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Systematic and zoogeographical characteristics of the oribatid mite fauna (Acari: Oribatida) of Vietnam

Đặc điểm cấu trúc phân loại và địa động vật của khu hệ ve giáp (Acari: Oribatifa) ở Việt Nam

Research article

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The article is a synthesis of the studies on oribatid mites carried out in Vietnam during the period of 1980-2013, and is based on the oribatid materials obtained throughout the country. The oribatid mite fauna (Acari: Oribatida) of Vietnam is diversified, and has high specialization. It is diverse by the number of superfamilies, families, genera and species recorded. However, the number of genera per family, as well as the number of species and subspecies per genus, is not high. 43.75% and 37.50% of the total 64 families and subfamilies consist of one and of 2-3 genera, respectively. The only one family Oppiidae Grandjean, 1954 consists of 23 genera. The majority of the genera, 68.10% of the total, are represented by one species. The only two genera are represented by more than 10 species, namely *Galumna* Heyden, 1826 and *Pergalumna* Grandjean, 1936, with 13 and 11 species, respectively. The main zoogeographical characteristics of the oribatid mite fauna of Vietnam are the Oriental species, representing 60.30% of the total number. It also includes the elements of the Palaearctic – Oriental (12.2%), the Cosmopolitan (10.6%), the Afrotropical (Ethiopical) – Oriental (6.9%), the Australian – Oriental (5.0%), the Neotropical – Oriental (3.8%), the Nearctic – Oriental (0.9%), and the Pacific - Oriental (0.3%).

Để đánh giá cấu trúc phân loại và đặc điểm địa động vật của khu hệ ve giáp Việt Nam (Acari: Oribatida), trên cơ sở mẫu vật nghiên cứu thu từ toàn lãnh thổ quốc gia, công trình đã tổng hợp và phân tích các kết quả nghiên cứu về ve giáp trong giai đoạn 1980-2013. Khu hệ động vật ve giáp Việt Nam có tính chuyên biệt cao, và rất đa dạng về số lượng họ, giống và loài xác định được. Tuy nhiên số lượng giống trong 1 họ, cũng như số lượng loài trong 1 giống lại không cao. 43,75% và 37,50% của 64 họ và phân họ, tương ứng chỉ xác định được có 2 và 3 giống. Duy nhất có họ Oppiidae Grandjean, 1954 ghi nhận được 23 giống. 68,10% tổng số giống, chỉ xác định được 1 loài. Duy nhất có 2 giống ghi nhận được hơn 10 loài, là Galumna Heyden, 1826 và Pergalumna Grandjean, 1936, tương ứng có 13 và 11 loài. Đặc điểm địa động vật cơ bản của khu hệ ve giáp Việt Nam là tính chất Đông phương (Oriental), với 60,30% tổng số loài xác định được. Tính chất địa động vật của nó còn bao gồm các yếu tố sau: Cổ bắc - Đông phương (Palaearctic-Oriental, 12,2% tổng số loài xác định được), Toàn cầu (Cosmopolite, 10,6%), Nhiệt đới Phi châu - Đông phương (Afrotropical (Ethiopical)-Oriental, 6,9%), Úc châu - Đông phương (Australian-Oriental, 5,0%), Tân nhiệt đới - Đông phương (Neotropical-Oriental, 3.8%), Vùng cực - Đông phương (Nearctic-Oriental, 0.9%), và Thái Bình Dương - Đông phương (Pacific-Oriental, 0,3%).

Keywords: oribatida, systematic, zoogeography, Vietnam

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1. INTRODUCTION

Oribatid mites (Acarina: Oribatida) are small arachnids (Microarthropoda), comprising the main component of microarthropod populations in the soil ecosystem, and are an important component in all biological processes taking place in soil. They disperse bacteria and fungi, both externally on their body surface, or by feeding, with subsequent survival of spores during passage through their alimentary tracts. Others are intermediate hosts for important tapeworm parasites (Cestoda) of animals (Ghilarov & Krivolutsky 1975, Behan-Pelletier 1999) [4, 13].

