Upper Ordovician sponge spicules from Gondwana: New data from Peru and Libya

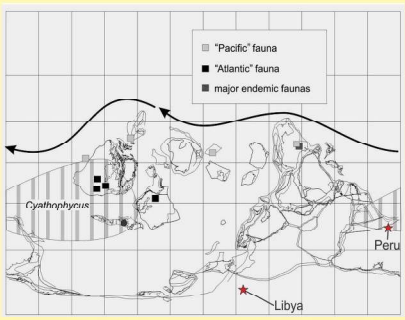
Gutiérrez-Marco, J. C.[1], Carrera, M.G.[2], Ghienne, J.-F.[3] and Chacaltana, C.A.[4]

[1] Instituto de Geociencias (CSIC, UCM), José Antonio Novais 12, 28040 Madrid, Spain; jcgrapto@ucm.es

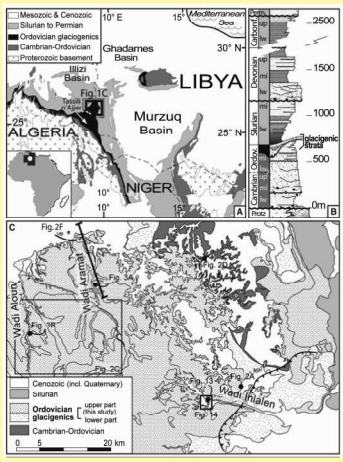
[2] CICTERRA-CONICET Universidad Nacional de Córdoba, Fac. Cs. Exactas Físicas y Naturales, Av. Velez Sarfield 1611 Ciudad Universitaria, Córdoba, Argentina

[3] Institut de Physique du Globe de Strasbourg. UMR 7516 CNRS - Université de Strasbourg. 1 rue Blessig. F-67084 Strasbourg Cedex. France

[4] Dirección de Geología Regional, Instituto Geológico Minero y Metalúrgico (INGEMMET), Av. Canadá 1470 San Borja, Lima, Peru



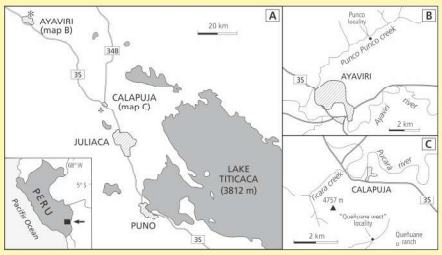
Summary of Late Ordovician sponge distribution (reproduced from Muir et al., 2013), including the previously described major provinces "Pacific" and "Atlantic" (Carrera and Rigby, 1999), which are mainly based on lithistid demosponges and sphinctozoans from shallow-water settings. The arrow represents a putative north equatorial current. The hatched region indicates the known range of the widespread offshore hexactinellid Cyathophycus, restricted to low palaeolatitudes. The new Gondwanan occurrences are indicated by red stars.



Location of the study area in the Tihemboka High in western Libya (western Murzuq Basin), adjacent to eastern Algeria (Tassili n'Ajjer area), and the synthetic Palaeozoic succession in the Murzuq basin. Red stars and arrow indicate the localities and their stratigraphical placement, respectively, in the column and on the detailed map. Figure reproduced from Ghienne *et al.* (2010).

Landscapes formed by fossiliferous Upper Ordovician outcrops in the Tihemboka High, southwestern Libya

The record of Middle to Upper Ordovician sponges outside Laurentia and north-Gondwana (=Australia) is too sparse that any new record significantly contributes to the global diversity and biogeographic knowledge of the group (Muir *et al.* 2013). Conspicuous spicule assemblages and a partially complete sponge have been found in Peru and Libya (Hughes *et al.* 1980, Bergström and Massa 1992), from where isolated occurrences of Ordovician sponge spicules have been previously reported without any morphological or taxonomical detail.



Location maps of the poriferan localities of Ayaviri and Queñuane in the Peruvian highland, west of Lake Titicaca. Reproduced from Villas *et al.* (2015) and Vinn and Gutiérrez-Marco (2016).

