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Adaptive morpho-traits, taxonomy and biogeography of *Metania* Gray, 1867 (Porifera: Spongillina: Metaniidae) with the description of a new species from Madagascar

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Abstract

A comparative analysis of gemmular architecture adaptive morpho-traits at family level is reported for Metaniidae together with the discovery and description of a new species from the River Mangoky (High Plateau), Madagascar. The new Malagasy species, ascribed to *Metania* for diagnostic traits of the skeleton and the gemmular architecture, differs from all the other known species of the genus in its unique combination of diagnostic traits. *Metania madagascariensis* **sp. nov.** is characterised by encrusting growth form, conulose surface, specialized ectosomal skeleton, alveolate-reticulate choanosomal skeleton, two types of megascleres as smooth oxneas (α) and acanthoxeas (β) ornamented with spines and/or tubercles, one type of microsclere as acanthoxeas with dense spines/tubercles bearing rosettes of microspines at tips; gemmules with or without cage of megascleres and frequently surrounded by microscleres; gemmular theca trilayered with pneumatic layer of fibrous spongin, boletiform (trumpet-like) gemmuloscleres with proximal true rotule large, smooth and with irregular blunt margins, and distal knob-like pseudorotule notably smaller, with a few hooks at the margins. *M. madagascariensis* belongs to the Afrotropical species group of *Metania*. Identification keys and an annotated checklist at global level are also provided together with a species-level discussion of *Metania* focusing on morphology, taxonomy, nomenclature and biogeography.

Key words: freshwater sponges, morphology, SEM, Malagasy biodiversity, identification keys at global level

Introduction

The terrestrial fauna of Madagascar is presently encompassed in the Malagasy biogeographical province *sensu* Procheş & Ramdhani (2012) of the Afrotropical Region. This fauna is quite well studied (see Goodman & Benstead, 2003 for a review) and Madagascar is recognized among priority areas for biodiversity and conservation in the tropics for its species-rich and mostly endangered terrestrial hotspots (Myers *et al.* 2000; Mittermeier *et al.* 2005).

The island is recognized as a global hotspot also for freshwater biodiversity (fishes and invertebrates) with many species restricted to a specific region or even to single river basins often exclusively in water courses draining primary forests (Groombridge & Jenkins 1998; Benstead *et al.* 2003; Andreone *et al.* 2008; Vieites *et al.* 2009). Although the Malagasy freshwater invertebrate fauna is characterized by high values of species richness and endemism, many taxa, representatives of several phyla, remain poorly known and the knowledge of their historical biogeography is based only on scattered data. A freshwater biodiversity assessment is urgently needed in these extremely vulnerable habitats because the quality of freshwater is strongly influenced by human activities (see Dudgeon *et al.* 2006) and the rate of habitat destruction and forest fragmentation are dramatically increasing threats to biodiversity (Wilme *et al.* 2006; Harper *et al.* 2007).

Unfortunately few data are available on Malagasy freshwater invertebrates which are not arthropods. Basal invertebrates, such as sponges, have been scarcely investigated and only one record of *Spongilla alba* Carter, 1849

Afrotropical species (Figs 1, 2)

1. Only strongyles (smooth or/and tubercled) as megascleres 3
- Only oxeas as megascleres 2
2. Megascleres of two dimensional classes. Smooth oxeas (α) and tubercled oxeas (β) *M. rhodesiana*
- Megascleres of two dimensional classes. Large smooth oxeas (α), small spiny oxeas (β) *M. madagascariensis*
3. Megascleres smooth strongyles of a single dimensional class *M. godeauxi*
- Megascleres strongyles of two dimensional classes. Smooth and large (α); small and tubercled (β). *M. pottsi*

Oriental-Australian species (Figs. 1, 2)

1. Megascleres as only oxeas or oxeas/styles 2
- Strongyles megascleres of two dimensional classes (α and β); large and smooth (α), small and tubercled (β) . . . *M. vesparium*
2. Only oxeas megascleres of two dimensional classes (α and β); large and smooth (α), small and spiny (β) very slim (5–12 μ m in thickness). *M. ovogemmata*
- Oxeas/styles megascleres of two dimensional classes (α and β); smooth oxeas/styles (α); spiny and small oxeas (β) stout (12–25 μ m in thickness) *M. vesparioides*

