
¹Programa de Pós-graduação em Entomologia, Coordenação de Diversidade, Instituto Nacional de Pesquisas da Amazônia. Avenida André Araujo 2936, Aleixo, 69067-375 Manaus, AM, Brazil.

^{*}Corresponding author. E-mail: ant.agudelo@yahoo.com

ABSTRACT. The number of studies on Neotropical mantises has been growing in recent years, and the systematics of Mantodea is now a dynamic field with noteworthy contributions. Several taxonomic revisions have been published recently. The taxonomy of *Paraphotina* Giglio-Tos, 1915 is reviewed as part of current studies on systematics of Neotropical Mantodea. Currently, *Paraphotina* contains four species from South America: *P. caatingaensis* (Menezes & Bravo, 2013) **comb. nov.**, *P. insolita* (Rehn, 1941), *P. occidentalis* Lombardo, 1998 and *P. reticulata* (Saussure, 1871). *Paraphotina venezuelana* Beier, 1963 is a new junior synonym of *P. insolita*. Keys for the *Paraphotina* species are proposed. The distribution of *Paraphotina* species is apparently correlates with areas of endemism in the Amazonian and Cerrado regions.

KEY WORDS. Amazon, Neotropics, praying mantises, taxonomy.

Taxonomic revisions are an important tool towards a better understanding of the biodiversity, or at least a revalued characterization, of a particular taxon. Studies on Neotropical mantises have been emerging with greater frequency in recent years (RIVERA 2010). The increase in contributions highlights the interest in taxonomic revisions and the continuous emergence of new researchers. The systematic of Mantodea is currently in the process of high-level revision; hence the taxonomic arrangement of large families such as Mantidae and its subfamilies tends to be questionable. Although the first phylogenetic studies supported the groups that had been proposed in the past, for instance Acanthopidae and Thespidae (at least with respect to the Neotropical groups) (YAGER & SVENSON 2008, SVENSON & WHITING 2009, WIELAND 2013), they have also left some unresolved questions. For example, the phylogenetic relationships of Mantidae, the largest family of Mantodea, remain unresolved. These preliminary phylogenetic studies with a Mantodean focus have demonstrated a way to resolve possible taxonomic conflict using cladistics and probabilistic methods.

Paraphotina Giglio-Tos, 1915 is located within Photinaidae Giglio-Tos, 1915. The Photinaidae species are distributed only in the Neotropical region, specifically in South America, with the exception of *Macromantis nicaraguae* Saussure & Zehntner, 1894. The division of Photinainae into two tribes, Photinini and Coptopterygini, introduced by BEIER (1964) was the most widely accepted (EHRMANN 2002, OTTE & SPEARMAN 2005, AGUDELO et al. 2007, EHRMANN & KOÇAK 2009). Results from molecular phylogenetic studies (YAGER & SVENSON 2008, SVENSON & WHITING 2009) and

morphological data (WIELAND 2013) do not support Photinainae sensu BEIER (1964) as monophyletic. Therefore, suprageneric level relationships are currently under investigation with combined morphological and molecular data (A. Agudelo, unpub. data). Despite the parafyly of Photinaidae (SVENSON & WHITING 2009), the taxonomic validity of its genera appears to not have been questioned, except for *Metriomantis* Saussure & Zehntner, 1894, and *Photinella* Giglio-Tos, 1915 (J. Rivera & A. Agudelo, pers. obs.). Photinainae are easily identifiable and their diagnostic features allow for the delimitation of sets of species with well-defined patterns. Taxonomic revisions of Photinaidae genera began with the contributions of HEITZMANN-FONTENELLE (1968), who revised the species of *Cardioptera* Burmeister, 1838, and TERRA (1995), who reviewed the Neotropical genera and proposed a classification of the subfamily without tribes. LOMBARDO (1999) commented on *Metriomantis* and described *Rehniella* (nec HEBARD 1928), current synonym of *Photiomantis* Piza, 1968 (see AGUDELO & RIVERA 2015). Later, ROY (2002) revised *Macromantis* Saussure, 1871 while ROY & STIEWE (2011) did the same with *Orthoderella* Giglio-Tos, 1897.

There are discrepancies among authors about the number of known species of *Paraphotina*. While LOMBARDO (1998), OTTE & SPEARMAN (2005), AGUDELO et al. (2007) and RIVERA (2010) accepted two species based on CERDÁ (1992), TERRA (1995), EHRMANN (2002) and EHRMANN & KOÇAK (2009) recognized three species. All these proposals have been made without a revisionary study. The objective of this study is to revise *Paraphotina* species based on type specimens, review material from different localities, and propose a key for proper species identification.

MATERIAL AND METHODS

Ninety-eight specimens of *Paraphotina* from the following collections were examined for comparison (alphabetical list by acronym): ANSP – Academy of National Science of Philadelphia, USA; CEAAVF – Coleção Entomológica Adalberto Antonio Varela Freire, Universidade Federal do Rio Grande do Norte, Brazil; CZMA – Coleção Zoológica de Maranhão, Universidade Estadual de Maranhão, Brazil; CZPB – Coleção Zoológica Paulo Bührnhein, Departamento de Biologia, Universidade Federal do Amazonas, Brazil; INPA – Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil; MHNG – Muséum d'histoire naturelle de Genève, Switzerland; MNHN – Muséum national d'Histoire naturelle, France; MPEG – Museo Paraense Emilio Goeldi, Brazil; MZFS – Coleção Entomológica Professor Johann Becker do Museu de Zoologia da Universidade Estadual de Feira de Santana, Brazil; ZMH – Zoologische Museum Hamburg, Germany; ZSM – *Zoologische Staatssammlung München, Germany*.

