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Neuropterida from South America: large diversity, largely unknown

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Abstract. Neuropterida comprises about 6 430 extant and 930 fossil species distributed all over the world, except in Antarctica. In South America, 919 extant species of 135 genera in 13 families of Neuroptera and Megaloptera – 15 % of the world's diversity – have been recorded so far. With regard to fossils in the region, 91 species of 53 genera in 19 families of Glosselytrodea, Raphidioptera, Neuroptera and Megaloptera – 10 % of the world's diversity – are known to date.

Introduction

In the last 250 Ma, the evolutionary history of South America was affected by several events: opening of the Atlantic Ocean during the Gondwana fragmentation; high volcanic activity on the eastern margin of the continent during the Cretaceous resulting in the rock formation named as 'Serra Geral'; uplift of the Andes mountain range from southern Chile to northern Colombia; mass extinctions, especially those that occurred in the passage from the Permian to the Triassic (*ca* 245 Ma), in the Triassic-Jurassic (*ca* 208 Ma) and in the Cretaceous-Paleogene (~65 Ma); glaciation increasing the ice volume on the continent and a reduction in the level of the oceans (Lavina & Fauth 2010). All these events resulted in a complex geological history and heterogeneous relief and climate, as well as several biogeographical domains and great biological diversity (including for the species of Neuropterida) (Lavina & Fauth 2010; Morrone 2014).

Neuroptera (lacewings) and allied orders Megaloptera (dobsonflies, alderflies) and Raphidioptera (snakeflies) make up the clade Neuropterida, which is well established as the sister group of the Coleoptera (beetles) plus Strepsiptera (twisted-wings parasites) forming the Neuropteroidea clade (Misof et al. 2014; Winterton et al. 2017). Raphidioptera, Neuroptera and Megaloptera are considered minor orders based on the low number of extant species (*ca* 6 430 species). Their fossil record – composed of approximately 930 species – is, however, considered rich and highly diverse (Winterton et al. 2017; Oswald & Machado 2018).

Neuropterida is considered a relict superorder that has all families originating in the Mesozoic period, larval stages with disparate morphology and extant lineages with disjunct distribution (Aspöck et al. 2001; Winterton et al. 2017; Engel et al. 2018). Representatives of the three orders belonging to Neuropterida are present all over the world, except in Antarctica (Oswald 2019). Among a total of about 6 430 Neuropterida extant species, 919 occur in South America representing 15 % of the world's known

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diversity, fauna that has a relatively high degree of endemism even at higher taxonomic levels – 46 % (63 of 135) of their genera are known to occur only in South America (Oswald 2019). From a total of approximately 930 fossil species of Neuropterida, 91 are present in South America (88 from the lower Cretaceous Crato Formation of Ceará State, Brazil), representing almost 10 % of the world's known diversity of Neuropterida fossils (Oswald 2019).

Despite the great diversity of Neuropterida already known for South America (Heckman 2017), there is still an unknown diversity of the group in this continent deemed to be of substantial magnitude, which demonstrates the necessity for further studies to understand this diversity. This paper reviews and organizes the main information on the diversity of South American Neuropterida with the aim of facilitating future studies.

Material and methods

The data used for counting South American Neuropterida species and checked their distribution have been accessed via the web portal 'Lacewing Digital Library' (Oswald 2019), and in specialized articles for each family or order. Microsoft Excel software was used to tabulate and organize the data, as well as to create graphics.

Results

Extant species of South American Neuropterida (Table 1)

Megaloptera: Sialidae. Sialidae (alderflies) comprise seven recorded species of *Ilyobius* Enderlein, 1910, across the South American continent (Liu et al 2015; Oswald 2019), representing 10 % of the world's fauna. Brazil and Colombia have the greatest alderfly diversity for the region; there are, however, no records of species of alderflies for Ecuador, French Guiana, Guyana, Paraguay, Suriname and Uruguay (Liu et al 2015; Oswald 2019). The immature stages of five South American species are unknown; larvae of only *Ilyobius flammatus* (Penny, 1982) and *Ilyobius chilensis* (McLachlan, 1871) are known to this region.

Megaloptera: Corydalidae. About 17 % of Corydalidae (dobsonflies, fishflies) diversity is present in South America and 52 species of six genera have records from this continent (Oswald 2019). Venezuela and Brazil have the greatest diversity of the family for the region, whereas Suriname, Uruguay and Paraguay have no record of Corydalidae species. *Corydalus* Latreille, 1802, is the largest South American genus and *Chloronia* Banks, 1908, is the second largest; *Nothochauliodes* Flint, 1983, and *Puri* Cardoso-Costa et al., 2013, occur only in South America; and *Protochauliodes* van der Weele, 1909, and *Archichauliodes* van der Weele, 1909, have records only in Chile. Despite some knowledge of the immature stages of the South American Corydalidae, the immature stages of *Puri* and *Nothochauliodes* are still unknown to date.