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References

- Addis, J.S. & Peterson, K.J. (2005) Phylogenetic relationships of freshwater sponges (Porifera, Spongillina) inferred from analyses of 18S rDNA, COI mtDNA, and ITS2 rDNA sequences. *Zoologica Scripta*, 34, 549–557.
<http://dx.doi.org/10.1111/j.1463-6409.2005.00211.x>
- Andreone, F., Carpenter, A.I., Cox, N., du Preez, L., Freeman, K., Furrer, S., Garcia, G., Glaw, F., Glos, J., Knox, D., Köhler, J., Mendelson, JR. 3rd, Mercurio, V., Mittermeier, R.A., Moore, R.D., Rabibisoa, N.H.C., Randriamahazo, H., Randrianasolo, H., Raminosoa, N.R., Ramilijaona, O.R., Raxworthy, C.J., Vallan, D., Vences, M., Vieites, D.R. & Weldon, C. (2008) The challenge of conserving amphibian megadiversity in Madagascar. *PLoS Biol*, 6, e118.
<http://dx.doi.org/10.1371/journal.pbio.0060118>
- Annandale, N. (1911) Freshwater Sponges, Hydroids and Polyzoa. In: Shipley, A.E. (Ed.), *Fauna of British India, including Ceylon and Burma: Porifera*. Taylor & Francis, London, pp. 1–126.
- Benstead, J.P., De Rahm, P.H., Gattolliat, J.L., Gibon, F.M., Loiselle, P.V., Sartori, M., Sparks, J.S. & Stiassny, M.L.J. (2003) Conserving Madagascar's freshwater biodiversity. *BioScience*, 53 (11), 1101–1111.
[http://dx.doi.org/10.1641/0006-3568\(2003\)053\[1101:CMFB\]2.0.CO;2](http://dx.doi.org/10.1641/0006-3568(2003)053[1101:CMFB]2.0.CO;2)
- Bowerbank, J.S. (1863) A Monograph of the Spongillidae. *Proceedings of the Zoological Society of London*, 1863, 440–472.
- Brien, P. (1970) Les Potamolepides africaines nouvelles du Luapula et du Lac Moero. Polyphylétisme des éponges d'eau douce. In: Fry, W.G. (Ed.), *Biology of the Porifera. Symposium of the Zoological Society London. Vol. 25*. Academic Press, London, pp. 163–187.
- Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z.I., Knowler, D.J., Lévêque, C., Naiman, R.J., Prieur-Richard, A.H., Soto, D., Stiassny, M.L.J. & Sullivan, C.A. (2006) Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews*, 81, 163–182.
<http://dx.doi.org/10.1017/S1464793105006950>
- Erpenberck, D. & Wörheide, G. (2007) On the molecular phylogeny of sponges (Porifera). *Zootaxa*, 1668, 107–126.
- Gee, N.G. (1929) Notes on the Fresh-water Sponges from the Dutch East Indies. I. Historical. *Treubia*, 11 (2), 297–300.
- Gee, N.G. (1930) Notes on the Fresh-water Sponges from the Dutch East Indies. II. Descriptions. *Treubia*, 12 (1), 67–114.