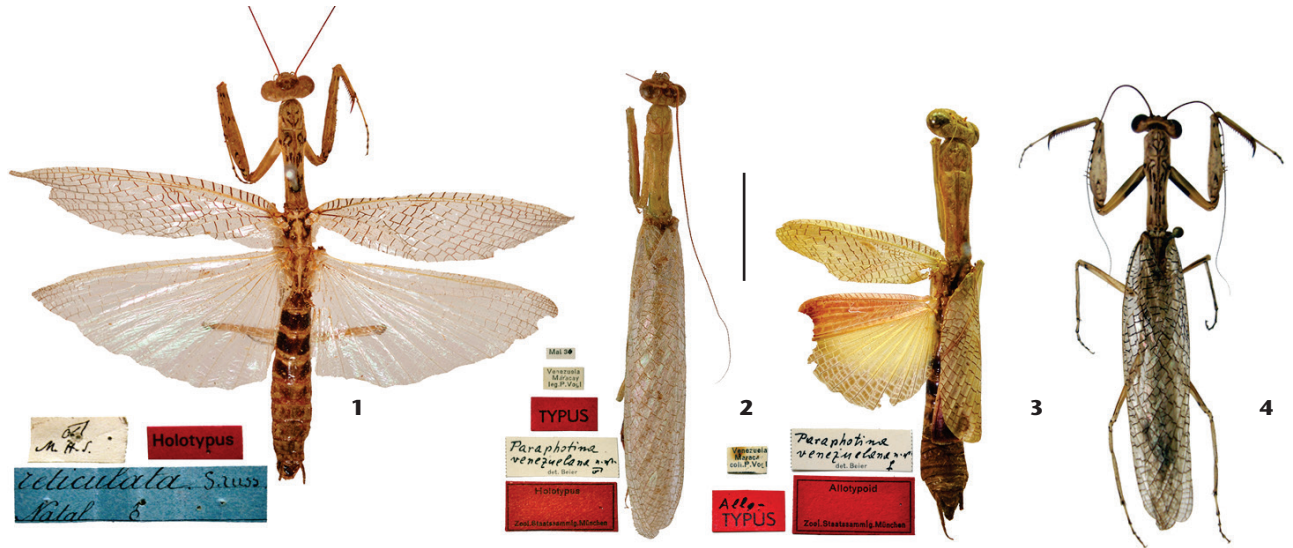
Specimens were measured and identified using a stereomicroscope Nikon SMZ645[®], photographed using a Leica M205C[®] and Leica application suite 2010-Montage[®]. To dissect the male genitalia, the distal portion of the specimen's abdomen was soaked for about 30 minutes in hot water (70°C). The external genitalia were then removed and dissected using a hypodermic needle. Isolated genital parts were cleared using a warmed 10% KOH solution, neutralized with acetic acid, then rinsed and preserved in glycerol. Genital nomenclature follows BEIER (1970). The redescription of the genus was based on all consistent patterns observed in all specimens studied.

TAXONOMY

Historical overview. *Paraphotina* Giglio-Tos, 1915 was created based on the unique nominal species *Cardioptera reticulata* Saussure, 1871 (Fig. 1). The original description of *C. reticulata* was published in the *Memoires de la Société de Physique et d'Histoire Naturelle de Genève* in 1871 (SAUSSURE 1871a: 196), later a reprinted edition from *Memoires SPHNG* was published by SAUSSURE (1871c), including the XXI tome (SAUSSURE 1871a: 1-214) where *C. reticulata* had been described. SAUSSURE (1871b) listed two species with the name *C. reticulata*, the first species described by him in the same year, and second species (*M. reticulata* Burmeister, 1838) with provisional combination *C. reticulata* (Burmeister, 1838). In a footnote, SAUSSURE (1871b) makes clear that if Burmeister's species would turn out belong to *Cardioptera*, the name of his own species need to be changed. WESTWOOD (1889) changed the name of Burmeister's homonymous species to *C. burmeisteri*. KIRBY (1904a), however, recognized that the nomination by Westwood correspond, it fact, to the second species of the Saussure's list (Burmeister's species), which had priority because is the older available name. He decided to rename Saussure's species to *P. gracilipes*. Currently, Burmeister's species is combined with *Photina* as *P.*

reticulata, so the name given by Saussure should be maintained, thus eliminating the need of the name proposed by KIRBY (1904a). GIGLIO-TOS (1915) discovered that *C. reticulata* Saussure is not a representative of *Cardioptera* nor *Photina*, thus rejecting the combinations of WESTWOOD (1889) and KIRBY (1904a, b). In order to distinguish between *C. reticulata*, *Orthoderella ornata* Giglio-Tos, 1897 and the species included in *Photina*, GIGLIO-TOS (1915) created the genus *Paraphotina*. Among the diagnostic features he used are shape of pronotum, elevation of the vertex, development of juxta-ocular tubercles, and the size of forefemora which are thinner in *C. reticulata* than in *Photina* species. GIGLIO-TOS (1915) created Photininae to group genera morphologically related to *Paraphotina*, e.g., *Photina*, *Metricromantis* and *Photinella*, his Photininae also included other groups of genera of the subfamily such as the *Coptopteriges*-group, the *Orthoderellae*-group and the *Irides*-group. Interestingly, his *Orthoderellae*-group included representatives from *Orthoderella* but not *Paraphotina*, a genus which GIGLIO-TOS (1915) had implicitly stated as being similar to *Orthoderella*. Later, GIGLIO-TOS (1919, 1927) transferred *Paraphotina* to *Orthoderellae*. BEIER (1935) placed *Paraphotina* within the Photinini, under the large subfamily Mantinae. Subsequently, BEIER (1964, 1968) revalidated this group back to subfamily status, but transferred *Paraphotina* from Photinini to Coptopterygini. In his revisionary work of Neotropical genera, TERRA (1995) redescribed *Paraphotina* within Photininae (without tribes), drawing attention to the nomenclatural status of the name Photininae, which was pre-occupied by a firefly genus of Lampyridae (Coleoptera), the case was reprised and analyzed by SVENSON & BRANHAM (2007). EHRMANN (2002) reprised the classification of Photininae into two tribes (Photinini and Coptopterygini) and transferred *Paraphotina* back to Photinini. The classification of EHRMANN (2002) was followed by several authors (AGUDELO & CHICA 2003, OTTE & SPEARMAN 2005, AGUDELO et al. 2007, EHRMANN & KOÇAK 2009), some already using the amended name Photinoinae (RIVERA 2010, RODRIGUES & CANCELLO 2013, ROY 2014, FRANÇOIS & ROY 2015). A new proposed classification by RIVERA & SVENSON (2016) includes *Paraphotina* within Orthoderellini.

BEIER (1942) was the first to report a female of the genus from Bahia, highlighting the spots on the anterior coxae. BEIER (1963) described *Paraphotina venezuelana* Beier, 1963 from Maracay, Venezuela, based on a male holotype (Fig. 2) and a female allotype (Fig. 3). CERDÁ (1992) discovered that the specimen described by REHN (1941) as the holotype of *Guaraunia insolitum* (type species of *Guaraunia*) corresponds to a representative of the genus *Paraphotina*. He also suggested that *P. venezuelana* and *G. insolita* are synonyms of *P. reticulata*, arguing that differences in size and coloration are just geographical variations of the same species. Apparently, TERRA (1995) was not aware of the procedure of CERDÁ (1992) and also proposed *Guaraunia* as a new synonym of *Paraphotina* without establishing a species-level synonymy. That is, he treated the three species known at the time as valid: *P. insolita* (*Guaraunia insolitum*), *P. reticulata* and *P. venezuelana*.



Figures 1-4. Types of *Paraphotina* (dorsal habitus): (1) *Paraphotina reticulata* (originally *Cardioptera reticulata* Saussure, 1871) holotype male deposited in MHNG; (2-3) *Paraphotina venezuelana*, (2) holotype male, (3) allotype deposited in ZSM; (4) *Paraphotina caatingaensis* **comb. nov.** (originally *Orthoderella caatingaensis* Menezes & Bravo, 2013) holotype male deposited in MZFS. Arrow highlights the basal spot on fore coxa. Scale bar: 10 mm. Photo of *P. caatingaensis* courtesy of E. Menezes (MZFS).