The study on oribatid mites of Vietnam started in 1967 by Hungarian oribatologists (Balogh & Mahunka 1967) [3]. It continued in the 1980's, and has obtained the important results (Golosova 1983 & 1984, Vu Quang Manh 1985, Jeleva & Vu 1987, Mahunka 1987, 1988 & 1989) [14, 16, 17, 18, 28]. However, because of the diverse fauna of the tropical soil ecosystem of Vietnam the studies on oribatid mites of Vietnam are still not enough sufficient (Krivolutsky et al. 1997, Vu & Nguyen 2000, Vu Quang Manh 2007, 2012 & 2015, Dao Duy Trinh et al. 2010, Vu et al. 2010, Ermilov et al. 2011, Ermilov & Vu 2012, Nguyen Hai Tien & Vu Quang Manh 2012, Nguyen Huy Tri et al. 2014, Fernandez et al. 2014 & 2015) [5, 9, 11, 12, 15, 20, 30, 31, 32, 34, 35, 36].

In recent years, the Russian colleague Sergey G. Ermilov and his collaborators have made a significant contributions to the knowledge of the oribatid mite fauna of Southeast and Southwest of Vietnam. However, many of their oribatid specimens have been obtained by unofficial lines, and Ermilov rarely collected materials by himself in the field. Their data on the geographical locations and natural conditions of Vietnam are founded on incorrect and sometime on illegal sources. In particular, the administrative maps of the socialist republic of Vietnam in their publications are introduced fully false, lacking islands and the island regions of the Vietnam (Ermilov et al. 2012, Ermilov & Anichkin 2014, Ermilov 2015, Minor & Ermilov 2015) [7, 8, 10, 19]. Therefore, the data on Vietnam's oribatid mites given by the Russian colleague Sergey G. Ermilov and his coauthors must be checked and revised carefully, before consulting them. Even so, although lacking of knowledge and right source of Vietnam's nature, this is an encouraging attempt by Russian colleague on study of oribatid mites of Vietnam, and it showed up the importance of the soil oribatid mites of Vietnam.

This article is a synthesis of the studies on oribatid mites carried out in Vietnam during the period of 1980-2013, and is based on the oribatid materials obtained throughout the country. Its aim is to characterize the systematic and zoogeographical characteristics of the oribatid mite fauna of Vietnam.

2. MATERIALS AND METHODS

2.1 Study area

During the period of 1980-2013, oribatid specimens obtained throughout Vietnam, including fifty sites located in 27 provinces, and from all of the 8 natural geographical regions of Vietnam, namely Northwest, Northeast, Red River Delta, North Central Coast, South Central Coast, Central Highlands, Southeast, and Mekong River Delta (Vu, Taillard 1994) [37]. Fifty study sites were classified into six main types, as follows: Natural forest, Human-disturbed forest, Grassland and scrub, Grassland, Cultivated land with perennial and annual plants, and Agricultural land with annual plants (Vietnam Ministry of Agriculture and Rural Development 2006) [26]. The study soils were arranged in a six main groups: Coastal saline-acid soil, Acid alluvial soil, Neutral alluvial soil, Ferralitic reddish brown soil, Ferralitic brownish soil derived from limestone, Reddish brown soils derived from basic and intermediate magmatic rocks (Vietnam National Institute for Soils and Fertilizers 2002) [27].

2.2 Sampling and extraction

Soil samples were taken according to soil vertical layers, as follows: Forest litter, and soil vertical layers of 0-10cm, 10-20cm, 20-30cm. Soil samples were taken by rectangular metal sampler, with ($0{,}25m^2$) surface area, 20 cm in depth and with both ends open. Forest litter samples were taken from the total forest litter covered an area of ($0{,}25m^2$). Modifications of Berlese-Tullgren funnels were used for extraction of oribatid mites from the obtained materials. An extraction lasted seven days in the laboratory at normal air condition of 25-30^oC. Extracted oribatid mites were preserved in 70° ethanol, sorted and counted (Edwards 1991) [6].