Neuroptera, Coniopterygoidea: Coniopterygidae. There are records for 88 species and eight genera of dustywings in the South American region, representing approximately

15 % of the world fauna (Sziráki 2011; Oswald 2019). Brazil and Argentina have the greatest Coniopterygidae diversity on the continent, and there are no records of Coniopterygidae species for French Guiana, Guyana, Suriname or Venezuela (Table 1) (Martins & Amorim 2016; Machado & Martins 2019a; Oswald 2019). *Coniopteryx* Curtis, 1834, and *Semidalis* Enderlein, 1905, are part of the subfamily Coniopteryginae and are the most diverse genera with a number of South American species (Table 1) (Sziráki 2011; Oswald 2019); Brucheiserinae occurs only in South America and comprises *Brucheiser* Navás, 1927, and *Flintoconis* Sziráki, 2007 (Sziráki 2011; Oswald 2019) (Table 1). The other four genera of South American dustywings are *Pampoconis* Meinander, 1972 and *Neoconis* Enderlein, 1929, from Aleuropteryginae, and *Incasemidalis* Meinander, 1972 and *Parasemidalis* Enderlein, 1905, from Coniopteryginae (Sziráki 2011; Oswald 2019). Immature stages of Coniopterygidae are practically unknown for the South American genera; immature of species of only *Brucheiser*, *Coniopteryx* and *Semidalis* are currently known, whereas immature stages of *Flintoconis*, *Pampoconis*, *Neoconis*, *Incasemidalis* and *Parasemidalis* are not known.

Neuroptera, Osmyloidea: Sisyridae. There is about 30 % of the world fauna of spongillaflies in South America; to date, 22 species of *Sisyra* Burmeister, 1839, and *Climacia* McLachlan, 1869, have been recorded in the region (Oswald 2019). Brazil, Guyana and Argentina have the greatest diversity in spongillaflies on the continent, whereas there are no records of Sisyridae species in Ecuador or French Guiana (Machado & Martins 2019b; Oswald 2019). With respect to the immatures stages of South American Sisyridae, only a small part is currently known (Martins & Ardila-Camacho 2018; Oswald 2019).

Neuroptera, Osmyloidea: Osmylidae. Currently, 12 % of the world diversity (25 species) of lance lacewings has been recorded in South America (Martins et al. 2016, 2019; Martins & Ardila-Camacho 2018; Winterton et al. 2019). The greatest number of species is found in the Andes mountain range, especially in Peru, Colombia and Chile; there are no records of Osmylidae for French Guiana, Guyana, Suriname or Uruguay. *Gumilla* Navás, 1912, is the only genus of the subfamily Gumillinae and occurs in the South American region; *Phymatosmylus* Adams, 1969 (Stenosmylinae) and *Paryphosmylus* Krüger, 1913 (Protosmylinae) are monotypic genera; *Kempynus* Navás, 1912 (Kempyninae) has four species in South America; and *Isostenosmylus* Krüger, 1913 (Stenosmylinae) is the most diverse genus occurring in eight countries. Immature stages of Osmylidae are virtually unknown in South America; larvae of only *Isostenosmylus pulverulentus* (Gerstaecker, 1893) and *Kempynus* sp. have been described in this region (Martins et al. 2018).

Neuroptera, Dilaroidea: Dilaridae. All South American representatives of pleasing lacewings belong to the genus *Nallachius* Navás, 1909 (Oswald 2019), and represent 22 % of the world diversity in this family. Brazil, Paraguay and Argentina are the coun-

tries with the greatest diversity of Dilaridae for the region, whereas there are no records of Dilaridae for Bolivia, French Guiana, Guyana, Peru, Suriname or Uruguay (Machado & Martins 2019c; Oswald 2019). Among all the species of Dilaridae that occur in South America, there is information only for *Nallachius americanus* (McLachlan, 1881) and its immature stages (Gepp 1984).

Neuroptera, Hemerobioidea: Hemerobiidae. The South American fauna of brown lacewings consists of 81 species of 12 genera distributed in eight subfamilies (Oswald 2019), which represent approximately 14 % of the world fauna. Brazil, Argentina, Peru and Chile have the greatest Hemerobiidae diversity for the South American region (Machado & Martins 2019d, Oswald 2019). *Hemerobius* Linnaeus, 1758, is the most diverse genus of South America, *Sympherobius* Banks, 1904, and *Megalomus* Rambur, 1842, are second in number of species (Oswald 2019). *Adelphohemerobius* Oswald, 1994, *Gayomyia* Banks, 1915, *Conchopterella* Handschin, 1955, and *Neosympherobius* Kimmins, 1929, are endemic to South America (Oswald 2019); *Hemerobiella* Kimmins, 1940, has three species that occur mainly in northern South America, although there is one occurrence in southern Mexico (Sosa et al. 2015; Oswald 2019). *Notiobiella* Banks, 1909, *Nomerobius* Navás, 1915, and *Biramus* Oswald, 1993, have been recorded in South America and also occur in other world regions (Oswald 2019). Despite their economic importance, immature stages of South American Hemerobiidae are poorly studied; only few species of *Gaymomyia*, *Nusalala*, *Nomerobius*, *Sympherobius*, *Megalomus* and *Hemerobius* have known immature stages (Monserrat 2003; Oswald 2019).

Neuroptera, Mantispoidea: Berothidae. Species of *Lomamyia* Banks, 1904, and *Spiroberotha* Adams, 1989, of Berothinae; *Berothimerobius* Monserrat & Deretzky, 1999, of Berothimerobiinae; *Cyrenoberotha* MacLeod & Adams, 1967, and *Ormiscocerus* Blanchard, 1851, of Cyrenoberothinae; and *Naizema* Navás, 1919, of Nosybinae (Aspöck & Randolf 2014; Oswald 2019) have been recorded in South America, representing 7 % of the world diversity within Berothidae. Only Argentina, Brazil, Chile, Colombia and Venezuela have records of beaded lacewings. The monotypic genera *Berothimerobius*, *Cyrenoberotha* and *Ormiscocerus*, plus *Naizema*, occur only in South America, whereas *Spiroberotha* and *Lomamyia* also have species recorded in Central and North America (Oswald 2019). With the exception of *Berothimerobius,* the immature stages of all five other genera of South American Berothidae are unknown (Monserrat 2006).