Later LOMBARDO (1998) approved the synonymy of CERDÁ (1992) and added the description of *Paraphotina occidentalis* from Peru, leaving *Paraphotina* with two valid species: *P. occidentalis* and *P. reticulata*. However, EHRMANN (2002) and EHRMANN & KOÇAK (2009) treated *P. insolita* as valid and *P. venezuelana* as a synonym of *P. reticulata*, thus accepting three species for the genus. Recently, *Orthoderella caatingaensis* Menezes & Bravo, 2013 has been described from Bahia (Fig. 4). We will show that this species has some features that are not seen in *Orthoderella* and should be transferred to *Paraphotina*.

Paraphotina has been morphologically associated with *Orthoderella* and very likely they are closely related. Although at first glance the general appearance is similar, conserved features in this group of species have confirmed the generic status of *Paraphotina*, e.g., the weak development of the juxta-ocular tubercles, and the shape of the head and pronotum. The original descriptions of *Paraphotina* species were well detailed, except for *P. reticulata*. The species currently included in *Paraphotina* are morphologically homogeneous (Figs. 5-8) the differences between them being very subtle. They essentially concern only the shape of some body parts (Figs. 9-16) and the male external genitalia (Figs. 17-33). We provide a complete redescription of the genus and a diagnosis with comparative figures for each species. Particularities of each species are commented upon in the diagnoses. Unfortunately, the number of available females does not allow us to make a proper review of this sex to be incorporated into the key. Therefore, it has become necessary to use features of the male external genitalia for elaborating the key.

Key for adult males of *Paraphotina*

1. Fore coxae without spots2
- 1'. Fore coxae with ventrobasal spot (Fig. 4, arrow).....
.....*P. caatingaensis*
2. Body length, from the anterior part of vertex to the apex of the subgenital plate, usually 40 mm, rarely reaching 45 mm. Right membranous lobe (dorsal view) of hypophallus with moderately long setae (Fig. 22), or hypophallus ending in a strongly sclerotized lateral process (Fig. 24, lp).....3
- 2'. Body length, from the anterior part of vertex to the apex of the subgenital plate, usually greater than 45 mm. Right membranous lobe (dorsal view) of hypophallus with minute setae and without lateral process (Fig. 23)*P. occidentalis*
3. Pseudophallus projected towards dextro-ventrally (dorsal view) (Fig. 18, psph). Hypophallus without lateral process (Fig. 22)*P. insolita*
- 3'. Pseudophallus projected towards dextro-dorsally (dorsal view) (Fig. 20, psph). Hypophallus with a strongly sclerotized lateral process (Fig. 24, lp)*P. reticulata*

Paraphotina Giglio-Tos, 1915

Paraphotina Giglio-Tos, 1915: 72

= *Guaraunia* Rehn, 1941 (synonymy by CERDÁ 1992).

Type species. *Cardioptera reticulata* Saussure, 1871: 196 (1871c: 344, reprint), by monotypy.

Redescription. Body pale yellow to yellow-ochre. Length of body (vertex to apex of abdomen) 30-52 mm (Table 1). Head



Figures 5-8. Males of *Paraphotina* (dorsal habitus): (5) *P. caatingaensis* from Bahia, Brazil; (6) *P. insolita* from Meta, Colombia; (7) *P. occidentalis* from Coari, Amazonas, Brazil; (8) *P. reticulata* from Maranhão, Brazil. Scale bar: 10 mm.



Figures 9-12. Head of males of *Paraphotina* (frontal view): (9) *P. caatingaensis* from Bahia, Brazil; (10) *P. insolita* from Meta, Colombia; (11) *P. occidentalis* from Coari, Amazonas, Brazil; (12) *P. reticulata* from Maranhão, Brazil. Scale bar: 1 mm.

elliptical; antennae filiform with scattered short setae, longer than half of body; pedicel and scape clear; vertex convex in frontal view, higher than juxta-ocular tubercles; juxta-ocular tubercles slightly developed; eyes globose (Figs. 9-12); ocellar tubercle pale yellow to dark gray without developed expansions in male; female ocelli located at center of a transversal carina; frontal shield more than three times wider than high, central part of dorsal margin convex. Pronotum with arabesque marks, elongated, smooth; prozona with anterior margin convex, lateral margins subparallel; metazona 2.5 times longer than prozona,

with longitudinal carina slightly marked; pronotal terminal tubercle poorly developed with two distal spots, which may be fused (Figs. 13-16). Fore coxae almost as long as metazona. Forecoxae and trochanters smooth, with or without black spots. Fore femora mildly concave dorsally, generally with three spots on anterior surface and arabesque marks in posterior surface; 13-14 anteroventral spines, the even spines generally with black spot at base, rarely at distal odd spines; 5 posteroventral spines, black at base; 3 discoidal spines, second spine with an anterior black spot at base. Fore tibiae usually with three black spots on



Figures 13-16. Pronota of males of *Paraphotina* (dorsal view): (13) *P. caatingaensis* from Bahia, Brazil; (14) *P. insolita* from Meta, Colombia; (15) *P. occidentalis* from Coari, Amazonas, Brazil; (16) *P. reticulata* from Maranhão, Brazil. Scale bar: 1 mm.

Table 1. Comparative measurements of the examined specimens of *Paraphotina*.

Length	<i>P. caatingaensis</i>		<i>P. insolita</i>		<i>P. occidentalis</i>		<i>P. reticulata</i>	
	Male (mm)	Female (mm)	Male (mm)	Female (mm)	Male (mm)	Female (mm)	Male (mm)	Female (mm)
Body (head to tip of abdomen)	30.0-39.0	45.0	38-40	37.0	47.0-52.0	–	36.0-45.0	43.64
Head (vertex to distal margin of labrum)	3.8-4.0	5.2	3.6-3.8	–	4.2-4.7	–	3.6-4.2	5.10
Distance between lateral margins of the eyes	5.0-5.5	7.0	5.3-5.5	–	6.0-6.8	–	5.0-6.3	6.91
Pronotum	9.8-11.7	13.5	9.0-11	11.0	12.6-14.2	–	10.0-12.5	13.67
Prozona	2.9-3.8	4.3	2.2-2.8	–	2.6-3.7	–	3.0-3.5	3.78
Metazona	6.9-7.9	9.2	6.8-8.2	–	10.0-10.5	–	7.0-9.0	9.89
Prothoracic coxae	6.0-7.5	9.5	7.0-7.5	8.0	9.0-9.7	–	7.0-9.0	9.38
Prothoracic femora	8.0-9.5	12.0	9.0-9.5	–	10.7-11.5	–	8.5-10.5	12.35
Prothoracic tibiae	4.8-5.0	7.0	4.8-5.2	–	6.2-7.0	–	4.5-6.2	7.41
Prothoracic tarsomere I	3.2-3.5	3.7	3.5-4.0	–	4.0-4.2	–	3.0-4.0	4.11
Meso thoracic femora	6.0-7.0	7.3	6.0-7.0	–	8.5-10.0	–	6.5-6.8	7.08
Meso thoracic tibiae	5.0-6.0	7.0	7.0-7.8	–	7.5-8.0	–	6.0-6.8	8.23
Meso thoracic tarsomere I	1.3-1.6	1.5	2.6-3.2	–	2.0	–	1.5-2.0	1.64
Metathoracic femora	6.5-7.5	8.0	7.0-8.0	–	9.0-9.5	–	7.0-9.0	9.22
Metathoracic tibiae	7.0-8.5	10.0	9.0-9.5	–	10.0-10.8	–	8.5-10.2	11.85
Metathoracic tarsomere I	2.0-2.3	2.0	2.0-2.3	–	2.5-2.8	–	2.0-2.8	2.63
Meso thoracic wings (base to apex)	25.5-28	21.0	27.0-29.0	15.0	35.0-38.8	–	25.5-33.5	21.74
Metathoracic wings (base to apex)	23.5-26	18.0	26.0-27.0	–	34.0-37.5	–	24.5-31.5	18.44