2.3. Identification and data analysis

Oribatida materials are identified mainly after Balogh (1992), Gilyarov & Krivolutsky (1975), Balogh & Balogh (1988, 1989, 2002), Norton & Behan-Pelletier (2009), Schatz et al. (2011), and Subias (2013) [1, 2, 13, 22, 23, 24]. A zoogeographical characteristic of the oribatid mite fauna of Vietnam is analyzed according to the World zoogeographical regions, consisting NE. Nearctic, PA. Palaearctic, NO. Neotropical, AF. Afrotropical (Ethiopian), OR. Oriental, AU. Australian, PC. Pacific, and AN (Illies 1974, Udvardy 1975) [25].

3. RESULT AND DISCUSSION

3.1. Species biodiversity

Table 1 presents the species diversity and an analysis of a systematic characteristics of the oribatid mite fauna of Vietnam, consulting to classifications of Gilyarov & Krivolutsky (1975), Balogh & Balogh (2002), Norton & Behan-Pelletier (2009), Schatz et al. (2011), and Subias (2013) [2, 13, 22, 23, 24]. In the table introduced are also a number of superfamilies per order, of families per superfamily, of genera per family, as well as a number of species per genus.

Table 1. Systematic characteristics of the oribatid mite fauna of Vietnam

No	Infraorder	Superfamily	Family	Genus	Species & Sub-species
I	**ENARTHRONOTA Grandjean, 1947**	**1.HYPOCHTHONOIDEA Berlese, 1910**	1. Hypochthoniidae Berlese, 1910	1. *Malacoangelia* Berlese, 1913	1
				2. *Eohypochthonius* Jacot, 1938	2
				3.*Eniochthonius* Grandjean, 1933	1
		2. PROTHOPLOPHORIDEA Ewing, 1917	2. Cosmochthoniidae Grandjean, 1947	4. *Cosmochthonius* Berlese, 1910	1
			3. Sphaerochthoniidae Grandjean, 1947	5. *Sphaerochthonius* Berlese, 1910	1
			4.Prothoplophoridae Ewing, 1917	6. *Apoplophora* Aoki, 1980	2
				7.*Arthrhoplophora* Berlese, 1910	1
II	**MIXONOMATA Grandjean, 1969**	**3. PHTHIRACAROIDEA Perty, 1841**	5. Steganacaridae Niedbala, 1986	8. *Arphthiracarus* Niedbala, 1994	1
				9. *Atropacarus* Ewing, 1917	3
				10. *Austrophthiracarus* Balogh et Mahunka, 1978	1
				11. *Plonaphacarus* Niedbala, 1986	2
			6. Phthiracaridae Perty, 1841	12. *Hoplophorella* Berlese, 1923	4
				13. *Phthiracarus* Perty, 1841	1
		4. EUPHTHIRACAROIDEA Jacot, 1930	7. Oribotritiidae Grandjean, 1954	14. *Indotritia* Jacot, 1929	1
				15. *Oribotritia* Jacot, 1924	1
				16. *Sabahtritia* Mahunka, 1987	1
			8. Euphthiracaridae Jacot, 1930	17. *Rhysotritia* Markel & Meyer, 1959	6
		5. LOHMANNIOIDEA Berlese 1916	9. Lohmanniidae Berlese, 1916	18. *Haplacarus* Wallwork, 1962	1
				19. *Javacarus* Balogh, 1961	1
				20. *Lohmannia* Michael, 1898	1
				21. *Meristacarus* Grandjean, 1934	1
				22. *Mixacarus* Balogh, 1958	2
				23. *Papilacarus* Kunst, 1959	8
				24. *Vepracarus* Aoki, 1965	1
			10. Malaconothridae Berlese, 1916	25. *Trimalaconothrus* Berlese, 1916	1
		6. CROTONIOIDEA Thorell, 1876	11. Nothridae Berlese, 1896	26. *Nothrus* Koch, 1836	4
				27. *Afronothrus* Wallwork, 1961	1
			12. Trhypochthoniidae Willmann, 1931	28. *Allonothrus* Hammer, 1953	1
				29. *Archegozetes* Grandjean, 1931	1