Neuroptera, Mantispoidea: Mantispidae. There are 87 South American species of mantidflies distributed in *Anchieta* Navás, 1909, *Plega* Navás, 1928, and *Trichoscelia* Westwood, 1852, of Symphrasinae; *Drepanicus* Blanchard in Gay, 1851, and *Gerstaeckerella* Enderlein, 1910, of Drepanicinae; *Nolima* Navás, 1914, of Calomantispinae; *Buyda* Navás, 1926, *Climaciella* Enderlein, 1910, *Dicromantispa* Hoffman in Penny, 2002, *Entanoneura* Enderlein, 1910, *Haematomantispa* Hoffman in Penny, 2002, *Leptomantispa*

Hoffman in Penny, 2002, *Mantispa* Illiger, 1758, *Paramantispa* Williner & Kormilev, 1958, and *Zeugomantispa* Hoffman in Penny, 2002, of Mantispinae (Oswald 2019), representing about of 21% of the world fauna. All South American countries have records of Mantispidae species, Brazil has the greatest South American diversity of mantidflies species, and Colombia follows in number of species, whereas Guyana and Paraguay have the lowest diversity of Mantispidae in the region (Machado & Martins 2019e; Ardila-Camacho et al. 2018). *Anchieta* and *Paramantispa* are endemic to the region, and the genera *Mantispa* and *Trichoscelia* are the most diverse (Oswald 2019). The immature stages of few species in South America are known, mainly species of *Plega* and *Zeugomantispa* (Hoffman & Brushwein 1992).

Neuroptera, Chrysopoidea: Chrysopidae. Representatives of 316 species of 27 genera of green lacewings have been recorded in South America, which is equivalent to about 23 % of the world's fauna (Oswald 2019). There are records of Chrysopidae for all South American countries; among them Brazil has the largest number of species on the continent and Venezuela is the second country in number of Chrysopidae species, whereas Chile, French Guiana and Uruguay have the lowest diversity (Martins & Machado 2019). *Leucochrysa* McLachlan, 1868, is the most diverse genus in South America, followed by *Ceraeochrysa* Adams, 1982, and *Chrysopodes* Navás, 1913. A total of 11 genera are endemic to South America: *Asthenochrysa* Adams & Penny, 1992, and *Leptochrysa* Adams & Penny, 1992, of Nothochrysinae; *Belonopteryx* Gerstaecker, 1863, *Vieira* Navás, 1913, *Furcochrysa* Freitas & Penny, 2001, *Parachrysopiella* Brooks & Barnard, 1990, *Titanochrysa* Sosa & Freitas, 2012, *Cacarulla* Navás, 1913, *Neula* Navás, 1917, *Nuvol* Navás, 1916, and *Santocellus* Tauber & Albuquerque, 2008, of Chrysopinae (Oswald 2019), although there is no genus of Apochrysinae that is endemic to this region. Immature stages of South American green lacewings are relatively well known when compared to the other Neuropterida families.

Neuroptera, Myrmeleontoidea: Ithonidae. In South America, there are records of only *Fontecilla graphicus* Navás, 1932, and *Polystoechotes gazullai* Navás, 1924, representing 5 % of world diversity, both species have been recorded in Chile (Oswald 2019) and their immature stages are unknown.

Neuroptera, Myrmeleontoidea: Nemopteridae. Eight species of five genera of spoonwings have been recorded in South America, and all of them are endemic to this region: *Amerocroce* Mansell, 1983, *Moranida* Mansell, 1983, *Veurise* Navás, 1927, and *Pastranaia* Orfila, 1955, of Croninae; and *Stenorrhachus* McLachlan, 1886, of Nemopterinae (Oswald 2019). Only Argentina, Bolivia, Chile, Peru and Venezuela have records of Nemopteridae species, and the former three countries are the most diverse on the continent. Immature stages of Nemopteridae are well known in the South American region, with larvae of all genera except *Pastranaia* being known (Miller & Stange 2012; Oswald 2019).

Table 1. Number of extant genera and species of Neuropterida per country recorded in South America.