posterior surface; 16-17 anteroventral spines; 13-14 posteroventral spines. All foreleg spines, including tibial claw, darker at tip. Fore metatarsus longer than remaining tarsomeres altogether. Meso and metathoracic femora, tibiae and tarsi setose in male.

Male wings surpassing the tip of abdomen, hyaline, with array of interference colors (wing interference patterns, WIPs by SHEVTSOVA et al. 2011). Female wings opaque; mesothoracic wings as long as abdomen, but shorter than the abdomen when at rest above

it (Figs. 3, 34). Veins of mesothoracic wings almost entirely light brown in males, dark brown in females; venules dark brown, arranged parallel in costal area; stigma hyaline in males, opaque in females. Female with costal area of methathoracic wing pale yellow; apex of discoidal area dark brown, remaining parts ochre or reddish-brown; anal area yellow and subhyaline becoming brownish towards distal end (Fig. 3). Male abdomen subcylindrical (Fig. 1); in female somewhat dilated and ventrally compressed (Fig. 34); both sexes with dark horizontal stripes on first four tergites, less noticeable in T1. Supra-anal plate short and tongue-shaped, shorter than cerci. Cerci (Figs. 34) notably exceeding apex of subgenital plate, conical and laterally compressed. Subgenital plate with left lateral process developed and well sclerotized (Figs. 30-33, 11p).

Paraphotina caatingaensis
(Menezes & Bravo, 2013) **comb. nov.**

Figs. 4, 5, 9, 13, 17, 21, 30

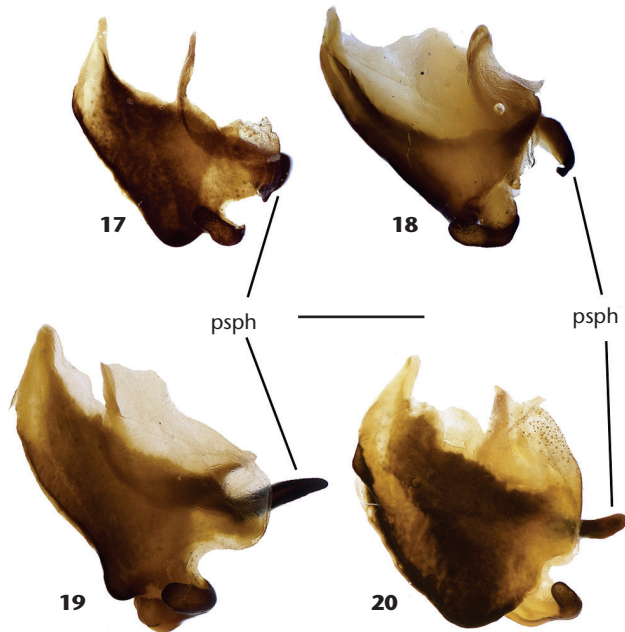
Orthoderella caatingaensis Menezes & Bravo, 2013: 13. Beier, 1942: 139, female *partim*; Rodrigues & Canello, 2013: 964, *partim*. Type material: male holotype, male paratype deposited in MZFS.

Diagnosis. Length 30-45 mm. Size small and slender for the genus (Fig. 5). Ocellar tubercle grayish. Pseudophallus short and trapezoidal (Fig. 17, psph). Hypophallus with a strongly sclerotized lateral process, right membranous lobe with moderately long setae (Fig. 21).

Type locality. Brazil (Bahia, Pilão Arcado).

Material examined. All specimens of *P. caatingaensis* **comb. nov.** from BRAZIL, *Bahia*: Encruzilhada (850 m) 15°34'35"S, 40°58'51"W, 1 male, arm., luz, Rafael JA, Grossi EJ leg.; *Maranhão*: Mirador (Parque Est. Mirador, Base da Geraldina), 06°37'25"S 45°52'08"W, 1 male, 13-19.viii.2012, armadilha luminosa, Santos LL, Pinto JS, Santos LS leg. (INPA); same data but 6 males, 21-26.viii.2006, armadilha luminosa, Limeira de Oliveira F leg. (INPA); same data but 3 males, 07-11.ix.2007, armadilha luminosa, Limeira de Oliveira F, Silva JC leg. (CZMA); same data but 1 male, 07-11.ix.2007, armadilha luminosa, Limeira de Oliveira F, Silva JC leg. (INPA); same data but 8 males, 28.viii-03.ix.2008, armadilha luminosa, Limeira de Oliveira F, leg. (CZMA); same data but 11 males, 28.viii-03.ix.2008, armadilha luminosa, Limeira de Oliveira F leg. (INPA); Mirador (Parque Est. Mirador, Base dos Cágados), 06°48'29"S 45°06'34"W, 3 males, Limeira de Oliveira F, Santos AA, Lima TM leg. (CZMA); same data but 2 males, Limeira de Oliveira F, Santos AA, Lima TM leg. (INPA); *Minas Gerais*: Berizal (Fazenda Veradão), 15°39'54"S, 41°39'56"W, 1 male, 12.xii.2012, Rafael JA, Rossi EJ leg. (INPA); *Rio Grande do Norte*: Serra Negra do Norte, 5 males, i.2003, Varela Freire AA leg. (UFRN); Parnamirim (Barreira do inferno), 2 females, 20.iv.2011, Araujo JC leg. (UFRN).

Distribution. Brazil (Bahia, Maranhão, Minas Gerais, Piauí, Rio Grande do Norte).