No	Infraorder	Superfamily	Family	Genus	Species & Sub-species
III	**DESMONOMATA Woolley, 1973**	**7. EPILOHMANNIOIDEA Oudemans, 1923**	13.Epilohmanni-idae Oudemans, 1923	30. *Epolihmannia* Berlese, 1910	5
		8. NANHERMANNOIDEA Sellnick, 1928	14. Nanhermanni-idae Sellnick, 1928	31. *Cosmohermannia* Aoki & Yoshida, 1970	1
				32. *Cyrthermannia* Balogh, 1958	1
				33. *Masthermannia* Ber-lese, 1913	1
				34. *Nanhermannia* Berlese, 1913	1
		9.HERMANNOIDEA Sellnick, 1928	15. Hermanniidae Sellnick, 1928	35. *Phyllhermannia* Ber-lese, 1916	3
		10. HERMANNIELLOIDEA Grandjean, 1934	16. Hermanniellidae Grandjean, 1934	36. *Hermanniella* Berlese, 1908	1
		11. NEOLIODOIDEA Grandjean, 1954	17.Neoliodidae Grandjean, 1954	37. *Neolides* Heyden, 1826	1
				38. *Platyliodes* Berlese, 1916	1
	BRACHYPYLINA Hull, 1918	**12. GYMNODAMAEOIDEA Grandjean, 1954**	18. Gymnodamae-idae Grandjean, 1954	39. *Adrodamaeus* (Paschoal, 1984)	1
		13. PLATEREMAEOIDEA Traegardh, 1931	19.Pedrocortesell-idae Paschoal, 1987	40. *Hexachaetoniella* Paschoal, 1987	1
				41. *Pedrocortesella* Ham-mer, 1961	2
		14. DAMAEOIDEA Berlese, 1896	20. Damaeidae Berlese, 1896	42. *Belba* Heyden, 1826	1
				43. *Metabelba* Grandjean, 1936	1
		15. CEPHEOIDEA Berlese, 1896	21. Cepheidae Berlese, 1896	44. *Sphodrocepheus* Wool-ley e Higgins, 1963	1
			22. Microtegeidae Balogh, 1972	45. *Microtegeus* Berlese, 1916	4
			23. Eremaeozeti-dae Piffl, 1972	46. *Eremaeozetes* Berlese, 1913	1
IV		**16. MICROZETOIDEA Grandjean, 1936**	24. Microzetidae Grandjean, 1936	47. *Berlesezetes* Mahunka, 1980	2
				48. *Caucasiozetes* Shtanchaeva, 1984	1
				49. *Kaszabozetes* Ma-hunka, 1988	1
				50. *Schalleriella* Balogh, 1962	1
		17. AMEROBELBOIDEA Grandjean, 1954	25. Amerobelbi-dae Grandjean, 1954	51. *Roynortonia* Ermilov, 2011	1
			26. Eremulidae Grandjean, 1965	52. *Austroeremulus* Ma-hunka, 1985	1
				53. *Eremulus* Berlese, 1908	3
				54. *Mahunkana* Kocak and Kemal, 2008	1
			27. Damaeolidae Grandjean, 1965	55. *Fosseremus* Grandjean, 1954	1
				56. *Gressittolus* Balogh, 1970	1
			28. Eremobelbi-dae Balogh, 1961	57. *Eremobelba* Berlese, 1908	6
				58. *Fenestrella* Mahunka, 1987	1
			29. Heterobelbi-dae Balogh, 1961	59. *Heterobelba* Berlese, 1913	1