Order (Family: Subfamily)	Genus	Number of species per Country												Total species
		Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	French Guiana	Guyana	Paraguay	Peru	Suriname	Uruguay	Venezuela	
Megaloptera (Corydalidae)	1. *Archichauliodes* van der Weele, 1909				2										2
	2. *Chloronia* Banks, 1908		2	5		2	2	1	1		4			4	11
	3. *Corydalus* Latreille, 1802	6	5	11		8	8	4	3	2	7	1	1	13	33
	4. *Nothochauliodes* Flint, 1983				1										1
	5. *Protochauliodes* van der Weele, 1909				4										4
	6. *Puri* Cardoso-Costa et al., 2013			1											1
Megaloptera (Sialidae)	7. *Ilyobius* Enderlein, 1910	1	1	3	1	2					1			1	7
Neuroptera (Coniopterygidae: Aleuropteryginae)	8. *Pampoconis* Meinander, 1972	4			5										7
	9. *Neoconis* Enderlein, 1930		1	6		1				1	2			1	9
Neuroptera (Coniopterygidae: Brucheiserinae)	10. *Brucheiser* Navás, 1927	1			1										2
Neuroptera (Coniopterygidae: Coniopteryginae)	11. *Flintoconis* Sziráki, 2007				2										2
	12. *Coniopteryx* Curtis, 1834	6	2	30	1	6				1	4		2	8	37
	13. *Incasemidalis* Meinander, 1972	3		1	2	1					1				7
	14. *Parasemidalis* Enderlein, 1905	3			1										3
	15. *Semidalis* Enderlein, 1905	5	3	9	1	5	1			1	7				21
Neuroptera (Sisyridae)	16. *Climacia* McLachlan, 1869	6	1	11	1				5	1	2	1	3	4	16
	17. *Sisyra* Burmeister, 1839		1	6		1			1	1	3	1	1	1	6
Neuroptera (Osmylidae: Gumillinae)	18. *Gumilla* Navás, 1912			1											2
Neuroptera (Osmylidae: Kempyninae)	19. *Kempynus* Navás, 1912	3			4										4
Neuroptera (Osmylidae: Protosmylinae)	20. *Paryphosmylus* Krüger, 1913						1								1
Neuroptera (Osmylidae: Stenosmylinae)	21. *Isostenosmylus* Krüger, 1913	1	2	2		4	3			1	6			2	17
	22. *Phymatosmylus* Adams, 1969	1	1												1
Neuroptera (Dilaridae: Nallachiinae)	23. *Nallachius* Navás, 1909	2		10	1	1	1			2				1	17
Neuroptera (Hemerobiidae: Adelphohemerobiinae)	24. *Adelphohemerobius* Oswald, 1994	1			1										2
Neuroptera (Hemerobiidae: Drepanacrinae)	25. *Conchopterella* Handschin, 1955	1			3										3
Neuroptera (Hemerobiidae: Drepanepteryginae)	26. *Gayomyia* Banks, 1913	1	1		2						1				2

Order (Family: Subfamily)	Genus	Number of species per Country												Total species
		Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	French Guiana	Guyana	Paraguay	Peru	Suriname	Uruguay	Venezuela	
Neuroptera (Hemerobiidae: Hemerobiinae)	27. *Biramus* Oswald, 1993													1	1
	28. *Hemerobiella* Kimmins, 1940						1							2	3
	29. *Hemerobius* Linnaeus, 1758	3	3	5	4	9	5			2	5	1	1	8	23
Neuroptera (Hemerobiidae: Megalominae)	30. *Megalomus* Rambur, 1842	5	2	6	5	3	2			1	5			2	13
Neuroptera (Hemerobiidae: Microminae)	31. *Nusalala* Navás, 1913	2	2	4		5	4			2	6		1	3	9
Neuroptera (Hemerobiidae: Notiobiellinae)	32. *Notiobiella* Banks, 1909		1	4		2				2	1			2	4
Neuroptera (Hemerobiidae: Sympherobiinae)	33. *Neosympherobius* Kimmins, 1929	1													1
	34. *Nomerobius* Navás, 1915	6	1	1	4						3		1		7
	35. *Sympherobius* Banks, 1905	5	1	4	4	2	2			2	3		2		13
Neuroptera (Berothidae: Berothimerobiinae)	36. *Berothimerobius* Monserrat & Deretsky, 1999				1										1
Neuroptera (Berothidae: Berothinae)	37. *Lomamyia* Banks, 1904			1											1
	38. *Spiroberotha* Adams, 1989			1		1								2	3
Neuroptera (Berothidae: Cyrenoberothinae)	39. *Cyrenoberotha* MacLeod & Adams, 1967				1										1
	40. *Ormiscocerus* Blanchard, 1851				1										1
Neuroptera (Berothidae: Nosybinae)	41. *Naizema* Navás, 1919	2													2
Neuroptera (Mantispidae: Calomantispinae)	42. *Nolima* Navás, 1914								1						1
	43. *Drepanicus* Blanchard, 1851	2			5										5
Neuroptera (Mantispidae: Drepanicinae)	44. *Gerstaeckerella* Enderlein, 1910	1		3	3	1				1			1		6
Neuroptera (Mantispidae: Mantispinae)	45. *Buyda* Navás, 1926	1	1	1		2		1			1	1	1		2
	46. *Climaciella* Enderlein, 1910	3	4	3		5	2	3		1	4	2	2		8
	47. *Dicromantispa* Hoffman, 2002	1	2	6		3	3	2	2		1	1	1	2	6
	48. *Entanoneura* Enderlein, 1910	1		5		1		1	1					1	4
	49. *Haematomantispa* Hoffman, 2002			1		1									2
	50. *Leptomantispa* Hoffman, 2002			5		2		2						1	6
	51. *Mantispa* Illiger, 1758		2	5		2				3		1			13
	52. *Paramantispa* Williner & Kormilev, 1958	3	1	3					1	1		1	2		3
	53. *Zeugomantispa* Hoffman, 2002	2	1	2		3	2	2	1	1	2	3	2	3	3
Neuroptera (Mantispidae: Symphrasinae)	54. *Anchieta* Navás, 1909			5		3		2							8
	55. *Plega* Navás, 1928		1	5		2								1	6
	56. *Trichoscelia* Westwood, 1852	1	1	8	1	4	1	1	1		1		1	1	14