Figures 17-20. External genitalia, left epiphallus of species of *Paraphotina* (dorsal view): (17) *P. caatingaensis* from Rio Grande do Norte, Brazil; (18) *P. insolita* from Meta, Colombia; (19) *P. occidentalis* from Coari, Amazonas, Brazil; (20) *P. reticulata* from Maranhão, Brazil). (psph) Pseudophallus. Scale bar: 10 mm.

Remarks. In the original description of *O. caatingaensis*, the authors noted that the top of vertex is as high as the juxta-oculars tubercles in frontal view (MENEZES & BRAVO 2013). This single characteristic does not match one of the main diagnostic features of *Orthoderella*, which exhibit the vertex with the two juxta-ocular tubercles produced into conical postero-lateral processes much higher than the eyes (ROY & STIEWE 2011). Therefore, in *Orthoderella* the top of vertex is concave (in frontal view). The examination of the photograph (Fig. 4) of *O. caatingaensis* (Eliomar Menezes, pers. comm.), drawings of its phallic complex (MENEZES & BRAVO 2013) and additional material from the same region as the type locality established that *O. caatingaensis* is a representative of *Paraphotina*. Hence we establish the new combination here.

Perhaps, *P. caatingaensis* **comb. nov.** is the most easily distinguished species of the genus. The spots on the anterior coxae and the slender appearance of males are remarkable. BEIER (1942) described a female of *P. caatingaensis* **comb. nov.** from Bahia (identified as *P. reticulata*), reporting the presence of spots on the anterior coxae. However, it appears that these spots are not always present in females of *P. caatingaensis* as opposed to males. The examined females from Rio Grande do Norte (Brazil), which came from a region where only males of *P. caatingaensis* **comb. nov.**, have been reported so far, do not have these spots.

Paraphotina insolita (Rehn, 1941)

Figs. 6, 10, 14, 18, 22, 31

Guaraunia insolitum Rehn, 1941: 2. Type material: male holotype deposited in ANSP.

Paraphotina venezuelana Beier, 1963: 7-8, **syn. nov.**; Terra, 1995: 77. Type material: male holotype (type 5632), female allotype deposited in ZSM.

Paraphotina insolita: Cerdá, 1992, *partim*; Terra, 1995: 77, *partim*; Lombardo, 1998: 214, *partim*; Agudelo & Chica, 2001, 2003: 135, *partim*; Ehrmann, 2002; Agudelo, 2004: 49, 58, *partim*; Otte & Spearman, 2005: 288, *partim*; Agudelo et al., 2007: 129, *partim*; Ehrmann & Koçak, 2009: 9, *partim*.

Type Locality. Venezuela (Monagas, Quiriquire).

Diagnosis. Length 38-40 mm. Vertex convex and slightly undulated. Juxta-ocular tubercles slightly developed (Fig. 10). Ocellar tubercle dark gray. Pseudophallus long and projected ventro-dextrally (Fig. 28), rarely with apex curved dorsally (Figs. 18, 27). Right membranous lobe of hypophallus with moderately long setae (Fig. 22, rml).

Material examined. BRAZIL, Amazonas: Barcelos, Rio Aracá-Curudurí, 00°05'50"N, 63°17'22"W, 1 male, 15-19.vi.2010, arm., luminosa, Andreazze R, Rafael JA, Takiya D, Agudelo AA leg. (INPA); Roraima: Rio Branco, "Amazonas", 1 male, 30.viii.1924, Bequaert leg., determined as *Guaraunia insolitum* by JWH Rehn in 1954 (ANSP); Alto Alegre ESEC Maracá, 03°21'59"N, 61°26'04"W, 1 male 12.xii.2015, Boldrini R, Rafael J, Xavier F leg. (INPA); COLOMBIA, Meta: San Martín, Vereda La Pascualera, 200 msnm, 1 male, 17.i.2000, t. luz, Agudelo AA, Chica LM (UDFJC); San Martín, Reserva El Caduceo, 1 male, 05.ii.2011, Agudelo AA leg. (INPA). *Paraphotina venezuelana*: VENEZUELA, Maracay: 1 male holotype, 1 female allotype; P. Volg leg., Beier det. (ZSM).

Distribution. Brazil (Amazonas, Roraima), Colombia (Meta), Venezuela (Aragua, Monagas).

Remarks. The synonymy established by CERDÁ (1992) between *Guaraunia insolitum* and *P. reticulata* is rejected here because CERDÁ (1992) only examined material from Venezuela without examining the type specimen of *C. reticulata*, including its phallic complex. This erroneous synonymy was followed by LOMBARDO (1998), who revised the holotype of *G. insolitum* but considered it a representative of *C. reticulata*. The review of the phallic complex of the type specimen of *C. reticulata* (Figs. 20, 24) and comparison with LOMBARDO'S (1998) figures of the phallic complex of the *Guaraunia insolitum* holotype showed that these species are not synonymous. The specimens of *P. reticulata* present pseudophallus project dextro-dorsally, while in *P. insolita* it is projected to dextro-ventrally. Aside from this, specimens of *P. insolita* lack lateral process on the hypophallus, while *P. reticulata* possesses a well-developed and strongly sclerotized lateral process, projecting to the right (dorsal view). This aspect was corroborated by *P. insolita* material from northern Brazil, Amazonas and Roraima, and the Colombian and Venezuelan "Llanos", also when compared with material of *P. reticulata* from the east of the Amazon. The morphology of the phallic complex of the

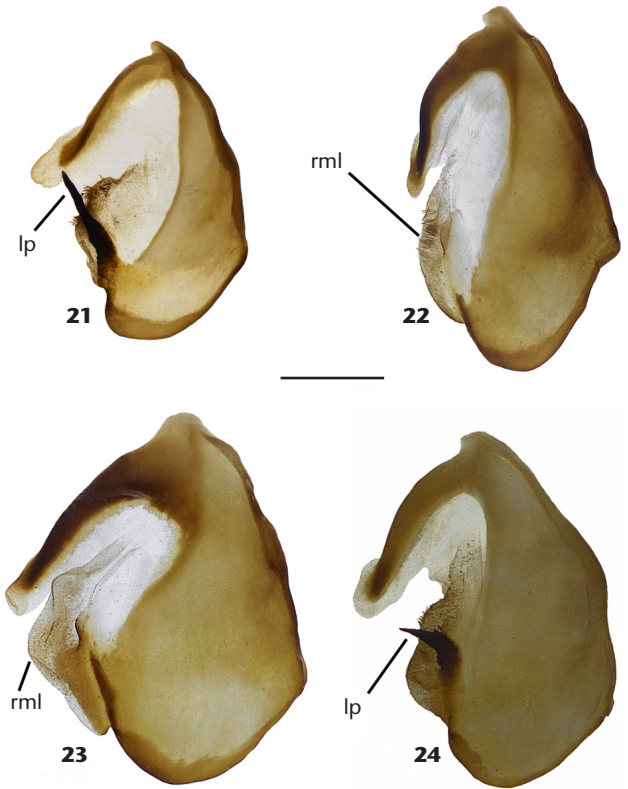


Figure 21-24. External genitalia, hypophallus of species of *Paraphotina* (ventral view): (21) *P. caatingaensis* from Rio Grande do Norte, Brazil; (22) *P. insolita* from Meta, Colombia; (23) *P. occidentalis* from Coari, Amazonas, Brazil; (24) *P. reticulata* from Maranhão, Brazil. (lp) Lateral process; (rml) right membranous lobe. Scale bar: 1 mm.

holotype of *P. venezuelana* (Figs. 28, 29) was found to be very similar to that of *P. insolita* (Figs. 18, 22, see also LOMBARDO 1998: figs. 4, 7, 8). In addition, the typical localities of *P. venezuelana* and *P. insolita* are found in the northern Amazon of Venezuela (Fig. 35); Therefore, the synonymy is established.