No	Infraorder	Superfamily	Family	Genus	Species & Sub-species
			30. Basilobelbidae Balogh , 1961	60. *Basilobelba* Balogh, 1958	1
		18. ZETORCHESTOIDEA Balogh, 1961	31.Zetorchestidae Michael, 1898	61. *Zetorchestes* Berlese, 1888	2
		19. GUSTAVIOIDEA Oudemans, 1900	32. Astegistidae Balogh, 1961	62. *Cultroribula* Berlese, 1908	2
			33. Peloppiidae Balogh, 1943	63. *Ceratoppia* Berlese, 1908	1
				64. *Furcoppia* Balogh et Mahunka, 1969	2
		20. CARABODOIDEA C. L. Koch, 1837	34. Carabodidae C.L.Koch, 1837	65. *Aokiella* Balogh et Mahunka, 1967	2
				66. *Austrocarabodes* Hammer, 1966	3
				67. *Chistyakovella* Ermilov, Aoki, Anichkin, 2013	1
				68. *Gibbicepheus* Balogh, 1958	1
				69. *Pentabodes* P.Balogh, 1984	1
				70. *Carabodes (Phyllocarabodes)* Balogh et Mahunka, 1969	1
			35. Nipobodidae Aoki, 1959	71. *Leobodes* Aoki, 1965	1
		21. TECTOCEPHEOIDEA Grandjean, 1954	36.Tectocepheidae Grandjean, 1954	72.*Tectocepheus* Berlese, 1896	2
				73.*Tegeozetes* Berlese, 1913	1
			37.Otocepheidae Balogh, 1961	74.*Otocepheus (Acrotocepheus)* Aoki, 1965	4
				75.*Archegotocepheus (Megalotocepheus)* Mahunka, 1988	1
				76.*Dolicheremaeus* Jacot, 1938	8
				77.*Eurostocepheus* Aoki, 1965	1
		22. OPPIOIDEA Grandjean, 1954	38. Eremellidae Balogh, 1961	78. *Eremella* Berlese, 1913	1
			39.Granuloppiidae Balogh, 1983	79. *Gigantoppia* Mahunka, 2008	1
				80. *Granuloppia* Balogh, 1958	1
			40. Oppiidae Grandjean, 1954	81. *Acroppia* Balogh, 1883	1
				82. *Arcoppia* Hammer, 1977	6
				83. *Belloppia* Hammer, 1968	1
				84. *Brachioppiella* Hammer, 1962	1
				85. *Congoppia* Balogh, 1963	1
				86. *Cryptoppia* Csiszár, 1961	1
				87. *Hammerella* Ermilov, Shtanchaeva, Subias, Anichkin, 2012	1
				88. *Helioppia* Balogh, 1983	1

No	Infraorder	Superfamily	Family	Genus	Species & Sub-species
				89. *Karenella* Hammer, 1962	1
				90. *Kokoppia* Balogh, 1983	1
				91. *Lanceoppia* Subías, 1989	1
				92. *Lasiobelba* Aoki, 1959	2
				93. *Lineoppia* J & P. Balogh, 1983	1
				94. *Multioppia* Hammer, 1961	1
				95. *Neoamerioppia* Subías, 1989	1
				96. *Oppia* Wallwork, 1961	2
				97. *Oppiella* Jacot, 1937	1
				98. *Oxybrachioppia* Subías, 1989	1
				99. *Pseudoamerioppia* Subias, 1989	1
				100. *Pulchroppia* Hammer, 1979	5
				101. *Ramusella* Hammer, 1962	3
				102. *Ramuselloppia* Subías & Rodríguez, 1986	1
				103. *Striatoppia* Balogh, 1958	3
				104. *Taiwanoppia* Tseng, 1982	1
		23.TRICOZETOIDEA Ewing, 1917	41. Suctobelbidae Jacot, 1938	105. *Suctobelba* Paoli, 1908	3
				106. *Suctobelbila* Jacot, 1937	1
				107. *Suctobelbella* Jacot, 1937	8
		24. LIMNOZETOIDEA Thor, 1937	42. Limnozetidae Grandjean, 1954	108. *Limnozetes* Hull, 1916	1
		25. CYMBAEREMAEOIDEA Sellnick, 1928	43. Cymbaeremaeidae Sellnick, 1928	109. *Scapheremaeus* Berlese, 1910	4
V	**PORONOTA Balogh J. et Balogh P. 2002 (?)**	**26. IDIOZETOIDEA Aoki, 1976**	44. Idiozetidae Aoki, 1976	110. *Idiozetes* Aoki, 1976	1
		27. ORIPODOIDEA Jacot, 1925	45. Chaunoproctidae Balogh, 1961	111. *Chaunoproctus* Pearce, 1906	1
			46. Parakalummidae Grandjean, 1936	112. *Neoribates* Berlese, 1914	3
			47. Mochlozetidae Grandjean, 1960	113. *Unguizetes* Sellnick, 1925	4
				114. *Uracrobates* Balogh et Mahunka, 1967	1
			48. Haplozetidae Grandjean, 1936 (Xylobatidae J. Balogh et Balogh P., 1984)	115. *Brasilobates* Pérez-Ínigo y Baggio, 1980	1
				116. *Perxylobates* Hammer, 1972	6
				117. *Setoxylobates* Balogh et Mahunka, 1967	1
				118. *Vilhenabates* Balogh, 1963	1