- Gee, N.G. (1931) A contribution toward an alphabetical list of the known fresh-water sponges. *Peking Natural History Bulletin*, 5, 31–52.
- Gee, N.G. (1932) The known fresh-water sponges. *Peking Natural History Bulletin*, 6 (3), 25–51.
- Gee, N.G. (1933) Fresh-water sponges Genus *Tubella*. *Peking Natural History Bulletin*, 7, 237–250.
- Goodman, S.D. & Benstead, J.P. (Eds.) (2003) *The natural history of Madagascar*. Chicago University Press, Chicago, 1728 pp.
- Gray, J.E. (1867) Notes on the Arrangement of Sponges, with the Descriptions of some New Genera. *Proceedings of the Zoological Society of London*, 1867 (2), 492–558.
- Groombridge, B. & Jenkins, M. (1998) *Freshwater Biodiversity: A Preliminary Global Assessment*. WCMC Biodiversity Series no. 8. World Conservation Monitoring Centre (WCMC), World Conservation Press, Cambridge, 104 pp.
- Harper, G., Steininger, M., Tucker, C., Juhn, D. & Hawkins, F. (2007) Fifty years of deforestation and forest fragmentation in Madagascar. *Environmental Conservation*, 34, 325–333.
<http://dx.doi.org/10.1017/S0376892907004262>
- Hooper, J.N.A. & Van Soest, R.W.M. (2002) *Systema Porifera. A Guide to the Classification of Sponges. Vol. 1*. Kluwer Academic/Plenum Publishers, New York, 1099 pp.
- Itskovich, V., Belikov, S., Efremova, S., Masuda, Y., Perez, A., Borchiellini, C. & Boury-Esnault, N. (2007) Phylogenetic relationships between freshwater and marine Haplosclerida (Porifera, Demospongiae) based on the full length 18S rRNA and partial COXI gene sequences. In: Custódio, M.R., Lôbo-Hajdu, G., Hajdu, E. & Muricy, G. (Eds), *Porifera Research: Biodiversity, Innovation, Sustainability. Série Livros*. Museu Nacional, Rio de Janeiro, pp. 383–391.
- Itskovich, V., Gontcharov, A., Masuda, Y., Nohno, T., Belikov, S., Efremova, S., Meixner, M. & Janussen, D. (2008) Ribosomal ITS sequences allow resolution of freshwater sponge phylogeny with alignments guided by secondary structure prediction. *Journal of Molecular Evolution*, 67 (6), 608–620.
<http://dx.doi.org/10.1007/s00239-008-9158-5>
- Keller, C. (1887) *Reisebilder aus Ostafrika und Madagaskar*. Leipzig, 78 pp. [pp. 215–292]
- Manconi, R. & Pronzato, R. (2000) Rediscovery of the type material of *Spongilla lacustris* (L., 1759) from the Linnean Herbarium. *Italian Journal of Zoology*, 67, 89–92.
<http://dx.doi.org/10.1080/11250000009356300>
- Manconi, R. & Pronzato, R. (2002) Suborder Spongillina subord. nov.: Freshwater sponges. In: Hooper, J.N.A. & Van Soest, R.W.M. (Eds.), *Systema Porifera. A guide to the classification of sponges. Vol. 1*. Kluwer Academic/Plenum Publishers, New York, pp. 921–1020.
- Manconi, R. & Pronzato, R. (2007) Gemmules as a key structure for the adaptive radiation of freshwater sponges: a morphofunctional and biogeographical study. In: Custódio M.R., Lôbo-Hajdu, G., Hajdu, E. & Muricy, G. (Eds.), *Porifera research: biodiversity, innovation and sustainability. Série Livros*. Museu Nacional, Rio de Janeiro, pp. 61–77.
- Manconi, R. & Pronzato, R. (2008) Global diversity of sponges (Porifera: Spongillina) in freshwater. *Hydrobiologia*, 595, 27–33.
<http://dx.doi.org/10.1007/s10750-007-9000-x>
- Manconi, R. & Pronzato, R. (2009) Atlas of African freshwater sponges. *Studies in Afrotropical Zoology Tervuren*, 295, 1–214. [Royal Museum for Central Africa]
- Manconi, R., Ruengsawang, N., Vannachak, V., Hanjavanit, C., Sangpradub, N. & Pronzato, R. (2013) Biodiversity in South East Asia: an overview of freshwater sponges (Porifera: Demospongiae: Spongillina). *Journal of Limnology*, 72 (s2), 313–326.
<http://dx.doi.org/10.4081/jlimnol.2013.s2.e15>
- Meixner, M.J., Lüter, C., Eckert, C., Itskovich, V., Janussen, D., Rintelen, T. von, Bohne A.V., Meixner, J.M. & Hess, W.R. (2007) Phylogenetic analysis of freshwater sponges provide evidence for endemism and radiation in ancient lakes. *Molecular Phylogenetics and Evolution* 45 (3), 875–886.
<http://dx.doi.org/10.1016/j.ympev.2007.09.007>
- Mittermeier, R.A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J. & Fonseca, G.A.B. (2005) *Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. Conservation International, Arlington (VA), 392 pp.
- Muricy, G., Lopes, D.A., Hajdu E., Carvalho, M.S., Moraes, F.C., Klautau, M., Menegola, C. & Pinheiro, U.S. (2011) *Catalogue of Brazilian Porifera*. Museu Nacional, Rio de Janeiro, pp. 300.
- Myers, N., Mittermeier, R.A., Mittermeier, C.G., Fonseca, G.A.B. da & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature*, 403, 853–858.
<http://dx.doi.org/10.1038/35002501>
- Penney, J.T. (1960) Distribution and bibliography (1892–1957) of the freshwater sponges. *University South Carolina Publication*, 3 (1), 1–111.
- Penney, J.T. & Racek, A.A. (1968) Comprehensive revision of a world-wide collection of freshwater sponges (Porifera: Spongillidae). *United States National Museum Bulletin*, 272, 1–184.
<http://dx.doi.org/10.5479/si.03629236.272.1>
- Pinheiro, U. & Nicacio, G. (2012) Resurrection and redefinition of the genus *Tubella* (Porifera: Spongillidae) with a worldwide list of valid species. *Zootaxa*, 3269, 65–68.

