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Amphitheca isaacsonii gen. et sp. nov. (Acritarcha) from the Ananea Formation (Silurian/Devonian transition), southern Peru

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Abstract. The acritarch *Amphitheca isaacsonii* gen. et sp. nov. was described from the layers of latest Silurian to earliest Devonian age in southern Peru. Overall, 40 genera and 74 species of organic-walled microfossils were found in surface samples from the San Gabán and Ananea formations. Age-diagnostic species, such as *Evittia denticulata*, *Thysanoprobolus polykion*, *Riculasphaera fissa* and *Chutecloska athyrma*, indicate a Ludlovian to Lochkovian age for the base of the Ananea Formation. Specimens with atypically heteromorphic radial processes were assigned to a new genus and species, *Amphitheca isaacsonii* gen. et sp. nov. Morphological features of this new genus resemble fossil hypnozygotes of dinoflagellates.
Keywords. Ananea Formation, *Amphitheca* gen. nov., acritarchs, southern Peru

INTRODUCTION

Acritarchs, the unicellular microfossils of unknown origin, are distinguished by acid-resistant polymeric cell wall and common distribution in marine sediments of Paleozoic age. Majority of acritarchs most probably represent reproductive cysts (autospores) of unicellular marine phytoplankton. Distribution, chemical properties of cell wall and predisposed aperture connect acritarchs with hypnocyst of peridinioids. Main difference is the lack of morphological features reflecting peridinioid tabulation. In this paper we describe a new genus and species of acritarchs from pelitic layers of the Ananea Formation of southern Peru.

MATERIAL AND METHODS

Samples of dark grey silty shales and silty to sandy micaceous claystones were collected by Enrique Díaz-Martínez (IGME, Geological Survey of Spain) at surface exposures along the Inambari River, ca 17 km north-northeast from San Gabán, Puno Dept., southern Peru. Samples SG-1 and IN-4, 5 and 6 contain organic-walled microfossils. Sediments have been processed following standard palynological preparation methods by J. Bek (Laboratory of the Geological Institute, Academy of Sciences of the Czech

Republic, Prague). Crushed samples were treated with diluted HCl, 40% HF, and 10% KOH, without sieving. Palynological residue were mounted in glycerine jelly and deposited in the Collections of Laboratory of Paleobiology and Paleoecology, Geological Institute, Academy of Sciences of the Czech Republic, Prague (hereafter 'GLI').

SYSTEMATICS

Acritarcha Evitt, 1963
A 32 of Le Herissé et al. 2009 (tubular processes)

***Amphitheca* gen. nov.**

Type species: *Amphitheca isaacsonii* sp. nov.

Included species: Type species only.

Type locality: The same as for *A. isaacsonii* sp. nov. (see below).

type level: The same as for *A. isaacsonii* sp. nov. (see below).

Derivation of name: *Amphi*, from the Greek 'of both kinds', 'in between'.

Diagnosis: Spherical vesicles with radial processes of variable size and shape. Processes thin, tubular or triangular, bifurcate, trifurcate or with finely crenulate distal extremities. Disposition of individual types of processes without apparent regular pattern.

Description: Vesicle spheroidal, secondarily flattened. Eilyma two-layered. Globular central body provided with numerous (20-30) radial processes. Eilyma surface ranges from psilate to irregularly wrinkled or granulate. Heteromorphic processes are thin, solid, wire-like, with bifurcate terminations, and conical with wide bases and central rib, or tubular with open distal extremities and crenulate margin and do not communicate with vesicle interior. Crests are supported by thin ribs. Surface occasionally divided into irregular polygons.

Remarks: Excystment opening realized most probably by straight equatorial rupture. The genus *Fulgisphaeridium,* described by Deunff (1980), from the Gedinnian Landévennec Sandstones (Rade de Brest, Finistère, France) is similar to *Amphitheca* gen. nov., but differs in morphogically less variable radial processes, and in the presence of distal umbrella-like expansions of the outer eilyma.