No	Infraorder	Superfamily	Family	Genus	Species & Sub-species
				119. *Xylobates* Jacot, 1925	6
			49. Protoribatidae Balogh Balogh J. Balogh et P. Balogh, 1984	120. *Protoribates* Berlese, 1908	3
			(1) Protoribatinae Balogh Balogh J. Balogh et P. Balogh, 1984 (Subfamily)	121. *Liebstadia* Oudemans, 1906	1
			(2) Liebstadiinae Balogh Balogh J. Balogh et P. Balogh, 1984 (Subfamily)		
			50. Oribatulidae Thor, 1929	122. *Cordiozetes* Mahunka, 1983	1
				123. *Oribatula* Berlese, 1896	1
				124. *Sellnickia* Oudemans, 1927	1
				125. *Zygoribatula* Berlese, 1916	3
			51. Haplozetidae Grandjean, 1936	126. *Cosmobates* Balogh, 1959	1
				127. *Indoribates* Willmann, 1935	2
				128. *Magnobates* Hammer, 1967	1
				129. *Peloribates* Berlese, 1908	7
				130. *Rostrozetes* (*Trachyoribates*) Sellnick, 1925	5
			52. Scheloribatidae Grandjean, 1953	131. *Euscheloribates* Kunst, 1958	1
				132. *Fijibates* Hammer, 1971	1
				133. *Ischeloribates* Corpuz-Raros, 1980	1
				134. *Nanobates* Balogh et Mahunka, 1980	1
				135. *Philoribates* L.A.Corpuz-Raros, 1980	1
				136. *Rhabdoribates* Aoki, 1967	1
				137. *Scheloribates* Berlese, 1908	8
				138. *Tuberemaeus* Sellnick, 1930	2
			53. Oripodidae Jacot, 1925	139. *Cosmopirnodus* Balogh, 1970	1
				140. *Oripoda* Bank, 1904	1
				141. *Subpirnodus* Mahunka, 1988	1
				142. *Truncopes* Grandjean, 1956	1
			54. Birobatidae J. Balogh et P. Balogh, 1984	143. *Brachyoripoda* Balogh, 1970	1
			55. Mycobatidae Grandjean, 1954	144. *Allozetes* Berlese, 1913	1

No	Infraorder	Superfamily	Family	Genus	Species & Subspecies
		28. CERATOZETOIDEA Jacot, 1925	56. Ceratozetidae Jacot, 1925	145. *Ceratozetes* Berlese, 1908	2
				146. *Fuscozetes* Sellnick, 1928	1
			57. Austrachipteriidae Luxton, 1985	147. *Austrachipteria* Balogh et Mahunka, 1966	1
				148. *Lamellobates* Hammer, 1958	4
				149. *Paralamellobates* Bhaduri y Raychaudhuri, 1968	3
			58. Punctoribatidae Thor, 1937	150. *Punctoribates* Subías, Kahwash y Ruiz, 1990	1
		29. ORIBATELLOIDEA Jacot, 1925	59. Oribatellidae Jacot, 1925	151. *Novoribatella* Engelbrecht, 1986	1
				152. *Oribatella* Banks, 1895	3
			60. Achipteridae Thor, 1929	153. *Achipteria* Berlese, 1885	1
				154. *Parachipteria* Hammen, 1952	1
		30. GALUMNOIDEA Jacot, 1925	61. Galumnellidae Piffl, 1970	155. *Galumnella* Berlese, 1917	2
			62. Galumnidae Jacot, 1925	156. *Allogalumna* Grandjean, 1936	1
				157. *Dimidiogalumna* Engelbrecht, 1972	1
				158. *Galumna* Heyden, 1826	13
				159. *Globogalumna* P. y G. Palogh, 1990	1
				160. *Leptogalumna* Balogh, 1960	1
				161. *Neogalumna* Hammer, 1973	1
				162. *Pergalumna* Grandjean, 1936	11
				163. *Trichogalumna* Balogh, 1960	3
Total	**5 infraorders**	**30 superfamilies**	**62 families (2 subfamilies)**	**163 genera**	**320 species, subspecies**

