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Diversity and global distribution of oribatid mites (Acari, Oribatida) - evaluation of the present state of knowledge

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Summary

Up to present almost 10000 oribatid species were described. The species diversity in all classical zoogeographic regions and subregions is presented. About 3620 oribatid species are known from the Palaearctic region, 1900 from the Oriental, 1450 from the Ethiopian, 1120 from the Nearctic, 1850 from the Neotropical, 1245 from the Australian/Pacific region, and 118 from the Subantarctic/Antarctic (state July 2004). Cosmopolitan species are rare in oribatid mites, also circumtropical species. About 90% of all species were found in one region only. The similarity in species composition between the regions is generally low, highest between the Palearctic and Oriental as well as between the Palearctic and Nearctic regions. Similarity at the generic level is much higher and reaches about 40 to 60% between most regions. The delimitation of regions based on oribatid mites is problematical in some cases, especially along terrestrial borders. Examples of overlap are given, like the transition zone between Palaearctic and Ethiopian / Oriental regions and faunal bridges such as Central America, where highland adapted species reach far more southward on mountains than in surrounding lowlands. In those cases the borders should be considered as rather vertical than horizontal.

Key words: Acari, Oribatida, mites, general distribution, biogeography.

Introduction

Hammer and Wallwork (1979) and Wallwork (1984) published a review dealing with the world distribution of oribatid mites in relation to the continental drift. They compared the oribatid faunas of the major zoogeographical units at generic level, presenting the evidence and arguments that the oribatid mites are a very ancient group and that the global distribution of oribatids has been influenced by the movements and separation of continent masses since the Permian period. In the following years up to present

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no comprehensive study on this topic has been published, except for some specific regions (e.g. Mediterranean area: Bernini, 1984, 1991; Subias and Gil-Martin, 1997) or for certain groups (e.g. ptyctimous mites: Niedbala, 2000, 2001, 2002, 2004). However, in the last 25 years after Hammer's and Wallwork's work the number of newly described species as well as of newly erected higher taxa of oribatid mites increased rapidly, being presently on an almost double level in species numbers and a third more in numbers of genera (Schatz, 2002; updated).

The aim of this paper is to give an actual state of numbers of species and genera in each zoogeographical region and a rough comparison of the oribatid faunas in the different regions.

Method

Based on a species catalogue (see Schatz, 2002), all data on distribution from the available literature were registered. The existing major catalogues of oribatid faunas from different regions and countries (tab. 1) were checked and updated with recent literature (especially from publications of J. Aoki and collaborators, J. and P. Balogh, B. Bayartogtokh, L. Beck, V. Behan-Pelletier, A. Berlese: Castagnoli and Pegazzano, 1985, F. Bernini and collaborators, L. Corpuz-Raros, C. Engelbrecht and collaborators, F. Grandjean, M. Hammer, M. Luxton, S. Mahunka, W. Niedbala, R. Schuster, J. Stary, L.S. Subias and collaborators, J. Wallwork, G. Weigmann, S. Woas, and others. It is impossible to cite all references used for this work). Additionally, distribution records of oribatid species from the Zoological Record were included.

The resulting database contains all known species and genera as well as their known distribution patterns in zoogeographical regions and subregions. In the following, these lists are interpreted from several aspects. In some taxa differing opinions exist about classification or synonymy which have not been cleared up so far. No attempt was made to adjust for differences in those cases.

The similarity between regions was calculated using the Sørensen similarity coefficient (Southwood, 1978):

$$2 \times C * 100 / (A + B) \, [\%]$$

(C: spp./genera in common, A, B: total number of spp./genera in region)

Results and Discussion

Global distribution

The list of all known oribatid mites presently known (state: July 2004) includes 9898 species (352 subspecies are included in this number), 1333 genera (incl. 77 subgenera) and 181 families (tab. 2). Among the genera, 535 genera (40%) are monotypic, 210 genera (16%) contain two species.

Table 1 - Important catalogues with distribution records of oribatid mites (only the most recent catalogues of an area are listed).