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		Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	French Guiana	Guyana	Paraguay	Peru	Suriname	Uruguay	Venezuela	
Neuroptera (Chrysopidae: Apochrysinae)	57. *Domenechus* Navás, 1913			1											1
	58. *Joguina* Navás, 1912	?	?	?	?	?	?	?	?	?	?	?	?	?	1
	59. *Loyola* Navás, 1913			3											3
	60. *Belonopteryx* Gerstaecker, 1863			1											1
Neuroptera (Chrysopidae: Chrysopinae)	61. *Berchmansus* Navás, 1913		1	1							1				1
	62. *Cacarulla* Navás, 1913		1			1					1				1
	63. *Ceraeochrysa* Adams, 1982	3	3	33		8	3	2	5	7	2	5	1	13	41
	64. *Chrysopa* Leach, 1815	9		4	2	3	6			2	2	2	1	2	30
	65. *Chrysoperla* Steinmann, 1964	3	1	4	1	2	2			1	2		1	2	7
	66. *Chrysopodes* Navás, 1913	3	1	23	2	6	5	1	3	2	3	4	1	5	40
	67. *Furcochrysa* Freitas & Penny, 2001			1											1
	68. *Gonzaga* Navás, 1913			6			1		3		1	1		2	7
	69. *Italochrysa* Principi, 1946			1											1
	70. *Leucochrysa* McLachlan, 1868	5	4	78		20	13	5	5	5	5	13		13	114
	71. *Meleoma* Fitch, 1855					1								1	2
	72. *Nacarina* Navás, 1915	4	1	10		1			3					3	17
	73. *Neula* Navás, 1917					1									1
	74. *Nuvol* Navás, 1916			1											1
	75. *Parachrysopiella* Brooks & Barnard, 1990	2	1		3										3
	76. *Plesiochrysa* Adams, 1982	1		4		1	1		1		2			1	5
	77. *Santocellus* Tauber & Albuquerque, 2008			2											3
	78. *Titanochrysa* Sosa & Freitas, 2012	1	1	4		1	1					1		4	4
	79. *Ungla* Navás, 1914	6	5	1		5	2				5			6	23
	80. *Vieira* Navás, 1913		3	4		1		1	1		2	3		3	5
Neuroptera (Chrysopidae: Nothochrysinae)	81. *Asthenochrysa* Adams & Penny, 1992	1		1											1
	82. *Leptochrysa* Adams & Penny, 1992										1				1
	83. *Nothochrysa* McLachlan, 1868				1										1
Neuroptera (Ithonidae)	84. *Fontecilla* Navás, 1932				1										1
	85. *Polystoechotes* Burmeister, 1839				1										1
Neuroptera (Nemopteridae: Crocinae)	86. *Amerocroce* Mansell, 1983		1												1
	87. *Moranida* Mansell, 1983										1			1	2
	88. *Pastranaia* Orfila, 1954	1													1
	89. *Veurise* Navás, 1927	1	1												2
Neuroptera (Nemopteridae: Nemopterinae)	90. *Stenorrhachus* McLachlan, 1885				2										2

Order (Family: Subfamily)	Genus	Number of species per Country												Total species
		Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	French Guiana	Guyana	Paraguay	Peru	Suriname	Uruguay	Venezuela	
Neuroptera (Myrmeleontidae: Ascalaphinae)	91. *Albardia* van der Weele, 1903			1											1
	92. *Ameropterus* Esben-Petersen, 1922	5	2	9				1	1		4			2	18
	93. *Amoea* Lefebvre, 1842	2	1	4		1				3	1			1	8
	94. *Ascalobyas* Penny, 1981			3		1	2	1							3
	95. *Ascalorphne* Banks, 1915	1	1	2						2					4
	96. *Cordulecerus* Rambur, 1842	2		6		2	4	1	1		1	3		1	9
	97. *Dimares* Hagen, 1866	1	1	1						1			1		1
	98. *Fillus* Navás, 1919	1		1						1					3
	99. *Haploglenius* Burmeister, 1839	2	5	5		3	4	2	2		4			2	11
	100. *Millerleon* Stange, 1989				1		3				3				3
	101. *Nephelasca* Navás, 1914					1									1
	102. *Ululodes* Currie, 1899	6		6		3	4	2	1	3	1	1	1	3	13
	103. *Verticillecerus* van der Weele, 1909	1		1						1					1
	104. *Sodirus* Navás, 1912						1								1
Neuroptera (Myrmeleontidae: Myrmeleontinae)	105. *Abatoleon* Banks, 1943	2													2
	106. *Ameromyia* Banks, 1913	6		10	1	1				3		1	3	3	12
	107. *Argentoleon* Stange, 1994	2	1	1						2			1	1	2
	108. *Austroleon* Banks, 1909	3	1	2		1				2			1	1	3
	109. *Dejunaleon* Miller & Stange, 2017				2										2
	110. *Ecualeon* Stange, 1994						1				1				1
	111. *Elicura* Navás, 1911	3		1	1								1		3
	112. *Ensorra* Navás, 1915	1	1												1
	113. *Galapagoleon* Stange, 1994						1								1
	114. *Jaffuelia* Navás, 1918				2										2
	115. *Lemolemus* Navás, 1911				3										3
	116. *Myrmeleon* Linnaeus, 1767	2	3	11	2	1	1		1	2	1	1	2	2	15
	117. *Neulatus* Navás, 1912				1										1
	118. *Peruveleon* Miller & Stange, 2011	1					1			1	1		1		2
	119. *Porrerus* Navás, 1913			2						1			1		2
	120. *Scotoleon* Banks, 1913			1											1
	121. *Sical* Navás, 1928				2										3
	122. *Stangeleon* Miller, 2008													1	1
	123. *Vella* Navás, 1913	1		1		2	1		1		1			3	5
	124. *Venezueleon* Stange, 1994													1	1