Up to 2014, the oribatid mite fauna of Vietnam is represented by 320 species (including 4 subspecies), belonging to 163 genera, 62 families (not including two subfamilies), and 30 superfamilies (Balogh, Balogh 2002, Norton, Behan-Pelletier 2009, Schatz et al. 2011, and Subias 2013). Among the three hundred and twenty species (320 species, 100%) recorded from Vietnam, one hundred and twenty species (120 species, 37.50% of the total number), were described new for science. One hundred and eleven species (111 species, 34.68% of the total number), have been found only in Vietnam, and are probably endemic species. One hundred and fifty five (155) species, representing 48.44% of the total oribatid fauna, were new record for Vietnam (Table 1). After Subias (2013) [24], the World oribatid fauna comprised 10,342 species and subspecies, belonging to 1,249 genera and 163 families. In comparison with the World oribatid mite fauna the one of Vietnam occupies 3.09% (320 vs. 10,342 species), 13.05% (163 vs. 1,249 genera), and 38.03% (62 vs. 163 families) of the World fauna (Vu Quang Manh 2013, 2015 [33, 34].

In general, the oribatid mite fauna of Vietnam is very diverse, with a high number of species probably endemic. However, these data still not completely.

3.2. Systematic characteristics

Table 2 presents the oribatid systematic structure according to the number of genera per family. Almost all of the families consist of 1-3 genera, 43.75% and 37.50%, respectively, of the total 64 families and subfamilies. The families consisting of 4-5, and of 6-10 species are few, only 10.94% and 6.25%, respectively. Only one family consists of more

than 10 species, the family Oppiidae Grandjean, 1954 consisting of 23 genera (Table 1 and 2).

Table 2. Systematic characteristics of the oribatid mite fauna according to the number of genera per family

Number of genera per family	1	2-3	4-5	6-10	>10
Total					
64 families and subfamilies	28	24	7	4	1
100 %	43.75	37.50	10.94	6.25	1.56

Table 3 presents systematic characteristics of the oribatid mite fauna according to the number of species per genus. Almost all of the genera consist of one species, 68.10% of the 163 genera. The genera comprising of 2-3, 4-5 and 6-10 species are few, only 18.41%, 6.13% and 6.13%, respectively, of the total of 163 genera. Only two genera comprise of more than 10 species, namely Galumna Heyden, 1826 and Pergalumna Grandjean, 1936, with 13 and 11 species, respectively (Table 1 and 3).

Table 3. Systematic characteristics of the oribatid mite fauna according to the number of species per genus

Number of species per genus	1	2-3	4-5	6-10	>10
Total					
163 genera	111	30	10	10	2
100%	68.10	18.41	6.13	6.13	1.23

In general, according to the number of superfamilies, of families, of genera, as well as of species and subspecies recorded, the systematic characteristics of the oribatid mite fauna of Vietnam is diversified. However, the number of genera per family, as well as the number of species per genus are not high.

3.3. Zoogeographical characteristics

Table 2 presents the oribatid systematic structure according to the number of genera Vietnam is completely distributed in the in the Southeast Asia. Hammer and Wallwork (1979) considered that the source for the oribatid mite fauna of the south Pacific is probably Southeast Asia and that dispersal has occurred over seas, via island "stepping stones". However, Vietnam is a highly interesting region from a zoogeographical aspect. Although the whole country is mainly in the Oriental region, there is distinct differentiation between northern and southern parts of the country, and even between different subportions of the northern or the southern part. Northern Vietnam is closer to the south Chinese mountain range that makes it possible for some Palaearctic elements to infiltrate into this area, while Southern Vietnam is closer to the Pacific region.

