**Appendix 1.**

**Table S1.** Regions for which data on flea and host species composition were used in the analyses. Name: name of a region, Description: some description of regional components (when needed), Abb: abbreviation of region names used in the cluster analyses in some figures, F/H: number of species of fleas and hosts, respectively, Biome: predominant biome according to Olson et al. (2001)\*. Abbreviations of biome names are: TND: Tundra, TIG: Boreal forests/Taiga, TBF: Temperate broadleaf and mixed forests, TCF: Temperate conifer forests, SBF: Tropical and subtropical moist broadleaf forests, SDF: Tropical and subtropical dry broadleaf forests, TSG: Temperate grasslands, savannas, and shrublands, SSG: Tropical and subtropical grasslands, savannas, and shrublands, FGS: Flooded grasslands and savannas, MGS: Montane grasslands and shrublands, MFW: Mediterranean forests, woodlands, and scrub, DXS: Deserts and xeric shrublands. No biome information was used for Australasia (see text for explanation).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Realm | Name | Description | Abb | F/H | Biome |
| Afrotropics | Angola |  | ang | 27/45 | TSG |
|  | Botswana |  | btw | 23/31 | TSG |
|  | Congo | Democratic Republic of | cng | 41/42 | SBF |
|  | East South Africa | Orange Free State, North West, Gauteng, Mpumalanga, KwaZulu Natal, and Limpopo Provinces | esa | 30/32 | DXL |
|  | Ethiopia |  | eth | 17/29 | TSG |
|  | Kenya |  | ken | 48/55 | TSG |
|  | Madagascar |  | mdg | 29/39 | SBF |
|  | Mozambique |  | mzb | 21/30 | TSG |
|  | Namibia |  | nmb | 28/18 | DXL |
|  | Nigeria |  | ngr | 9/14 | TBF |
|  | Coastal South Africa | Eastern Cape and Western Cape Provinces | csa | 36/27 | MFW |
|  | Tanzania |  | tnz | 37/35 | TSG |
|  | Uganda |  | ugn | 29/35 | TSG |
|  | Western South Africa | Northern Cape Province | wsa | 32/31 | MGS |
|  | Zimbabwe |  | zmb | 18/31 | TSG |
| Australasia | New South Wales |  | nsw | 20/25 |  |
|  | Northern Territory |  | nt | 2/6 |  |
|  | Queensland |  | qld | 19/24 |  |
|  | Southern Australia |  | sa | 10/11 |  |
|  | Tasmania |  | tas | 19/21 |  |
|  | Victoria |  | vic | 24/30 |  |
|  | Western Australia |  | wa | 18/14 |  |
|  | New Guinea | Papua Province of Indonesia and Papua New Guinea | png | 98/75 |  |
| Indo-Malay | Borneo |  | bor | 27/25 | SBF |
|  | Guizhou | Province of China | gui | 29/28 | SBF |
|  | Java |  | jav | 15/7 | SBF |
|  | Malaysia |  | mly | 16/15 | SBF |
|  | Nepal |  | npl | 40/32 | TCF |
|  | Sulawesi |  | slw | 21/28 | SBF |
|  | Sumatra |  | smt | 9/4 | SBF |
|  | Thailand |  | tha | 10/5 | MGS |
|  | Vietnam |  | vtn | 15/13 | SBF |
|  | Yunnan | Province of China | ynn | 98/61 | SBF |
| Nearctic | Alaska | Mainland | als | 26/22 | TND |
|  | British Columbia |  | bcl | 68/44 | TIG |
|  | California |  | clf | 65/38 | MFW |
|  | Connecticut |  | cnc | 28/18 | TBF |
|  | Florida |  | flr | 9/12 | TCF |
|  | Georgia |  | grg | 13/17 | TCF |
|  | Idaho |  | idh | 35/19 | TBF |
|  | Indiana |  | ind | 18/22 | TBF |
|  | Maine |  | mai | 19/19 | TBF |
|  | Manitoba |  | mnt | 35/26 | TIG |
|  | Maryland |  | mrl | 18/13 | TBF |
|  | Mexico |  | mxc | 119/106 | SDF |
|  | Missouri |  | mss | 13/20 | TCF |
|  | Montana |  | mtn | 41/21 | TSG |
|  | New Mexico |  | nmx | 76/45 | DXS |
|  | Ohio |  | oho | 14/20 | TBF |
|  | Ontario |  | ont | 29/24 | TIG |
|  | Oregon |  | org | 76/60 | TCF |
|  | Tennessee |  | tns | 18/20 | TBF |
|  | Texas |  | txs | 11/14 | DXS |
|  | Utah |  | uta | 65/44 | DXS |