Associated microflora: The Ananea Formation contains a distinctive and diversified microflora of acritarchs, prasinophytes, and very rare chitinozoans. The most comon acritarch genera are *Veryhachium*, Deunff emend. Turner, 1984 (10 species), *Ammonidium* Lister, 1970 (5 species) and the *Deunffia-Domasia* complex. Species such as *Chutecloska athyrma* Loeblich & Wicander, 1976, *Fimbriaglomerella divisa* Loeblich & Drugg, 1968, *Ozotobrachion dicros* Loeblich & Drugg, 1968, *O. furcillatus* (Deunff) Playford, 1977, *Riculasphaera fissa* Loeblich & Drugg, 1968, and *Thysanoprobolus polykion* Loeblich & Tappan, 1970 allow for correlation between the Peruvian marine microplankton and the Lochkovian Haragan Formation, Oklahoma (Loeblich & Drugg 1968, Loeblich & Wicander 1976, Wicander 1986). On the other hand, species such as *Ammonidium conicum* Pöthe de Baldis, 1998, *Fimbriaglomerella crameri* Pöthe de Baldis, 1981, *Polyplanifer simplex* Pöthe de Baldis, 1981, *Quadraditum ibericum* Pöthe de Baldis 1981,

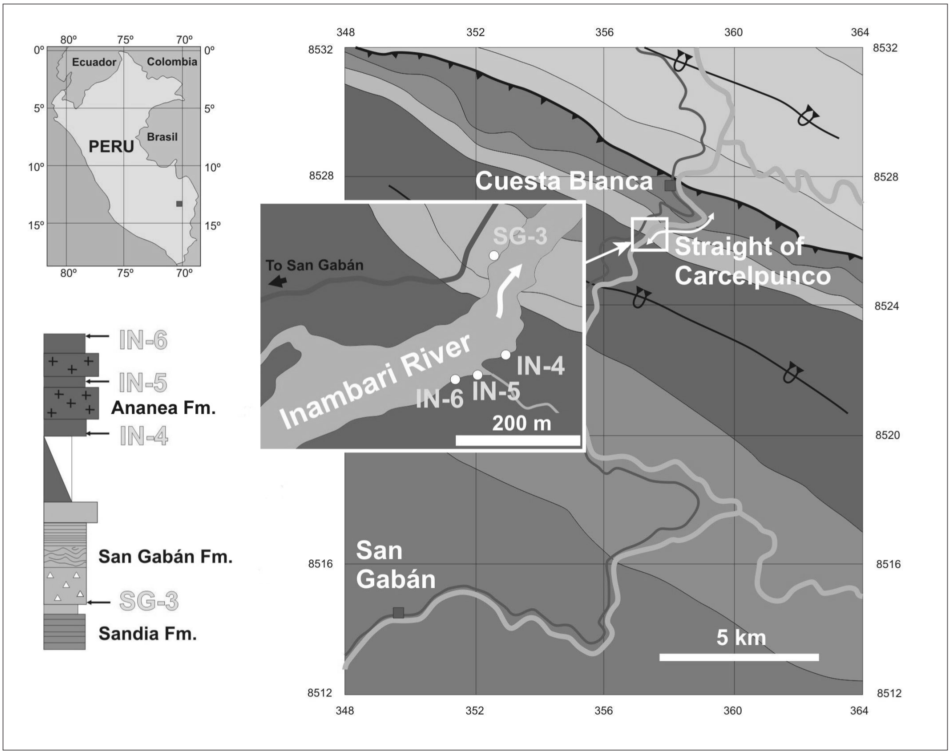

Fig. 1. Location of the study area and samples investigated (modified from an unpublished drawing by E. Díaz-Martínez).

Riculasphaera fissa Loeblich & Drugg, 1968, and many others are shared with coeval late Silurian assemblages from northern Argentina (Los Espejos Formation; Pöthe de Baldis 1981, 1998, Rubinstein 1992). Affinities to the Ludlovian acritarch assemblage described from the Kirusillas Formation in Bolivia (Cramer et al. 1974) is marked in a joint presence of many species, e.g. *Thysanoprobolus polykion* Loeblich & Tappan, 1970 and *Quadraditum fantasticum* Cramer, 1964.

Remarks on geology: Deposits of the Peru-Bolivia Silurian Basin are characterized by sequences indicating glacial influence. Diamictites, turbidites, and shales of the underlying glacigenic San Gabán Formation iniciated Silurian sedimentation (Díaz Martínez et al. 2001). The San Gabán Formation is correlated with the Zapla Formation in northern Argentina and the Cancaniri Formation in Bolivia (Díaz Martínez & Grahn 2007). Silurian deposits continue the overlying shelf-derived, predominantly pelitic Ananea Formation, which crops out along the eastern slopes of the Cordillera Oriental (Benedetto et al. 1992, Suarez-Soruco 1992). The predominantly Silurian age of the Ananea Formation was estimated by Laubacher et al. (1982) on the basis of the presence of the homalonotids and pelecypods.