Antarctic	Block and Stary, 1996, Pugh 1993, Stary and Block, 1998
Australia	Colloff and Halliday, 1998
Nearctic region	Marshall *et al*., 1987
Neotropical region	Balogh and Balogh, 1988, 1990
Palaearctic region	Ghilarov and Krivolutsky, 1975, Balogh and Mahunka, 1983
Extra-Holarctic regions	Balogh and Balogh, 2002
Records of Berlese's material	Castagnoli and Pegazzano, 1985
Ptyctimous mites	Niedbala, 1992, 2000, 2001, 2002, 2004
Algeria	Doumandji, 1985
Arctic	Danks, 1981
Austria	Schatz, 1983
Azores	Weigmann, 1976, Morell and Subias, 1991
Belgium	Lebrun *et al.*, 1989
Bohemia	Stary, 2000
British Isles	Luxton, 1996
Canary Islands	Izquierdo *et al*., 2001
Caucasus	Shtanchaeva, 2001
China	Wang *et al*., 2002, 2003
Cuba	Socarras et Palacios-Vargas, 1999
Denmark	Gjelstrup, 1978
Far East (Siberia)	Pankov *et al*., 1997, Ryabinin and Pankov, 2002
Finland	Niemi *et al*., 1997
Galapagos Islands	Schatz, 1998
Germany	Weigmann and Kratz, 1981
Greece	Flogaitis, 1992
Hawaiian Islands	Swift and Norton, 1998
Hungary	Mahunka and Mahunka-Papp, 2004
Iberian Peninsula	Pérez-Iñigo, 1993, 1997, Subias and Arillo, 2001
Iceland	Gjelstrup and Solhoy, 1994
India	Prasad, 1974, Sanyal and Bhaduri, 1986
Iran	Kamali *et al*., 2001
Italy	Bernini *et al*., 1995
Japan	Fujikawa *et al*., 1993
Korea	Choi, 1997
Lithuania	Eitminaviciute, 2003
Madagascar	Mahunka, 2002
Mexico	Palacios-Vargas, 1994, Palacios-Vargas and Iglesias, 2004
Morroco	Gil-Martin *et al*., 1992, Subias *et al*., 1994
New Zealand	Luxton, 1985
Poland	Olszanowski *et al.*, 1996
Romania	Vasiliu *et al.*, 1993
Saudi Arabia	Bayoumi and Al-Khalifa, 1985
Sweden	Lundqvist, 1987
St. Helena	Wallwork, 1977
Subantarctic Islands	Travé, 1981, Travé and De Bovée, 1989, Pugh, 1993, Stary and Block, 1995a, 1995b, 1996, 1998
Turkey	Özkan *et al*., 1988, Stary *et al*., 1995
Western Mediterranean	Subias and Gil-Martin, 1997
(former) Yugoslavia	Tarman, 1983

Very few Oribatid species (57 spp. [i.e. less than 1%] of the extant oribatid fauna) have a semicosmopolitan distribution (defined as the distribution of a taxon in the western and eastern Palaearctic, Nearctic, Neotropic and in eastern Gondwana - Ethiopian, Oriental or Australian regions). The number of semicosmopolitan genera is also low (162 genera [12%]), though much higher than at species level. Few oribatid taxa (119 spp. [around 1%], and 96 genera [7%] of the extant oribatid fauna) occur in all tropical regions and can be considered as "circumtropical".

The highest number of species is known from the Palaearctic region, followed by the Oriental and Neotropical regions (tab. 2). This reflects certainly also the intensity of the investigations carried out in the regions. The known species number in the Oriental, Ethiopian, Neotropical, Australian and Nearctic region is similar. A similar proportion was found at the generic level (Palaearctic followed by Neotropical region).

The vast majority (almost 90%) of all oribatid species and about 50% of all genera are restricted to one zoogeographical region (tab. 3), the similarity between the regions at species level is generally low. The highest numbers of common species are found between the Palaearctic and Nearctic, Palaearctic and Oriental, Oriental and Australian/Pacific regions. At the generic level, the similarity is much higher and reaches about 40 to 60% between most regions. The highest numbers of common genera can be found between the Palaearctic and Nearctic, as well as between the Palaearctic and Oriental region, but also between the Nearctic and Neotropical region. The Subantarctic-Antarctic area contains only few species and genera, and shows very low similarities to other regions.