Paraphotina occidentalis Lombardo, 1998

Figs. 7, 11, 15, 19, 23, 32

Paraphotina occidentalis Lombardo, 1998: 213; Agudelo & Chica, 2001: 34; Ehrmann, 2002: 268; Otte & Spearman, 2005: 287; Agudelo et al., 2007: 129; Ehrmann & Koçak, 2009: 9. Type material: male holotype, male paratype deposited in ANSP.

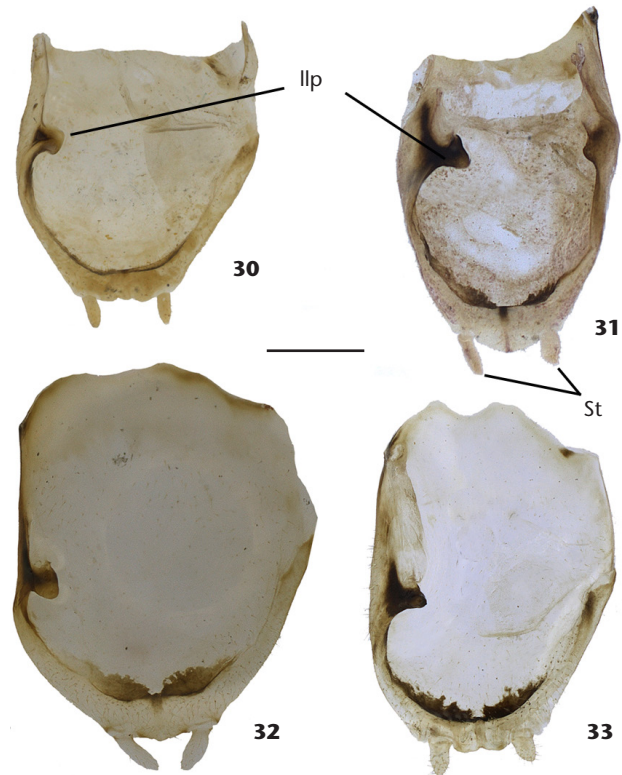
Diagnosis. Length 45-50 mm. Robust appearance for the genus (Fig. 7). Ocellar tubercle dark brown. Arabesques on pronotum, forefemora and foretibiae well-marked. Pseudophallus long and projected to the right (Fig. 19, psph). Hypophallus with numerous and minute setae on the lateral membranous lobe (Fig. 23, rml).

Type locality. Peru (Huellaga, Aguaytia).



Figures 25-29. Variations in the genitalia of species of *Paraphotina*: (25-27) *P. insolita*, pseudophallus, (25) from Meta, Colombia, (26) from Amazonas, Brazil, (27) from Roraima, Brazil. (28-29) *P. venezuelana*, external genitalia of holotype male, (28) left epiphallus (dorsal view), (29) hypophallus (ventral view). Photos by courtesy of Kai Schütte (ZMH).

Material examined. BRAZIL, Acre, (Bujari, Floresta Estadual Antimary), 09°33'67"S 68°32'05"W, 2 male, 24.viii.2016, armadilha luz mista, Agudelo AA, Rafael JÁ, leg. (INPA). Amazonas (Paq. Nac. do Jaú, Ig. Miratuca), 01°57'08"S 61°49'19"W, 1 male, 14-29.vii.1993, lençol c/luz mista mercúrio, luz negra BL e BLB, Andreazze R, Costa W, Aquino L leg., as *Melliera major* det. by R Ehrmann (xii 2003) (INPA-0027166); Amazonas (Paq. Nac. Do Jaú, MK médio Jaú- Miriti), 02°18'S, 64°39'W, 1 male, 05-06.vi.1994, Motta CS leg. (INPA); Amazonas (Uarini), 03°02'57"S, 65°41'42"W; 1 male, 22.vii-03.viii.1995, Bührnhein P, Aguiar NO leg. (CZPB); Amazonas (Tefé, São Mateus), 04°43'24"S 65°40'06"W, 2 males, 07-16.ix.1994, Bührnhein PF et al., leg. (CZPB); Amazonas (Autazes, Lit-1 AM), 03°32'07"S 59°13'30"W, 1 male, 21-22.vii.1996, á luz mista de mercúrio, Bührnhein P, Aguiar NO leg. (CZPB); Amazonas (Novo Airão, ramal do Olimpo), 02°39'23"S 60°55'44"W, 2 males, 03-15.vii.1997, sob luz mista de mercúrio, Bührnhein PF, Aguiar NO leg. (CZPB); Amazonas (Novo Airão, Sitio Carusá, Cominidade Terra Preta), 1 male, 05-07.2010; arm lençol luz mista; Mendes DM et al. leg (INPA); Amazonas (Beruri, Rio Purus), 03°56'62"S 61°21'02"W, 1 male, 30.ix-09.x.2002, armadilha luz mista, Filho FF, Barbosa UC leg. (INPA); Amazonas (Presidente Figueiredo, Est. da Balbina km 24), 02°01'05"S 59°49'60"W, 2 males, 01-12. ix.2002, armadilha luz mista, Filho FF, Barbosa UC leg. (INPA); Amazonas (Reserva Extrativista Unini, Rio Unini, Manapana), 01°53'18"S 62°27'45"W, 2 males, 11-12.vii.2004, luz mista de mercúrio,



Figures 30-33. External genitalia, subgenital plate of species of *Paraphotina* (dorsal view): (30) *P. caatingaensis* from Rio Grande do Norte, Brazil; (31) *P. insolita* from Meta, Colombia; (32) *P. occidentalis* from Coari, Amazonas, Brazil; (33) *P. reticulata* from Maranhão, Brazil. (St) Stylus, (llp) left lateral process. Scale bar: 1 mm.

Filho FF, Barbosa UC leg. (INPA); Amazonas (AM-240, km 24), 02°00'55"S 59°49'40"W, 1 male, viii.2005, luz mista de mercúrio, Xavier F leg. (INPA).

Distribution. Brazil (Acre, Amazonas), Peru.