On the basis of the zoogeographical data provided by Balogh (1961, 1972), Hammer (1972), Gilyarov & Krivolutsky (1975), Hammer & Wallwork (1979), Karppinen & Krivolutsky (1982), Karppinen et al. (1986, 1987), Balogh & Balogh (1988, 1989, 2002, 2012), Aoki (1999), Yin Wenying et al. (2000), Corpuz-Raros (2005), Subias (2013) [1, 2, 3, 13, 24], the results of the analysis of a zoogeographical characteristics of the oribatid fauna of Vietnam is presented in the Figure 1.

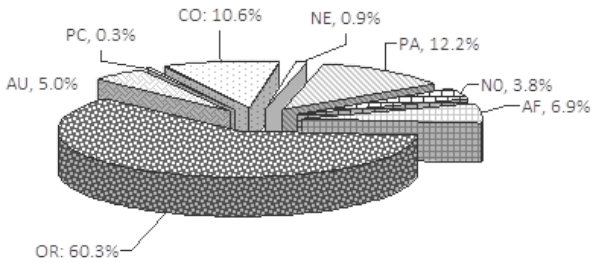

Figure 1. Zoogeographical characteristics of the oribatid mite fauna of Vietnam

Legends: (1) Oriental region: OR, (2) Palaearctic – Oriental: PA, (3) Cosmopolitan: CO, (4) Afrotropical (Ethiopical): AF, (5) Australian – Oriental: AU, (6) Neotropical – Oriental: NO, (7) Nearctic – Oriental: NE, (8) Pacific – Oriental: PC.

The result shows that, the oribatid mite fauna of Vietnam includes all eight zoogeographical elements. These eight zoogeographical elements can be arranged according to decreasing representation of species, as follows: (1) Oriental region (OR) occupies 60.3% of the total 320 species, with 193 species registered, (2) Palaearctic – Oriental (PA) - 12.2%, with 39 species, (3) Cosmopolitan (CO) - 10.6%, with 34 species, (4) Afrotropical (Ethiopical) – Oriental (AF) - 6.9%, with 22 species, (5) Australian – Oriental (AU) - 5.0%, with 16 species, (6) Neotropical – Oriental (NO) - 3.8%, with 12 species, (7) Nearctic – Oriental (NE) - 0.9%, with 3 species, (8) Pacific - Oriental (PC) – 0.3%, with 1 species (Figure 1).

The main zoogeographical component of the oribatid mite fauna of Vietnam are the Oriental species, representing 60.3% of the total 320 species, with 193 recorded. This oribatid mite fauna has high specialization, with 111 species (34.68% of the total) recorded only from Vietnam (probably endemic species, i.e. conditional endemics). Besides

that, the oribatid mite fauna of Vietnam includes also the Palaearctic - Oriental elements, with 39 species recorded, and cosmopolitan elements - 34 species, representing 12.2% and 10.6% of the total, respectively. The other categories are represented by a smaller number of species. There is now Antarctic element recorded in the oribatid mite fauna of Vietnam.

4. CONCLUSIONS

The oribatid mite fauna (Acari: Oribatida) of Vietnam is diversified, and has high specialization. It is diverse by the number of superfamilies, families, genera and species recorded. However, the number of genera per family, as well as the number of species and subspecies per genus, is not high. 43.75% and 37.50% of the total 64 families and subfamilies consist of one and of 2-3 genera, respectively. The only one family Oppiidae Grandjean, 1954 consists of 23 genera. The majority of the genera, 68.10% of the total, are represented by one species. The only two genera are represented by more than 10 species, namely *Galumna* Heyden, 1826 and *Pergalumna* Grandjean, 1936, with 13 and 11 species, respectively.
The main zoogeographical characteristics of the oribatid mite fauna of Vietnam are the Oriental species.

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