Distribution within and similarities between some subregions

It is impossible to discuss the distribution patterns of all regions and subregions (see tab. 2) in detail here. Some remarkable areas are presented in detail (tab. 4):

Macaronesia: The oribatid fauna of the Macaronesian Islands was studied intensively in the last years (e.g. Izquierdo *et al.*, 2001, Salomone *et al.*, 2002). About 70% of the species were described after 1975. The similarity to the Palaearctic region (tab. 4) is clearly higher than to the Ethiopian region with regard to species as well as to genera. These results regarding all oribatid mite species are contrary to Niedbala (2001) who considered the Canary Islands as part of the Ethiopian region for the ptyctimous Oribatida.

Cape Verde: The oribatid fauna of the Cape Verde Islands is just at its initial stage of exploration (Mahunka, 1987, 1991, Niedbala, 2001). The similarity is almost the same for the Palaearctic and Ethiopian regions, but as Mahunka (1991) stated, the dominant genera and species have close affinities to the Palaearctic region and are mainly characteristic of the Mediterranean area. From the distribution of the oribatid mites, this archipelago forms an outpost of the Palaearctic rather than of the Ethiopian region, although there are also strong affinities to Africa.

Table 2 - Numbers of oribatid species and genera in zoogeographical regions and subregions (state July 2004).

Region Subregion	species total	species restricted to region	species original described	genera total	genera restricted region
Palaearctic	**3625**	**2926**	**3428**	**589**	**174**
Macaronesia[1]	358	115	125	166	10
North Africa[2]	318	64	96	172	6
Europe[3]	2097	1176	1940	394	55
Caucasus	754	122	155	249	6
Asia (Palaearctic)	1148	450	560	333	26
China (Palaearctic)[4]	212	34	43	120	0
Japan	735	374	509	286	14
Oriental	**1900**	**1290**	**1378**	**509**	**117**
Oriental West[5]	706	370	390	285	18
Oriental East	955	662	772	318	57
China (Oriental)[4]	476	213	216	245	25
Ethiopian	**1453**	**1274**	**1349**	**429**	**127**
Africa (Ethiopian)	1177	1011	1084	367	93
Madagascar[6]	315	250	265	160	32
Nearctic	**1117**	**700**	**826**	**341**	**29**
Neotropical	**1848**	**1528**	**1666**	**515**	**133**
Central America	714	416	482	322	25
South America	1340	1005	1184	422	81
Austral. / Pacific	**1245**	**954**	**1062**	**398**	**105**
New Guinea	193	131	164	117	12
Australia	347	269	278	198	25
New Zealand	392	288	325	169	22
Pacific Islands[7]	352	175	237	166	16
Hawaii	104	48	58	60	2
Sub-Antarctic	**118**	**72**	**86**	**70**	**10**
Subantarctic	109	55	67	68	8
Antarctic	29	9	19	14	0
fossil	*107*	*103*[8]	*103*	*78*	*27*[8]
World	**9898**	**8847**	**9898**	**1333**	**722**

[1] Canary Islands, Azores, Madeira, Salvage Islands, Cape Verde Islands
[2] Morocco, Algeria, Tunisia, Libya, Egypt
[3] Macaronesia and Caucasus excluded
[4] China (Palaearctic): Northern Provinces; China (Oriental): Southern provinces (see text)
[5] India, Pakistan, Nepal, Bhutan
[6] Comores and Mascarenes included
[7] without Hawai
[8] only known from fossil records

North Africa: The southern border towards the Ethiopian region is formed by the Sahara desert. The oribatid fauna from North Africa clearly shows a higher similarity to the Palaearctic than to the Ethiopian region (tab. 4).

Arabian Peninsula: According to the general opinion the limit between the Palaearctic and Ethiopian regions runs more or less through the middle of the peninsula. Oribatida are known from Saudi Arabia and

Table 3 - Numbers of oribatid species (a) and genera (b) in common between two regions (left upper triangle) and Sørensen similarity coefficient (right lower triangle). (calculation see text). Highest values are marked in bold digits.