Bedding-plane assemblages of spicules from the Sandbian of Peru, dominated by monaxons (either isolated or in groups)

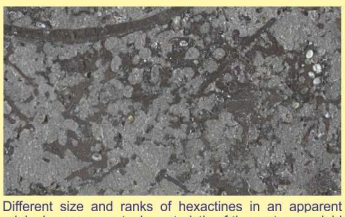
Above, field views of typical outcrops of the Calapuja Formation south of Calapuja (Puno Department), located more than 4,000 m in altitude. Below, details of the Queñuane section and a bed particularly rich in sponge spicules (lower right)

The spicule association found in Peru is from Sandbian Age beds in the lower part of the Calapuja Formation west of Lake Titicaca. It consists of isolated hexactins, pentactins and ropes or divergent tufts of elongate, large monaxons in subparallel orientation. Some of these monaxon groupings are clavate masses of slightly divergent, mainly smooth monaxons and some of them are ornamented. These forms resemble the genus *Pyritonema* McCoy (= *Hyalostelia* Hinde), commonly misinterpreted until the recent review by Botting (2005). Other spicule assemblages are root-tufts of hexactinellids with long monaxons including anchoring terminations.

Monaxon grouping of slightly divergent, mainly smooth spicules (above) and latex cast of isolated hexactin (below). All from the Ayaviri locality.

Isolated large monaxons and root-tufts of hexactinellids, some of them including anchoring terminations and partly ornamented forms, resembling the genus *Pyritonema* McCoy.

The spicules from the Upper Ordovician of Libya were collected from the basal horizons of the Melaz Shuqran Formation in the Tihemboka High, west of the Murzuq Basin. The assemblage consists of simple hexactines, hexactine-based stauracts and pentacts and some isolated large monaxons. The hexactines are vary in size or rank; some of them are in an apparent original arrangement. The specimens exhibit characteristics of protospongioid reticulosans. To our knowledge, this is the higher palaeolatitudinal record of Upper Ordovician sponges across the Gondwanan continent.



Different size and ranks of hexactines in an apparent original arrangement, characteristic of the protospongioid reticulosans.

Isolated hexactine and pentactine spicules from three localities on the Tihemboka High, including detailed latex casts of some of the specimens.

Acknowledgements

This is a contribution to projects CGL2012-39471 (Spanish Ministry of Economy and Competitiveness) and ICGP 591

References

Bergström, S.M., Massa, D. 1992. Stratigraphic and biogeographic significance of Upper Ordovician conodonts from northestern Libya. In Salem, M.J., Hammuda, O.S. and Eliagoubi, B.A. (eds): The Geology of Libya, Volume 4, 1323–1342. Elsevier, Amsterdam, The Nederlands.

Botting, J.P. 2005. Exceptionally-preserved Middle Ordovician sponges from the Llandegley Rocks Lagerstätte, central Wales. Palaeontology 48, 577–617.

Carrera, M.G., Rigby, J.K. 1999. Biogeography of Ordovician sponges. Journal of Paleontology 73, 26–37.

Ghienne, J.F., Girard, F., Moureau, J., Rubino, J.-L. 2010. Late Ordovician climbing-dune cross-stratification : a signature of outburst floods in proglacial outwash environments ?. Sedimentology 57, 1175–1198.

Hughes, C.P., Rickards, R.B., Williams, A. 1980. The Ordovician fauna from the Contaya Formation of Eastern Peru. Geological Magazine 117, 1–21.

Muir, L.A., Botting, J.P., Carrera, M.G., Beresi, M. 2013. Cambrian, Ordovician and Silurian non-stromatoporoid Porifera. In Harper, D.A.T. & Servais, T. (eds), Early Palaeozoic Biogeography and Palaeobiogeography. Geological Society, London, Memoirs 38, 81–95.

Villas, E., Colmenar, J., Gutiérrez-Marco, J.C. 2015. Late Ordovician brachiopods from Peru and their palaeobiogeographical relationships. Palaeontology 58, 455–487.

Vinn, O., Gutiérrez-Marco, J.C. 2016. New Late Ordovician cornulitids from Peru. Bulletin of Geosciences, 91, 59–95.