Order (Family: Subfamily)	Genus	Number of species per Country												Total species
		Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	French Guiana	Guyana	Paraguay	Peru	Suriname	Uruguay	Venezuela	
Neuroptera (Myrmeleontidae: Nemoleontinae)	125. *Brasileon* Miller & Stange, 1989			2											2
	126. *Dimarella* Banks, 1913	2	2	7		1	2	3	4	1	3	4	1	8	13
	127. *Elachyleon* Esben-Petersen, 1927	1		1					1			1			2
	128. *Eremoleon* Banks, 1901	2	2	1		4	2			1	4			8	16
	129. *Euptilon* Westwood, 1837			1		1									1
	130. *Glenurus* Hagen, 1866	3	2	1			1		1	1	1	1		1	5
	131. *Navasoleon* Banks, 1943	3	1	2				1	1		2			2	10
	132. *Purenleon* Stange, 2002			5		4								3	9
	133. *Ripalda* Navás, 1915		1	1				1		1	1			1	4
	134. *Rovira* Navás, 1914	2													2
	135. *Sericoleon* Esben-Petersen, 1933				1										1
Total species		**179**	**91**	**446**	**91**	**159**	**100**	**40**	**52**	**69**	**127**	**54**	**39**	**164**	**919**
Total genera		**69**	**52**	**82**	**45**	**55**	**38**	**22**	**27**	**39**	**50**	**24**	**29**	**53**	**135**

Neuroptera, Myrmeleontoidea: Myrmeleontidae. Myrmeleontidae is second largest Neuroptera family in numbers of South American species, with 205 species of 45 genera being currently known (Oswald 2019; Machado et al. 2019). Brazil has the greatest diversity of South American Myrmeleontidae, followed by Argentina, whereas French Guiana, Suriname and Uruguay have the lowest Myrmeleontidae diversity (Machado & Martins 2019f; Oswald 2019). Some small South American genera of antlions occur only in this region, *e.g.*, *Dimares* Hagen, 1866, *Millerleon* Stange, 1989, *Nephalesca* Navás, 1914, and *Verticillecerus* van der Weele, 1909, of Ascalaphinae; *Ensorra* Navás, 1915, *Stangeleon* Miller, 2008, of the Myrmeleontinae; and *Brasileon* Miller & Stange, 1989, of Nemoleontinae. *Ameropterus* Esben-Petersen, 1922, and *Eremoleon* Banks, 1901, have the largest number of species occurring in South America. Immature stages of the South American Myrmeleontidae species are relatively well known when compared to the other families of Neuropterida, although there are still many genera with unknown immature stages, *e.g.*, *Ecualeon* Stange, 1994, *Elicura* Navas, 1911, and *Galapagoleon* Stange, 1994.

Fossil species of South American Neuropterida (Table 2)

Glosselytrodea. This is a small fossil insect order which has been considered "orthopterids", Mecopterida, Neuropterida, or some problematic Holometabola (Béthoux et al. 2007). Due to the possibility of this order being related to Neuropterida, the two South American species of Glosselytridae from the late Triassic Los Rastros Formation of La Rioja, Argentina were added in this review: *Argentinoglosselytrina pulchella* Martins-Neto & Gallego, 2001, and *Chanarelytrina nana* Martins-Neto & Gallego, 2006 (Martins-Neto et al. 2006).

Raphidioptera. Extant species of snakeflies are not known to South America, although there are seven South American fossil species from the lower Cretaceous Crato Formation of Ceará State, Brazil (Oswald 2019). Of the seven, five species are members of Baissopteridae: *Austroraphidia brasiliensis* (Nel et al., 1990), *Baissoptera brasiliensis* Oswald, 1990, *Baissoptera lisae* Jepson et al., 2011, *Baissoptera pulchra* (Martins-Neto & Nel, 1993), and *Baissoptera rochai* (Martins-Neto & Vulcano, 1990); and two species are considered *incertae sedis*: *Caririraphidia reticulate* Martins-Neto, 2003, and *Caririraphidia sertaneja* Martins-Neto, 2003 (Oswald 2019).

Megaloptera. There are two South American fossil species of Corydalidae from the lower Cretaceous Crato Formation of Ceará State, Brazil: *Cratocorydalopsis brasiliensis* Jepson & Heads, 2016 and *Lithocorydalus fuscatus* Jepson & Heads, 2016 (Jepson & Heads 2016; Oswald 2019).

Neuroptera. Neuroptera show great diversity in South American fossil species. There are 76 neuropteran species of 45 genera distributed in 15 families from the lower Cretaceous Crato Formation of Ceará State, Brazil (Oswald 2019; Makarkin et al. 2018). Also there is one species of Pemithonidae from the Late Pemian Irati Formation of Rio Grande do Sul State, Brazil: *Permipsythone panfilovi* Pinto & Ornellas, 1980 (Pinto & Pinto de Ornellas 1980).

Discussion

South America has a complex geological history and heterogeneous relief and climate, which have resulted in more than 25 biogeographical domains and great biological diversity, including that of Neuropterida (Morrone 2014). Currently, South America is the home of 15 % of the Neuropterida extant species and 10 % of the fossil species of this group. Among the 6 430 valid extant species of Neuropterida, 919 occur in South America (only Megaloptera and Neuroptera), and among the 930 fossil species of this group, a total of 91 species (Raphidioptera, Glosselytrodea, Neuroptera and Megaloptera) are present in this region (Oswald 2019).

There are records of 13 extant families of Neuropterida for South America and 135 genera, of which 63 (approximately 46 %) occur only in this region; also there are records of 19 families with fossil species of 53 genera, of which 45 (about 88 %) have species only in

Table 2. Number of fossil genera and species of Neuropterida per country recorded in South America.