(a) species	total	ANT	AUS/Pac	NEO	NEA	ETH	OR	PAL
Palaearctic	3625	11	127	135	**359**	101	**384**	–
Oriental	1900	10	**218**	166	142	114	–	**13.90**
Ethiopian	1453	6	60	60	42	–	6.80	3.98
Nearctic	1117	10	62	111	–	3.30	6.10	**15.14**
Neotropical	1848	36	113	–	7.49	3.64	8.86	4.93
Austral/Pacific	1245	16	–	7.31	5.25	4.45	**13.86**	5.22
Sub-Antarctic	118	–	2.35	3.66	1.62	0.76	0.99	0.59

(b) genera	total	ANT	AUS/Pac	NEO	NEA	ETH	OR	PAL
Palaearctic	589	33	185	257	**276**	201	**285**	–
Oriental	509	37	216	249	200	222	–	**51.91**
Ethiopian	429	36	192	222	143	–	47.33	39.49
Nearctic	341	31	143	224	–	37.14	47.06	**59.35**
Neotropical	515	52	217	–	**52.34**	47.03	48.63	46.56
Austral/Pacific	398	48	–	47.54	38.70	46.43	47.63	37.49
Sub-Antarctic	70	–	**20.51**	17.78	15.09	14.43	12.78	10.02

Yemen. Bayoumi and Al-Khalifa (1985) collected oribatid mites from 49 localities throughout Saudi-Arabia. No difference was found in the general distribution pattern of oribatid species between the northern and the southern part of the country. The oribatid fauna of Saudi Arabia shows highest similarities to the Palaearctic, followed by the Oriental region (tab. 4). The similarity of the Saudi Arabian oribatids to the Ethiopian is considerably lower than to the Oriental region.

In Yemen only one study has been made up to now (Mahunka, 2000). Yemen has a mixed oribatid fauna. There are numerous Palaearctic elements present, but also several typical gondwanan elements. The similarities are almost the same to Palaearctic, Ethiopian and Oriental regions (tab. 4). Mahunka (2000) considered the oribatid fauna from Yemen as strongly mixed and rather as tropical than as Palaearctic.

Central Asian mountains: In general, the border between the Palaearctic and the Oriental regions can be delimited by the ridges of the Hindukush and Himalaya mountains. Oribatid mites are recorded from North Pakistan, Himalaya and Tibet. The oribatid fauna of North Pakistan has been studied intensively by Hammer (1977). Very few investigations have been carried out in this area since. The Palaearctic related species are by far the dominant group (tab. 5). The Gondwanan element is becoming diluted, and the Laurasian element strengthened as we move northwards. North Pakistan seems to be a meeting point of the Laurasia and Gondwanaland faunas (Hammer and Wallwork, 1979).

The states and Indian provinces Nepal, Bhutan, Sikkim, Himachal Pradesh and Assam lie along the Himalayan range. These mountains show

Table 4 - Oribatid species and genera in common between selected areas.