Sequences of the Silurian age are exposed along the Inambari River area near the Mina Carcel Punco, in southern Peru (Fig. 1).

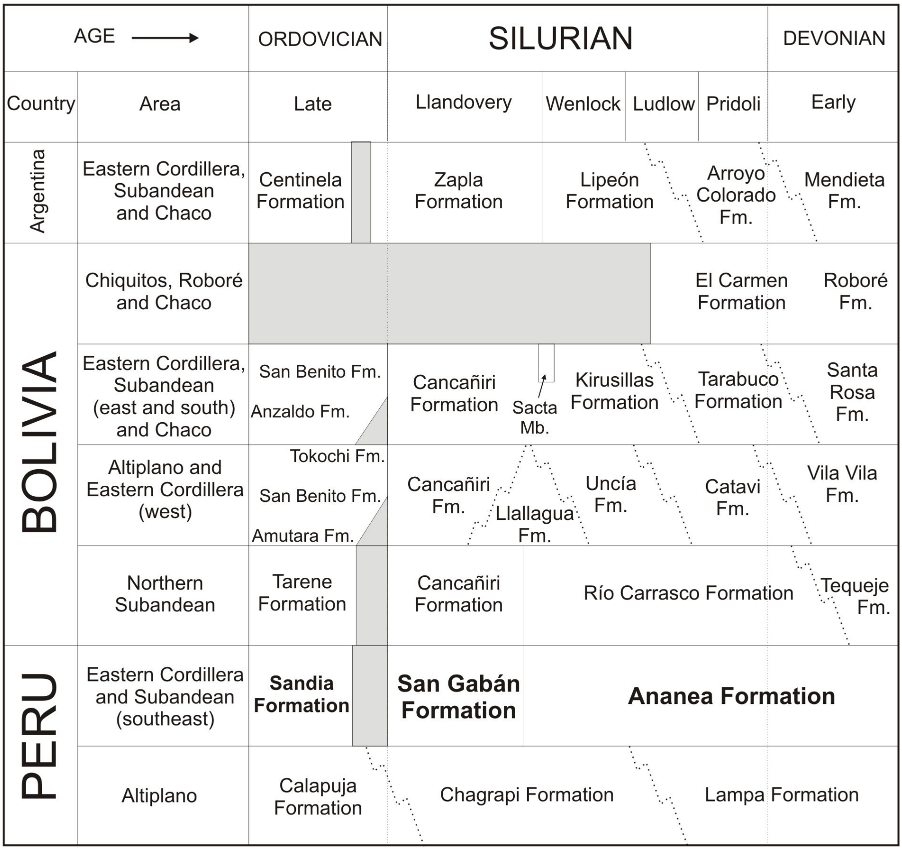

Fig. 2. The stratigraphic position of the Ananea Formation (modified from Díaz-Martínez 1998).

Amphitheca isaacsonii **sp. nov.**
Figs. 3a-f, 4/1, 5-7.

HOLOTYPE: Specimen figured on Figs. 3a and 4/1.

REPOSITORY: Collections of the Institute of Geology, Academy of Sciences of the Czech Republic, v.v.i., Prague.

TYPE LOCALITY: Straight of Carcelpunco of Inambari River, ca. 17 km NNE from San Gabán, southern Peru.

TYPE HORIZON: Sample IN 4, Ananea Formation, Upper Silurian. The Ananea Formation is part of the arcuate longitudinal belt of clastic sequences extending from Venezuela to northern Argentina and western Paraguay. See Laubacher et al. (1982). More detailed data on local geological situation and general lithology will be given elsewhere (Díaz-Martínez, Vavrdová & Isaacson in preparation).

DERIVATION OF NAME: Named in honour of Professor P. E. Isaacson, University of Idaho, Moscow, Idaho, USA, in recognition of his contribution to the knowledge of South American geology.

Diagnosis: Small spherical vesicles with smooth surface of with minor ornamentation. Radial processes distinctly heteromorphic, considerably differentiated in size and shape: thin simple spines, branched processes with flexible stems, flat triangular projections with central rib or thick tubular columns distally finely crenulate.

Description: Relatively small-sized acritarch with globular central body with large number of radial projections. Eilyma two-layered, smooth, finely granulate, crenulate or with other minor ornamentation. Projections are heteromorphic, irregular, of generally three types: Apical conical, tubular and thin bi- or trifurcate slender appendages. Flat triangular outgrowths with dark central rib. Massive tubular structures supported by septa, hollow, distally opened, margin crenulate, distally acuminate. Processes do not communicate with the vesicle interior. Number of processes varies from 20 to 30. No traces of predisposed regular excystment structure observed, although vesicle is very often divided by straight split into two halves.