Order (Family: Subfamily)	Genus	Number of species per Country	
		Argentina	Brazil
Glosselytrodea (Glosselytridae)	1. *Argentinoglosselytrina* Martins-Neto & Gallego, 2001	1	
	2. *Chanarelytrina* Martins-Neto & Gallego, 2006	1	
Megaloptera (Corydalidae)	3. *Cratocorydalopsis* Jepson & Heads, 2016		1
	4. *Lithocorydalus* Jepson & Heads, 2016		1
Raphidioptera (Baissopteridae)	5. *Austroraphidia* Willmann, 1994		1
	6. *Baissoptera* Martynova, 1961		4
Raphidioptera (*incertae sedis*)	7. *Caririraphidia* Martins-Neto, 2003		2
Neuroptera (Araripeneuridae)	8. *Araripeneura* Martins-Neto & Vulcano, 1989		5
	9. *Bleyeria* Martins-Neto, 1992		1
	10. *Caldasia* Martins-Neto & Vulcano, 1989		1
	11. *Cariri neura* Martins-Neto & Vulcano, 1989		2
	12. *Cratoalloneura* Martins-Neto, 1992		2
	13. *Cratoneura* Martins-Neto, 1992		4
	14. *Cratopteryx* Martins-Neto & Vulcano, 1989		2
	15. *Diegopteryx* Martins-Neto & Rodrigues, 2010		1
	16. *Paracaririneura* Martins-Neto &Vulcano, 1997		1
Neuroptera (Ascalaphidae)	17. *Cratoscalapha* Martins-Neto & Vulcano, 1997		1
Neuroptera (Babinskaiidae)	18. *Babinskaia* Martins-Neto & Vulcano, 1989		2
	19. *Neliana* Martins-Neto, 1992		2
	20. *Parababinskaia* Makarkin et al., 2017		1
Neuroptera (Berothidae: Cyrenoberothinae)	21. *Araripeberotha* Martins-Neto & Vulcano, 1990		1
	22. *Caririberotha* Martins-Neto &Vulcano, 1990		1
Neuroptera (Chrysopidae: Limaiinae)	23. *Araripechrysa* Martins-Neto & Vulcano, 1989		1
	24. *Caririchrysa* Martins-Neto & Vulcano, 1989		1
	25. *Limaia* Martins-Neto & Vulcano, 1988		2
	26. *Mesypochrysa* Martinov, 1927		2
Neuroptera (Corydasialidae)	27. *Cratochrysa* Martins-Neto, 1994		3
Neuroptera (*incertae sedis*)	28. *Brasilopsychopsis* Rumbucher, 1995		1
	29. *Cratopsychopsis* Rumbucher, 1995		1
	30. *Cratosisyrops* Martins-Neto, 1997		1
Neuroptera (Ithonidae)	31. *Principiala* Makarkin & Menon, 2007		1
Neuroptera (Kalligrammatidae)	32. *Makarkinia* Martins-Neto, 1997		2

Order (Family: Subfamily)	Genus	Number of species per Country: Argentina	Number of species per Country: Brazil
Neuroptera (Mesochrysopidae: Allopterinae)	33. *Cratovoluptia* Martins-Neto & Rodrigues, 2009		1
	34. *Karenina* Martins-Neto, 1997		4
	35. *Triangulochrysopa* Nel et al., 2005		1
Neuroptera (Mesochrysopidae: *incertae sedis*)	36. *Dryellina* Martins-Neto & Rodrigues, 2009		1
Neuroptera (Nemopteridae: *incertae sedis*)	37. *Cratonemopteryx* Martins-Neto, 1992		3
	38. *Krika* Martins-Neto, 1992		1
Neuroptera (Nemopteridae: Roeslerianinae)	39. *Roesleriana* Martins-Neto, 1997		1
Neuroptera (Nymphidae)	40. *Araripenymphes* Menon et al., 2005		1
	41. *Olindanymphes* Martins-Neto, 2005		1
	42. *Santananymphes* Martins-Neto, 2005		1
	43. *Cratosmylus* Myskowiak et al., 2015		1
Neuroptera (Osmylidae: Gumillinae)	44. *Nuddsia* Menon & Makarkin, 2008.		2
Neuroptera (Palaeoleontidae)	45. *Araripeleon* Millet & Nel, 2010		1
	46. *Neurastenyx* Martins-Neto & Vulcano, 1997		5
	47. *Paraneurastenyx* Martins-Neto, 1998		1
	48. *Parapalaeoleon* Menon & Makarkin, 2008		1
Neuroptera (Permithonidae)	49. *Permipsythone* Pinto & de Ornellas, 1980		1
Neuroptera (Pseudonymphidae)	50. *Blittersdorffia* Martins-Neto & Vulcano, 1989		5
	51. *Pseudonymphes* Martins-Neto & Vulcano, 1989		4
Neuroptera (Psychopsidae)	52. *Pulchroptilonia* Martins-Neto, 1997		1
	53. *Putzneura* Martins-Neto, 2010		1
Total species		**2**	**89**
Total genera		**2**	**51**

the South American region (Oswald 2019). The small order Glosselytrodea has only two fossil species of two genera that belong to Glosselytridae; Raphidioptera is also known in the South American continent only through fossil species; there are seven species of three genera considered *incertae sedis* or belonging to Baissopteridae; Megaloptera is the second order in number of species recorded in South America; there are 60 extant species from seven genera of Corydalidae and Sialidae, plus two fossil species of two genera in Corydalidae (Oswald 2019). The order Neuroptera dominates the South American Neuropterida in species richness: there are 860 extant species of 128 genera from 11 families, plus 80 fossil species of 46 genera from 16 families, highlighting the great diversity present in the lower Cretaceous Crato Formation of Ceará State, Brazil (Oswald 2019).