Area (spp., gen. total)	Similarities to	species in common	(%)[1]	genera in common	(%)[1]
Macaronesia	Palaearctic	235	65.64	152	91.57
(358 spp., 166 gen.)	Europe	226	63.13	145	87.35
	North Africa	111	31.01	106	63.86
	Ethiopian	47	13.13	101	60.84
Cape Verde	Ethiopian	20	74.07	24	92.31
(27 spp., 26 gen.)	Palaearctic	17	62.96	24	92.31
	Europe	12	44.44	20	76.92
	Macaronesia	6	22.22	13	50.00
North Africa	Palaearctic	247	77.67	162	94.19
(318 spp., 172 gen.)	Europe	218	68.55	155	90.12
	Macaronesia	111	34.91	106	61.63
	Ethiopian	42	13.21	98	56.98
Saudi Arabia	Palaearctic	37	78.72	32	91.43
(47 spp., 35 gen.)	Oriental	25	53.19	21	60.00
	North Africa	23	48.94	21	60.00
	Ethiopian	19	40.43	18	51.43
	Yemen	5	10.64	5	14.29
Yemen	Palaearctic	12	52.17	12	60.00
(23 spp., 20 gen.)	Oriental	10	43.48	10	50.00
	Ethiopian	10	43.48	10	50.00
	North Africa	8	34.78	8	40.00
	Saudi Arabia	5	21.74	5	25.00
China (Palaearctic)	Palaearctic	168	79.25	119	99.17
(212 spp., 120 gen.)	Oriental	126	59.43	99	82.50
(34 spp. restricted)	Asia (Palaearctic)	122	57.55	112	93.33
	China (Oriental)	116	54.72	91	75.83
China (Transition)[2]	Palaearctic	124	77.50	92	86.79
(160 spp., 106 gen.)	China (Oriental)	113	70.63	83	78.30
(12 spp. restricted)	China (Palaearctic)	85	53.13	74	69.81
	Asia (Palaearctic)	69	43.13	56	52.83
	Oriental	51	31.88	44	41.51
China (Oriental)	Palaearctic	228	47.90	184	75.10
(476 spp., 245 gen.)	Oriental	117	24.58	176	71.84
(200 spp. restricted)	Asia (Palaearctic)	112	23.53	140	57.14
	China (Palaearctic)	116	24.37	91	37.14
Japan	Palaearctic	249	33.88	222	77.62
(735 spp., 286 gen.)	Asia (Palaearctic)	178	24.22	193	67.48
	Nearctic	127	17.28	199	69.58
	East Oriental	80	10.88	146	51.05
	Pacific	41	5.58	85	29.72
	New Guinea	10	1.36	62	21.68
Madagascar	Ethiopian	39	12.38	98	61.25
(315 spp., 160 gen.)	Oriental Total	38	12.06	105	65.63
	Oriental West	28	8.89	92	57.50
New Guinea	Oriental	46	23.83	87	74.36
(193 spp., 117 gen.)	Australia	28	14.51	74	63.25
	Pacific I.	18	9.33	54	46.15
Central America	South America	294	41.18	239	74.22
(714 spp., 322 gen.)	North America	84	11.76	185	57.45
Sub-Antarctic	Neotropical	36	30.51	52	74.29
(118 spp., 70 gen.)	Australian	16	13.56	48	68.57
	Oriental	10	8.47	37	52.86
	Ethiopian	6	5.08	36	51.43

[1] The proportions refer to the total number of species resp. genera in the area considered (e.g. Macaronesia: 358 species total = 100%).
[2] Prov. Anhui, Jiangsu, Hobei, Honan.

a very strong altitudinal gradient of biota which results in Palaearctic elements dominating at higher and Indomalayan elements at lower elevations (Hoffmann, 2001). Of the 90 oribatid species known from the Himalayan states and provinces, the vast majority are endemic, and an almost equal number is widely distributed, both of palaearctic and of gondwanan origin (tab. 5). Among the 21 species with wide and gondwanan distribution only 12 species occur in the Oriental region.

Chakrabarti and Bhaduri (1989) report 283 oribatid species from the northeastern Himalaya and West Bengal. Gondwanan genera are present in considerable numbers in all lower areas, whereas the montainous states Nepal, Sikkim and Bhutan show an intermingling fauna, infiltrated by palaearctic elements.

The few oribatid species known from Tibet (16 spp. in total) do not present a clear distribution pattern. Almost half of the species are only known from there (7 spp.); among the remaining four are of Palaearctic origin, two of Oriental, and three occur in both regions (One of those species, *Platynothrus numatai* Aoki, 1965, is also known from Sikkim).

China: The border between the Palaearctic and Oriental regions in China is delimited differently by zoologists, depending on the distribution of different animal groups (Liang, 1998). Zhang (1998) has proposed a revised concept considering all new results of different animal taxa. According to this study, the border between the Palaearctic and Oriental regions follows mainly the Eastern margin of the Tibet Plateau and along the Qinling Mountains towards East. Hoffmann (2001) proposed a transition zone between the Palaearctic and Oriental regions with a small corridor north of the Himalaya, an a broader area in the lowland of East China. This corresponds roughly to the transitory zone of the Oriental region according to Niedbala (2000).

Wang *et al*. (2002, 2003) list 580 species and subspecies belonging to 279 genera from China and give detailed information on the distribution of each species in the Chinese provinces. According to the borderlines mentioned above most provinces could be assigned either to the Palaearctic or to the Oriental region. Provinces with questionable assignments are Anhui, Jiangsu, Hobei and Honan. In table 4 these provinces are treated separately as "Transition zone". The oribatid fauna in all zoogeographical zones in China shows largest similarities to the Palaearctic but also high similarities to the Oriental region. The similarity differ due to the high number of "endemic" species in the Oriental part. The distribution of palaearctic species reaches far south beyond the postulated transition zone. On the other hand the influence of oriental species is apparent in all three zones.