Remarks. This species was adequately described by LOMBARDO (1998). The appearance of *P. occidentalis* is more robust and the arabesque marks appear sharper. This agrees with the observations of CERDÁ (1992), who found that larger size was correlated with darker spots. The pseudophallus of both *Paraphotina occidentalis* and *P. reticulata* project dorso-dextrally (dorsal view), but in *P. occidentalis* the lateral process of ventral phallomere is weakly sclerotized without projecting to the right as in *P. reticulata*.

Paraphotina reticulata (Saussure, 1871)

Figs. 1, 8, 12, 16, 20, 24, 33, 34

Cardioptera reticulata Saussure, 1871a: 196; 1871b: 75; 1871c: 344 reprinted; Westwood, 1889: 15; Roy & Cuche, 2008: 17. Type material: male holotype deposited in MHNG.

Photina gracilipes Kirby, 1904a: 86; Kirby, 1904b: 274.



Figure 34. *Paraphotina reticulata*, alive aspect of a female from Pará, Brazil. Photo courtesy of César Favacho (MPEG).

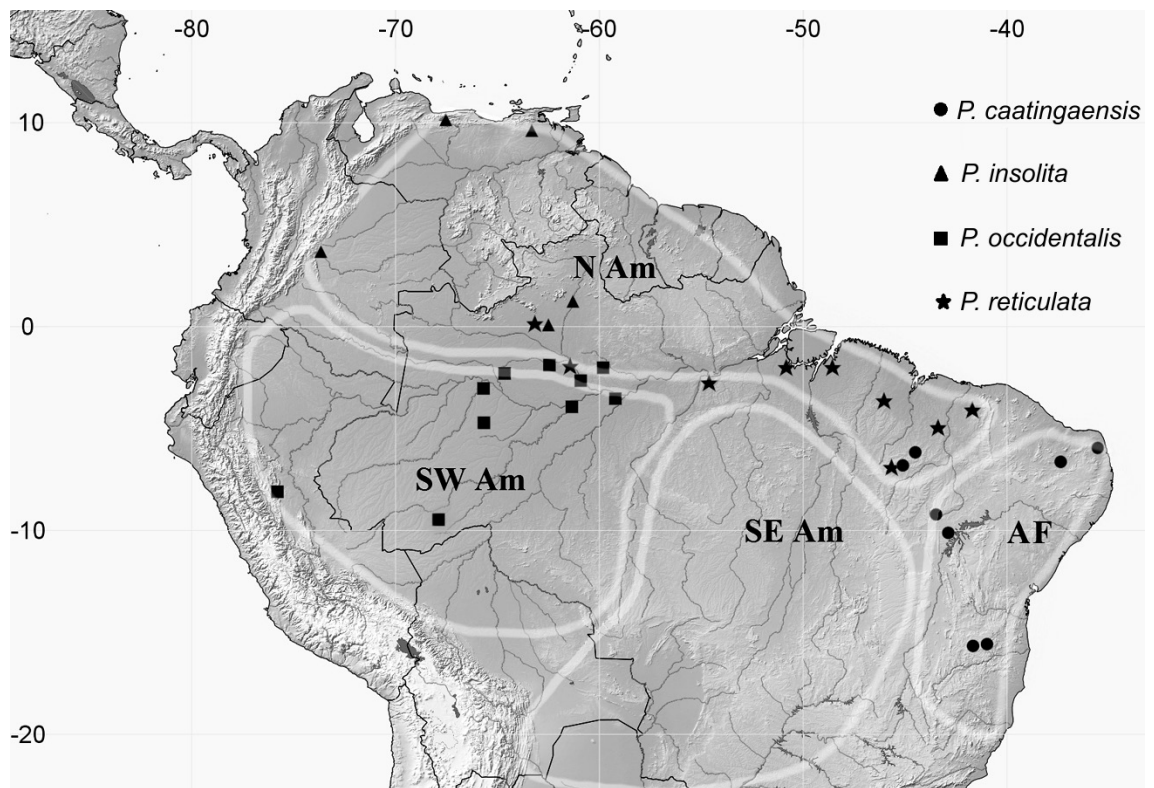


Figure 35. Map of the geographic records for species of *Paraphotina* with areas of endemism proposed by AMORIM (2009). Note that geographical records of *P. reticulata* include transition areas for each of the other three species. (AF) Atlantic Forest; (N Am) North Amazon; (SE Am) South East Amazon; (SW Am) South West Amazon.

Paraphotina reticulata Saussure, 1871a: 196; Giglio-Tos, 1915: 72; 1927: 330; Beier, 1930: 28; 1935: 124; Cerdá, 1992: 13, *partim*; Terra, 1995: 77; Ehrmann, 2002: 268, *partim*; Otte & Spearman, 2005: 287; Agudelo et. al., 2007: 129; Ehrmann & Koçak, 2009: 9.

Diagnosis. Length 36-45 mm. Ocellar tubercle dark. Pseudophallus long and projected to the right (Fig. 20, psp). Hypophallus with a strongly sclerotized lateral process, right membranous lobe with moderately long setae (Fig. 24, rml).

Type Locality. Brazil, Pará.

Material examined. *Cardioptera reticulata*: BRAZIL, Pará, holotype male (*reticulata* Saussure "Natal") (MNHG). Additional material. BRAZIL. Amazonas: Barcelos, Rio Araújo, comunidade Bacuquara, 00°09'17"N, 63°10'35"W, 2 males, 06.vi.2010, suspensa dosel 25 m; Alvim E, Rafael JA, Agudelo AA leg. (INPA); Novo Airão, M.E. Baixo rio Jaú, 01°56'28"S, 61°26'45"W, 1 male, 22-23.vii.1995, luz mista, luz negra, lençol, Motta C, Xavier F leg. (INPA-0027036); Maranhão: Caxias, Reserva Ecológica Inhamum, 2 males, 01-03.xii.2005, Limeira F et. al., leg. (CZMA); same date but Reserva Ecológica Inhamum, Povoado Coités, 1 male, 22-24.x.2006, Souza SO, Silva JJ leg. (INPA); same data but 1 male, 19-21.i.2007, Souza SO, Silva JJ leg. (INPA); same data but 1 male, 08-11.viii.2008, Limeria F, leg. (INPA); same municipality but Morro do Alecrim, Campus da UEMA, 1 male, 26-30.iii.2009, r. entomológica, Barbosa EA, Neto MB leg. (INPA); Carolina, povoado do Canto Grande, Balneario Urupuxete, 3 males, 23-27.ii.2009, armadilha luminosa, Limeira F et al., leg. (CZMA). same data but 2 males, 23-27.ii.2009, armadilha luminosa. Limeira F et al., leg. (INPA); same data but Fazenda Cincorá, 3 males, 17-22.x.2009, armadilha luminosa, Limeira F et al., leg. (CZMA); same data but 1 male, 17-22.x.2009, armadilha luminosa, Limeira F et al., leg. (INPA); Bom Jardim, REBIO, Res. Biol. Gurupí, 2 males, 15-19.iv.2010, Limeira F et al. leg. (INPA); Parnarama, Povoado Brejo de São Felix, 1 male, 03-06.vi.2010, Souza SS, Lino TR leg. (INPA); Pará: 1 male, holotype (*reticulata* "Natal") MHS (MHNG); Santo Antonio do Tauá, 2 males, 5-15.x.1979, Michel Boulard leg., genital preparation n° 3488 (MNH); Belém, Campus de Pesquisa do Museu Paraense Emílio Goeldi, 1 female, 10.iii.2014, Favacho C. leg. (MPEG); Piauí: Parque Nacional de Sete Cidades, 04.09909°S, 41.70952°W, 2 males, 15-25.iv.2012, Somavilla A, Oliveira leg. (INPA).