Chrysopidae is the Neuropterida family with the greatest diversity in South America; extant species of green lacewing represent 35 % of all Neuropterida diversity in this region. Chile, Venezuela and Argentina have the greatest number of extant Neuropterida families in South America, while Brazil, Argentina, Colombia and Peru have the greatest number of extant genera in the region (Table 1). South American fossil species have been recorded in only Brazil and Argentina (Table 2).

Brazil has the greatest number of Neuropterida species with 446 extant and 89 fossil species (Machado 2019; Oswald 2019), and it is estimated that the number of recorded species will at least double over the next few years (Freitas & Penny 2012). Countries of the north-eastern region of South America have the lowest diversity of families and genera (Tables 1, 2); French Guiana and Guyana have no record with respect to seven families of Neuropterida (Sialidae, Coniopterygidae, Sisyridae, Osmylidae, Di-

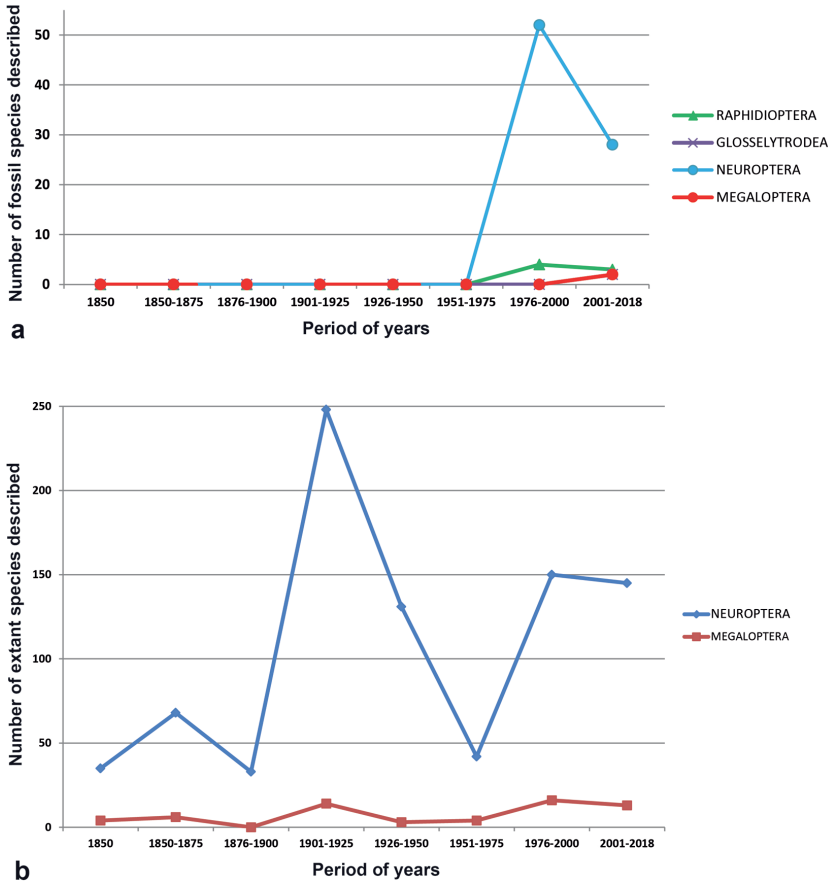

Figure 1. Number of South American Neuropterida species described over the years. a – Fossil species; b – extant species.

laridae, Hemerobiidae and Nemopteridae) that occur in nearby countries, whereas Ecuador and Suriname have a low diversity of Neuropterida. The scarcity of records in the sub-region is probably due to the lack of studies in these countries.

Approximately 1.7 million species have been named since Linnaeus, and it is estimated that there is still about 90 % of the world biota to be described (Wilson 2000; Disney 2000), including part of Neuropterida fauna. There is still an unknown, presumably huge diversity of the Neuropterida in South America which needs more study. Ithonidae has records only from Chile, Nemopteridae and Berothidae have records from five South American countries, and Sialidae and Dilaridae have records from only seven countries of South America; only Corydalidae, Chrysopidae, Mantispidae and Myrmeleontidae have records from all South American countries. As to the immature stages of South American Neuropterida, probably only 10 % is known.

The South American fauna is still practically unknown. We can cite as an example recent studies of Osmylidae; in the last five years, the number of species that have been recorded in South America increased from 13 to 26, and the first Osmylidae larvae for this region were described as well (Ardila-Camacho & Noriega 2014; Martins et al. 2016, 2018, 2019).

The number of fossil species of Neuropterida described grew considerably between 1976 and 2000 and has remained relatively high in the last 18 years (Fig. 1a). The greatest number of descriptions of South American Neuropterida species occurred during the years 1901–1925, probably due to the descriptions by Longinos Navás. After this period, there was a long decline in the number of descriptions in the period intermittent between the two World Wars (Fig. 1b). Recently, from the year 1975 onwards, a new increase in the number of descriptions of South American Neuropterida species (Fig. 1b) occurred which has been maintained despite the taxonomic impediment.

Forthcoming studies of South American Neuropterida should focus on data on immature stages, as well as on the fauna belonging to the countries of the north-eastern and southern sub-regions of South America. Studies with fossils should be carried out in the lower Cretaceous Crato Formation of Ceará State, Brazil, because there is a great diversity of Neuropterida fossils in that site; nevertheless, it is also important to carry out studies in other areas of other South American countries.

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