|  | Wisconsin |  | wsc | 23/17 | TBF |
|  | West Virginia |  | wvr | 24/19 | TBF |
| Neotropics | Argentinian Cuyo | Mendoza, San Juan, and San Luis Provinces | cuy | 35/32 | MGS |
|  | Argentinian Mesopotamia | Corrientes, Missiones, and Entre Rios Provinces | msp | 15/29 | FGS |
|  | Argentinian North-West | Jujuy, Salta, Catamarca, La Rioja, Santiago del Estero, and Tukuman Provinces | anw | 40/52 | MGS |
|  | Argentinian Pampas | Buenos Aires, La Pampa, Santa Fe, Entre Rios, and Cordoba Provinces | apm | 26/38 | SSG |
|  | Argentinian Patagonia | Rio Negro, Neuquen, Chubut, Santa Cruz, and Tierra del Fuego Provinces | ptg | 43/32 | TSG |
|  | Brazilian Amazonia | Acre, Amazonas, Roraima, Rondonia, Para, and Mato Grosso (north of 15˚S) Provinces | amz | 7/17 | SBF |
|  | Brazilian Caatinga | Maranhão, Piauí, Ceara, Paraibo, Alagoas, Sergipe, Bahia, Rio Grande do Norte, Pernambuco, and Minas Gerais (east of 47˚W) Provinces | caa | 12/27 | DXS |
|  | Brazilian Cerrado | Goyas, Maranhao, Mato Grosso do Sul, Tocantins, and Minas Gerais (west of 47˚W) Provinces | crd | 18/41 | SSG |
|  | Mata Atlantica | Esperito Santo, Rio de Janeiro, Parana, and San Paulo Provinces | mat | 22/57 | SBF |
|  | Brazilian Pampas | Santa Catarina and Rio Grande do Sul Provinces | bpm | 12/28 | SSG |
|  | Arid Chile | north of 32˚S; Sechura and Atacama Deserts, Puna, Bolivian, and Southern Andean Yungas | ach | 28/25 | MGS |
|  | Mediterranean Chile | south of 32˚S; Matorral, Valdivian, and Magellanic Forests | mch | 55/32 | TBF |
|  | Colombia |  | clb | 29/30 | SBF |
|  | Panama |  | pnm | 23/28 | SBF |
|  | Peru |  | per | 39/39 | SBF |
|  | Uruguay |  | urg | 13/17 | SSG |
|  | Venezuela |  | vnz | 26/42 | SSG |
| Palearctic | Adzharia | North Caucasus | adz | 17/10 | MGS |
|  | Afghanistan |  | afg | 47/30 | DXS |
|  | Akmolinsk region | Kazakhstan, now Nur-Sultan region | akm | 23/16 | DXS |
|  | Altai Mountains |  | alt | 9/22 | TCF |
|  | Armenia |  | arm | 37/15 | MGS |
|  | Azerbaijan |  | azb | 21/11 | MGS |
|  | Barguzin | Republic of Buryatia | bar | 29/15 | TIG |
|  | Caucasus | The Greater Caucasus | ccs | 79/55 | MGS |
|  | Dzungarian Alatau | Kazakhstan | dal | 22/14 | MFW |
|  | Eastern Balkhash |  | ebh | 37/21 | TSG |
|  | Egypt |  | egp | 17/24 | DXS |
|  | Fennoscandia |  | fen | 27/23 | TIG |
|  | France |  | fra | 40/31 | TBF |
|  | Iran |  | irn | 57/28 | TSG |
|  | Italy |  | ita | 38/28 | MFW |
|  | Japan |  | jpn | 34/19 | TBF |
|  | Korea | Republic of Korea | kor | 25/16 | TBF |
|  | Kostroma region | Confluence of the Volga and Kostroma Rivers | kst | 20/14 | TIG |
|  | Krasnojarsk region | Eastern Siberia | krj | 19/10 | TCF |
|  | Kostanay | Northern Kazakhstan | kos | 17/15 | TSG |
|  | Mongolia | Northwestern Khangai | mng | 33/19 | DXS |
|  | Morocco |  | mrc | 19/21 | MFW |
|  | Moscow region |  | msc | 14/15 | TBF |
|  | Moyyunkum Desert | Kazakhstan | moy | 28/14 | DXS |
|  | Northern Russian Far East |  | nfe | 15/15 | TND |
|  | Novosibirsk region |  | nov | 28/23 | TCF |
|  | Poland |  | pln | 24/19 | TBF |
|  | Polar Ural Mountains |  | pur | 10/9 | TND |
|  | Slovakia |  | slo | 22/18 | TBF |
|  | Spain |  | spa | 27/25 | MFW |
|  | Taimyr |  | tmr | 11/12 | TND |
|  | Central Siberia | Toms and Tumen regions | csi | 23/26 | TIG |
|  | Turkey |  | trk | 62/38 | TSG |
|  | Tatarstan |  | tts | 33/27 | TBF |
|  | Western Sayan Mountains | Southern Siberia | wsy | 28/13 | MFW |
|  | Xinjiang | Province of China | xin | 14/10 | DXS |