Chen *et al*. (1992) made an investigation of the oribatid mites from the Huangshan Mountain. This montainous region, also known as „Yellow Mountains", is located in the southeastern part of the Anhui Province and is of special zoogeographical interest because of its apparent location between the Palaearctic and Oriental regions. A total of 107 oribatid species belonging to 76 genera were collected in different vegetation belts from 150 m up to 1810 m (tab. 5). Species of palaearctic origin dominate at higher, species of

Table 5 - Oribatid species from Central and East Asian mountaneous areas – main zoogeographical elements.

	Pakistan	Himalaya	Tibet	Huangshan Mt.[1]
Total species number	134	90	16	107[2]
restricted (endemic)	53	59	7	5
widely distributed	23	10[3]	3	21
Palaearctic	53	10	4	33
Oriental / gondwanan	5	11[4]	2	20

[1] Prov. Anhui, China
[2] including 28 undetermined species
[3] among them 6 oriental species
[4] gondwanan species: 11, among them 6 oriental species

oriental origin at lower altitudes (Chen *et al*., 1992). One can suggest that in this area the border between the regions is rather vertical than horizontal.

Japan: The oribatid fauna of Japan has great similarities to the Palaearctic region as well as to the eastern part of the Oriental region (tab. 4). Similarities to the oribatid fauna of the Pacific and New Guinea are low, but connections to the Nearctic region are apparent. For the oribatid mites, Japan can be regarded as meeting point between the Palaearctic and Oriental regions, which was also postulated by Hammer and Wallwork (1979) as well as by Niedbala (2000).

Madagascar: Madagascar was isolated from Africa for a very long time, and the relationship between the fauna of this large island and the African mainland on one side and to the Oriental region on the other side has fascinated many biogeographers since more than a century. The oribatid fauna of Madagascar was investigated quite intensively in the last years (summarized in Mahunka, 2002; Niedbala, 2001). The fauna of the Comores and Mascarenes are included to the Madegassian subregion. Characteristic for the oribatid fauna of Madagascar is a very high endemism at species level (80%, tab. 2) which makes comparisons to the adjacent regions almost impossible. At the generic level, the endemism is much lower, and the similarities to mainland Africa and the Oriental region are almost at the same level (tab. 4).

New Guinea: The oribatid fauna of this island shows also a very high endemism at species level (68%, tab. 2). The similarity (tab. 4) is highest to the Oriental region, and low to the Pacific islands. Strong connections with the Australian fauna are apparent.

Central America: Of the oribatid fauna of Central America (including Antilles), 416 species (25 genera) are restricted to the area. The similarity in common species and genera to South America is much higher than to North America (tab. 4).

Many biogeographers regard the Central American landbridge as a transition zone in which the Nearctic and Neotropical regions overlap. The limits between the regions are defined by different geographical barriers by various authors. Halffter (1987) separates two well defined groups in the mountain ranges north and south of the Isthmus of Tehuantepec based on studies of montane insects. According to cladistic analysis of montane insects, fishes, reptiles and plants by Marshall and Liebherr (2000) the northern montane biota are limited to the regions north of the Mexican Sierra Transvolcanica.

Recent investigations on the oribatid fauna in the Cordillera de Talamanca in Costa Rica and Panama (Schatz, in press) show clearly that the highlands of these mountains contain an oribatid community with numerous nearctic taxa which differs from the species assemblage of the surrounding lowlands. Although several neotropical taxa ascended from the lowland tropical forests into highland cloud forests, a distribution limit for most neotropical taxa seems to exist around the 2800 m contour line, probably caused by the colder climate at higher altitudes. The presence and number of holarctic taxa in the highlands is conspicuous (Schatz, in press). Many of these taxa are restricted to the highlands and seem to be absent in the tropical lowland forests. The Central American high mountains seem to offer refuges with insular effect for cold adapted taxa.