Distribution. Brazil (Amazonas, Maranhão, Pará, Piauí).

Remarks. This species had been described with doubtful provenance. The holotype (Fig. 1) of *C. reticulata* bears a label giving the typus locality as Natal (South Africa). However, SAUSSURE (1871a) added a note to the description commenting that the specimen may have come from Pará (Brazil). This comment appeared again in his succeeding work (SAUSSURE 1871b). We confirmed the State of Pará as type locality due to the conspecific specimens examined are principally from Maranhão and Pará. CERDÁ (1992) established *P. venezuelana* as synonym of *P. reticulata*. The comparison between phallic complexes of the holotypes of *P. reticulata* and *P. venezuelana* (Figs. 20, 24, 28,

29) revealed that they are not conspecific, thus the synonymy between these species is rejected here.

DISCUSSION

Within a morphological context, the definition of most Photinaidae genera has been generally well supported by easily recognizable diagnostic features. Except in cases like *Metriomantis*, *Photina* and *Photinella*, the genera of this family appear to be acceptably defined, but their phylogenetic relationships are not necessarily as clear. After the review of *Orthoderella* by ROY & STIEWE (2011), the distinction between *Paraphotina* and *Orthoderella* has become more evident. The behavior of *Paraphotina* species is reminiscent of the observations described by BRUNNER & GANDOLFO (1990) for females of *Orthoderella ornata* (per. obs.). However, *Orthoderella* is distinguished from *Paraphotina* by a long head with a nearly straight vertex, and by well-developed juxta-ocular tubercles. The pronotum in *Orthoderella* is slender, its arabesque brands less conspicuous, and the lateral margins of the prozona are nearly parallel. Wings in female *Orthoderella* are noticeably shorter than the abdomen, exposing its distal half when at rest. In contrast, females of *Paraphotina* generally expose only the distal third of the abdomen. The genera *Orthoderella* and *Paraphotina* are distinguished from other Photinaidae genera by the arabesque marks on their pronotum, forefemora and foretibiae.

The four species of *Paraphotina* are superficially very similar, which renders their identification somewhat difficult to naked eye. *Paraphotina insolita* and *P. reticulata*, in particular, are difficult to distinguish morphologically. The fast identification of *P. caatingaensis* **comb. nov.** and *P. occidentalis*, is generally less problematic, because their sizes are at opposite ends of the *Paraphotina* range. Thus, it becomes necessary to resort to a more detailed observation, including the dissection of the genitalia.

While the phylogenetic relationships within Photinaidae are consecutively being analyzed, we are just beginning to understand the life history and systematics of the concerned genera. Some Photinaidae genera such as *Metriomantis* and *Photina* are in urgent need of revision. Ecological and behavioral data for *Paraphotina* as well as for the large majority of Photinaidae genera are rare. Behavioral data were studied in *Orthoderella* by BRUNNER & GANDOLFO (1990) and in *Cardioptera brachyptera* by TERRA (1992, 1996a, b). Taxonomic approaches are the basis for subsequent evolutionary analysis.

Biogeographical aspects. The distribution of Neotropical species of Mantodea seem to show some patterns similar to those of several others groups studied methodically in the biogeographical context, e.g., Diptera (AMORIM & PIRES 1996), fitting within subregions and areas of endemism proposed by NIHEI & CARVALHO (2007). These relationships of the continental northern Neotropical region and its biogeographical components were briefly described by RAFAEL & CUMMING (2009), while the biogeographical patterns were discussed by AMORIM (2009). In recent

reviews of Neotropical Mantodea (LOMBARDO & IPPOLITO 2004, ROY & EHRMANN 2009, ROY & STIEWE 2011), the distribution maps of species largely coincided with these classifications (Fig. 35). All species of *Paraphotina* occur in South America. Three species, *P. insolita*, *P. occidentalis*, and *P. reticulata*, occur in Northwestern Amazonia. *Paraphotina insolita* is found in North Amazonia (N Am) in Orinoco savannas (Colombia, Venezuela) and Brazil (Roraima and Amazonas, Barcelos). *Paraphotina occidentalis* occurs mainly in Southwestern Amazonia (SW Am) with records in the municipalities of Bujari (Acre), Novo Airão, Tefé, Autazes, and Beruri (Amazonas), but also with peripheral records in North Amazonia (Presidente Figueiredo). *Paraphotina reticulata* has been more widely recorded from North Amazonia and Southwestern Amazonia extending until the Atlantic Forest, in Maranhão. *Paraphotina caatingaensis* has been recorded only in the Brazilian domains of Cerrado and Caatinga, from Maranhão to Minas Gerais. No records from Southeast Amazonia (SE Am) are known to date, but according to the pattern recorded for the known species, it is possible that an unknown species of *Paraphotina* inhabits this zone. Many questions remain before we will understand the relationships among Photinaidae genera, especially biogeographical aspects and their closer relationship with Neotropical Acanthopidae and Liturgusidae more than Mantidae groups.

ACKNOWLEDGMENTS

This research was financed with resources from the Conselho Nacional de Desenvolvimento Técnico e Científico (CNPq) through the doctoral scholarship to AAA, (process 156567/2010-5), and Fundação de Amparo à Pesquisa do Estado do Amazonas FAPEAM/PAPAC (286/2013). We are indebted to Peter Schwendinger (MHNG), Dieter Doczkal (ZSM), Klaus Schönitzer (ZSM) and their respective institutions for granting access to type specimens and the entomological collections. To Francisco Limeira (CZMA), Orlando Tobias (MPEG) and Ricardo Andreasse (UFRN) for providing access to material of their respective institutions. We express our gratitude to Kai Schütte (ZMH) and César Favacho (MPEG) who kindly provided important photos and information for this work.

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Submitted: 22 March, 2016

Received in revised form: 20 May 2016

Accepted: 14 June 2016

Editorial responsibility: Ângelo Parise Pinto

Author Contributions: AAA conducted the taxonomic review; AAA and JAR analyzed the data and wrote the paper.

Competing Interests: The authors have declared that no competing interests exist.