- Procheş, Ş. & Ramdhani, S. (2012) Analyses towards determining Madagascar's place in global biogeography. *Current Zoology*, 58 (3), 363–374.
- Silva, C.M.M. de & Volkmer-Ribeiro, C. (1998) The Ethiopian species of the genus *Metania* (Porifera, Metaniidae): I. Redescription of *M. pottsi*, comb. n. *Iheringia*, 85, 157–168.
- Silva, C.M.M. de & Volkmer-Ribeiro, C. (2001) Key to the Ethiopian species of the genus *Metania* Gray, 1867 (Porifera, Metaniidae), with redescription of *Metania rhodesiana* and *M. godeauxi*, comb. n. *Bulletin Institut Royal de Sciences Naturelles de Belgique, Biologie*, 71, 127–138.
- Stocchino, G.A., Sluys, R. & Manconi R. (2014) A new and aberrant species of *Dugesia* (Platyhelminthes, Tricladida, Dugesiidae) from Madagascar. *Zookeys*, 425, 71–88.
<http://dx.doi.org/10.3897/zookeys.425.7811>
- Van Soest, R.W.M., Boury-Esnault, N., Hooper, J.N.A., Rützler, K. de Voogd, N.J., Alvarez de Glasby, B., Hajdu, E., Pisera, A.B., Manconi, R., Schoenberg, C., Janussen, D., Tabachnick, K.R., Klautau, M., Picton, B., Kelly, M., Vacelet, J., Dohrmann, M., Díaz, M.C. & Cárdenas, P. (2014) *World Porifera database*. Available from: <http://www.marinespecies.org/porifera> (accessed 13 January 2015)
- Vieites, D.R., Wollenberg, K.C., Andreone, F., Köhler, J., Glaw, F. & Vences, M. (2009) Vast underestimation of Madagascar's biodiversity evidenced by an integrative amphibian inventory. *Proceedings of the National Academy of Sciences*, 106 (20), 8267–8272. [USA]
<http://dx.doi.org/10.1073/pnas.0810821106>
- Volkmer-Ribeiro, C. (1976) A new monotypic genus of neotropical freshwater sponges (Porifera-Spongillidae) and the evidence of an speciation via hybridism. *Hydrobiologia*, 50 (3), 271–281.
<http://dx.doi.org/10.1007/BF00021002>
- Volkmer-Ribeiro, C. (1979) Evolutionary study of genus *Metania* Gray, 1867 (Porifera-Spongillidae). 1. The new species. *Amazoniana*, 6 (4), 639–649.
- Volkmer-Ribeiro, C. (1984) Evolutionary study of the genus *Metania* Gray, 1867 (Porifera: Spongillidae): 2. Redescription of two Neotropical species. *Amazoniana, Series 4*, 8, 541–553.
- Volkmer-Ribeiro, C. (1986) Evolutionary study of the freshwater sponge genus *Metania* Gray, 1867: 3. Metaniidae, new family. *Amazoniana*, 9 (4), 493–509.
- Volkmer-Ribeiro, C. (1990) A New insight into the systematics, evolution and taxonomy of freshwater sponges. In: Rützler, K. (Ed.), *New perspectives in sponge biology*. Smithsonian Institution Press, Washington, pp. 323–331.
- Volkmer-Ribeiro, C. & Costa, P.R.C. (1992) On *Metania spinata* (Carter, 1881) and *Metania kiliani* sp.n.: Porifera, Metaniidae Volkmer-Ribeiro, 1986. *Amazoniana*, 12 (1), 7–16.
- Volkmer-Ribeiro, C. & Costa, P.R.C. (1993) Redescription of the Oriental and Australian species of the genus *Metania* Gray, 1867 (Porifera: Metaniidae). *Iheringia Serie Zoologia*, 74, 81–101.
- Wilme, L., Goodman, S.M. & Ganzhorns, J.U. (2006) Biogeographic evolution of Madagascar's microendemic biota. *Sciences*, 312, 1063–1065.
<http://dx.doi.org/10.1126/science.1122806>