Niedbala (2004) divided Central America based on the distribution patterns of ptyctimous oribatid mites into Mexican Highlands, Mexican Lowlands, the Antilles and Central America sensu stricto. The ptyctimous fauna of the continental Central America is more homogenous in species composition than the fauna of the Mexican subregions and the Antilles (Niedbala, 2004). According to the results for all oribatid mite taxa mentioned above (Schatz, in press), Central America should be also divided into different highland and lowland biota.

Subantarctic / Antarctic: As can be expected, the oribatid fauna of the Antarctic continent and surrounding islands is very poor, although the arthropod fauna is dominated by Acari and Collembola (Block and Stary, 1996). The oribatid mites are widely distributed throughout the region and constitute significant members of the simple terrestrial communities found in ice-free areas (Block and Stary, 1996). Our present knowledge of the oribatid fauna of the area is mainly based on the studies of Pugh (1993, 1994), and Stary and Block (1998). A total of 70 species, 8 genera and 2 subgenera are considered to be endemic. Highest similarities (tab. 4) are found to the Neotropical oribatid fauna, followed by Australia.

A comparison with the oribatid fauna of Tierra del Fuego is indicated. A total of 54 spp. are known. Almost half of the species are endemic, and the Neotropical portion prevails over the Sub-Antarctic portion (tab. 6). This supports the hypothesis of Mahunka (1980) that the oribatid fauna of Tierra del Fuego belongs to the fauna of the Neotropical region, and cannot be considered as even a transitional territory between the Subantarctic and the Neotropical region; the borderline runs further southward along the Drake-Passage.

To the contrary, the oribatid fauna of the Falkland Islands (Stary and Block, 1996) and South Georgia (Stary and Block, 1995b) holds an intermediate position between the Neotropical and Sub-Antarctic regions. The proportions of Sub-Antarctic species of Falkland and South Georgia increase with distance from South America (tab. 6). Similarities in species between the oribatid fauna of the Falkland Islands and the Andes Mountains as well as with New Zealand are remarkable (Stary and Block, 1996).

Zoogeographical considerations

The "classical" approach of zoogeographical regions based on A.R.Wallace (1876) was used for a first assignment of the oribatid taxa. This concept applies mainly to the distribution of mammals and birds and has been largely accepted by zoogeographers ever since. It is still used by most biologists (Cox and Moore, 2000), as in the "Zoological Record". Recent modifications of the major biogeographical regions are proposed by Cox (2001, see also for history) and Morrone (2002), e.g. a separate Andean region comprising the temperate areas in South America.

It was not possible to incorporate all these modifications. Two major difficulties arose when the distribution of certain oribatid taxa was considered:

1. Frequently no detailed information on species distribution was available. Many publications classify the distribution of the mentioned taxa roughly according to the countries without further details on distribution. This might prove problematical when assigning species to certain regions along their edges.

2. The delimitation of the regions may change according to certain taxa. Most assignments to a certain region were done *apriori* using the classical definition of a region without considering the distribution of each taxon.

In this paper selected areas which are mainly situated between laurasian and gondwanan regions were chosen for a closer look. First analyses indicate that the observed distribution pattern of the oribatid fauna along terrestrial borders between the regions do not always agree completely with the "classical" definition of the regions. The presence of transition zones and meeting points must be postulated for oribatid mites. Especially in mountainous areas the borders should be considered as rather

Table 6 - Oribatid species from Tierra del Fuego and Subantarctic Islands - main zoogeographical elements.

	Tierra del Fuego[1]	Falkland I.[2]	South Georgia[3]
Total species number	54	32	31[4]
restricted (endemic)	23	6	9
widely distributed	4	5[3]	3
Neotropical	18	14	10
Sub-Antarctic	9	7	9

[1] Mahunka, 1980, Baranek, 1988, Arcidiacono, 1993.
[2] Stary and Block, 1995a, 1996.
[3] Stary and Block, 1995b.
[4] Including *Magellozetes processus* Hammer, 1962 (see Stary and Block, 1996).

vertical than horizontal - northern taxa can reach far south in high mountains, persisting in refuges with insular effect. These arguments can be added to the hypothesis of Hammer and Wallwork (1979). Based on a broader database due to the increase of knowledge during the last 25 years oribatid mite distribution can be viewed at a higher resolution.

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