Size: Central body: 15-19 µm; length of radial processes: 4 to 7 µm; width of the funnel-like tubes: to 15 µm; length: 21 (30 µm average) 35 µm. 21 specimens measured.

Remarks: In suitably oriented specimens, the radial projections seem to be distributed in a regular fashion, with large tubular ones in equatorial and subpolar positions, and thinner processes in between. However, in most of the studied forms, these projections are more or less randomly distributed on the vesicle surface. Similarly, as in *Fulgisphaeridium bristokii* Deunff, 1980, the Peruvian specimens distantly resemble the morphological features of some chorate dinoflagellate hypnozygotes, such as *Florentinia* Davey & Verdier, 1973, emend. Duxbury, and *Hystrichokolpoma fimbriata* Morgenroth, 1968.

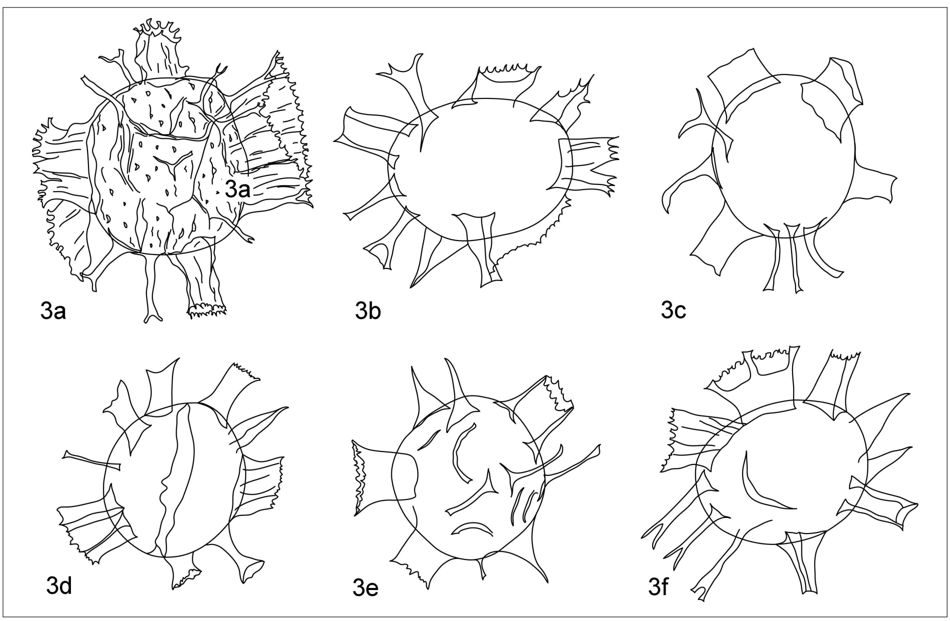

Fig. 3a-f *Amphitheca isaacsonii* gen. nov. et sp. nov. VS 35, GLI. 3a – holotype.