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**Appendix 2. Sources of information on flea and small mammalian host species compositions**

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**Appendix 3. Supplementary tables.**

**Table S2.** Tucker’s congruence coefficients between factors produced by step-down factor analyses for flea (bold font) and host (regular font) regional assemblages at the global scale.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Axis 1 | Axis 2 | Axis 3 | Axis 4 |
| **Axis 1** | 0.90 | 0.01 | 0.84 | 0.38 |
| **Axis 2** | 0.18 | 0.90 | -0.31 | 0.06 |
| **Axis 3** | 0.75 | 0.32 | 0.32 | 0.58 |
| **Axis 4** | -0.08 | -0.43 | -0.10 | 0.26 |

**Table S3.** Tucker’s congruence coefficients between factors produced by step-down factor analyses for flea (bold font) and host (regular font) regional assemblages in the Afrotropics.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Axis 1 | Axis 2 | Axis 3 | Axis 4 |
| **Axis 1** | 0.85 | 0.42 | 0.32 | 0.41 |
| **Axis 2** | 0.19 | 0.58 | 0.73 | 0.40 |

**Table S4.** Tucker’s congruence coefficients between factors produced by step-down factor analyses for flea (bold font) and host (regular font) regional assemblages in the Indo-Malay.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Axis 1 | Axis 2 | Axis 3 |
| **Axis 1** | 0.95 | 0.45 | 0.71 |
| **Axis 2** | 0.29 | 0.97 | 0.71 |
| **Axis 3** | 0.15 | -0.6 | -0.20 |

**Table S5.** Tucker’s congruence coefficients between factors produced by step-down factor analyses for flea (bold font) and host (regular font) regional assemblages in the Nearctic.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Axis 1 | Axis 2 | Axis 3 |
| **Axis 1** | 1.00 | 0.41 | -0.22 |
| **Axis 2** | 0.47 | 0.98 | -0.27 |
| **Axis 3** | 0.07 | -0.05 | 0.90 |

**Table S6.** Tucker’s congruence coefficients between factors produced by step-down factor analyses for flea (bold font) and host (regular font) regional assemblages in the Neotropics.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Axis 1 | Axis 2 | Axis 3 | Axis 4 |
| **Axis 1** | 0.95 | 0.24 | 0.52 | -0.17 |
| **Axis 2** | -0.47 | 0.72 | -0.92 | 0.52 |
| **Axis 3** | 0.14 | 0.88 | -0.41 | 0.35 |
| **Axis 4** | 0.02 | 0.26 | 0.12 | 0.84 |

**Table S7.** Tucker’s congruence coefficients between factors produced by step-down factor analyses for flea (bold font) and host (regular font) regional assemblages in the Palearctic.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Axis 1 | Axis 2 | Axis 3 | Axis 4 |
| **Axis 1** | 0.70 | 0.47 | 0.93 | 0.18 |
| **Axis 2** | 0.97 | 0.18 | 0.39 | -0.40 |
| **Axis 3** | 0.04 | 0.87 | 0.23 | 0.40 |
| **Axis 4** | 0.16 | 0.88 | 0.68 | 0.21 |

**Appendix 4. Supplementary figures**

**Fig. S1.** Distribution of regional flea and host assemblages across the Afrotropics (A) and the Indo-Malay (B) according to their loadings on axis 2 (for the Afrotropics) and axes 2 and 3 (for the Indo-Malay) of the step-down factor analyses. Point size and colours scale to the assemblage loading on the respective axis. Borders of terrestrial biomes according to Olson *et al.* (2001) are shown.

Map

Description automatically generated

**Fig. S2.** Distribution of regional flea and host assemblages across the Nearctic with their loadings on axes 2 and 3 of the step-down factor analyses. Point size and colours scale to the assemblage loading on the respective axis. Borders of terrestrial biomes according to Olson *et al.* (2001) are shown.

Map

Description automatically generated

**Fig. S3.** Distribution of regional flea and host assemblages across the Neotropics with their loadings on axes 2, 3, and 4 of the step-down factor analyses. Point size and colours scale to the assemblage loading on the respective axis. Borders of terrestrial biomes according to Olson *et al.* (2001) are shown.

Map

Description automatically generated

**Fig. S4.** Distribution of regional flea and host assemblages across the Palearctic with their loadings on axes 2, 3, and 4 of the step-down factor analyses. Point size and colours scale to the assemblage loading on the respective axis. Borders of terrestrial biomes according to Olson *et al.* (2001) are shown.

Map

Description automatically generated