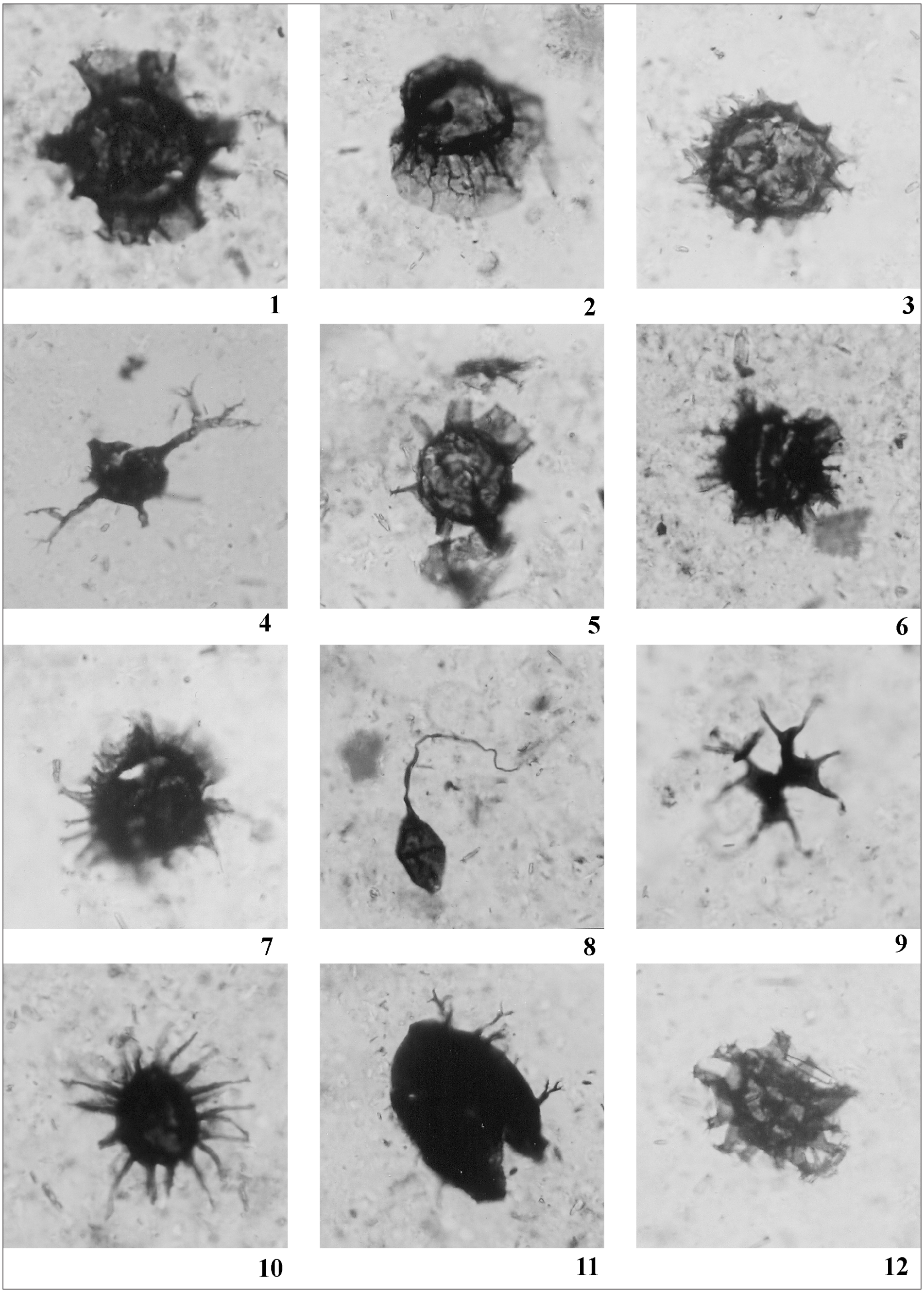

Fig. 4. Acritarchs and prasinophytes from the Ananea Formation, Curva Esperanza, southern Peru. Photomicrographs by M. Vavrdová.

1: *Amphitheca isaacsonii* gen. et sp. nov. 1: holotype (overall size = 33 µm); 2: *Chutecloska athyrma* Loeblich & Wicander, 1976 (52 µm); 3: *Ammonidium conicum* Pöthe de Baldis, 1998

Conspicuous variability of radial processes, with a tendency to form a regular pattern, connects the Peruvian Palaeozoic acritarchs with hypnozygotes of much younger peridinioids.

CONCLUSIONS

The newly proposed monospecific Siluro/Devonian acritarch genus *Amphitheca* gen. nov. (*A. isaacsonii* sp. nov.) from the pelitic Ananea Formation, southern Peru, may represent a connecting link between acritarchs and dinoflagellates. Two-layered vesicle eilyma, sutural projections, and markedly heteromorphic processes are similar to chorate peridinioid cysts (hypnozygotes). The small size of the recovered specimens, and their relatively poor preservation, did not allow for recognition of a regular pattern in the distribution of sculptural elements.

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(33 µm); 4: *Ozotobrachion furcillatus* (Deunff) Playford, 1977 (43 µm); 5-7: *Amphitheca isaacsonii* gen. et sp. nov. referred material (30 µm, 30 µm and 36 µm, respectively); 8: *Deunffia monospinosa* Downie, 1960 (65 µm); 9: *Polyplanifer simplex* Pöthe de Baldis, 1981 (33 µm); 10: *Ammonidium cornuatum* Loeblich & Wicander, 1998 (40 µm); 11: *Oppilatala despecta* Deunff, 1980 (57 µm); 12: *Thysanoprobolus polykion* Loeblich & Tappan, 1970 (28 µm).

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