# Zitteliana

An International Journal
of Palaeontology and Geobiology

Series A / Reihe A
Mitteilungen der Bayerischen Staatssammlung
für Paläontologie und Geologie

48/49

München 2009

Zitteliana

An International Journal of Palaeontology and Geobiology

Series A/Reihe A

Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Geologie

48/49

## CONTENTS/INHALT



| Zitteliana | A 48/49 | 176 Seiten | München, 30.09.2009 | ISSN 1612-412X |
|---|---|---|---|---|

Editors-in-Chief/Herausgeber: Gert Wörheide, Michael Krings
Production and Layout/Bildbearbeitung und Layout: Martine Focke, Manuela Schellenberger
Bayerische Staatssammlung für Paläontologie und Geologie



Bayerische Staatssammlung für Paläontologie und Geologie
Richard-Wagner-Str. 10, D-80333 München, Deutschland
http://www.palmuc.de/zitteliana
email: zitteliana@lrz.uni-muenchen.de



ISSN 1612-412X
Druck: Gebr. Geiselberger GmbH, Altötting

**Cover illustration:** Cover illustration: The floating plant *Cobbania corrugata* (Lesquereux) Stockey et al. from the Upper Cretaceous of North America inspected by an *Ornithomimus* dinosaur. The quarry in the Dinosaur Provincial Park, Alberta (Canada), produced numerous complete specimens of this plant and the most complete skeleton of the dinosaur (Reconstruction by Marjorie Legin). For details, see Bogner, J.: The free-floating Aroids (Araceae) – living and fossil, pp. 113–128 in this issue.

**Umschlagbild:** Umschlagbild: Ein *Ornithomimus* Dinosaurier betrachtet die Schwimmpflanze *Cobbania corrugata* (Lesquereux) Stockey et al. aus der Oberkreide Nordamerikas. Im Steinbruch des Dinosaur Provincial Park, Alberta (Kanada), wurden mehrere komplette Exemplare dieser Pflanze und ein nahezu vollständiges Skelett des Dinosauriers gefunden (Rekonstruktion Marjorie Legin). Für weitere Informationen siehe Bogner, J.: The free-floating Aroids (Araceae) – living and fossil, S. 113–128 in diesem Heft.

| Zitteliana | A48/49 | 171 - 173 | 2 Figs | München, 30.09.2009 | ISSN 1612 - 412X |
|---|---|---|---|---|---|

## Short Communication

# An enigmatic microorganism from the Upper Pennsylvanian Grand-Croix cherts (Saint-Etienne Basin, France)

By

Michael Krings[1,2*], Thomas N. Taylor[2] & Jean Galtier[3]

*[1]Bayerische Staatssammlung für Paläontologie und Geologie und GeoBio-Center[LMU], Richard-Wagner-Straße 10, 80333 Munich, Germany*

*[2]Department of Ecology and Evolutionary Biology, and Natural History Museum and Biodiversity Research Center, The University of Kansas, Lawrence KS 66045-7534, U.S.A.*

*[3]AMAP, UMR 5120 CNRS, CIRAD TA A-51/ PS2, Boulevard de la Lironde, 34398 Montpellier, France*

Manuscript received December 19, 2008; revised manuscript accepted February 2, 2009.

**Key words:** Acritarchs, Prasinophyceae, Peronosporomycetes, oogonium, phycoma, *Pythium* Pringsh.

**Schlüsselwörter:** Acritarchen, Prasinophyceae, Peronosporomycetes, Phycoma, Oogonium, *Pythium* Pringsh.

Microorganisms are critical in the bio- and geosphere today, and are responsible for the sustainability of ecosystem functions ranging from decomposition and bioerosion, to the catalyzation of nutrient cycles. With this recognition of the significance of microorganisms today, detailed knowledge about the evolutionary history of these organisms and their roles in biological and ecological processes in the past is pivotal to understanding ancient ecosystems.

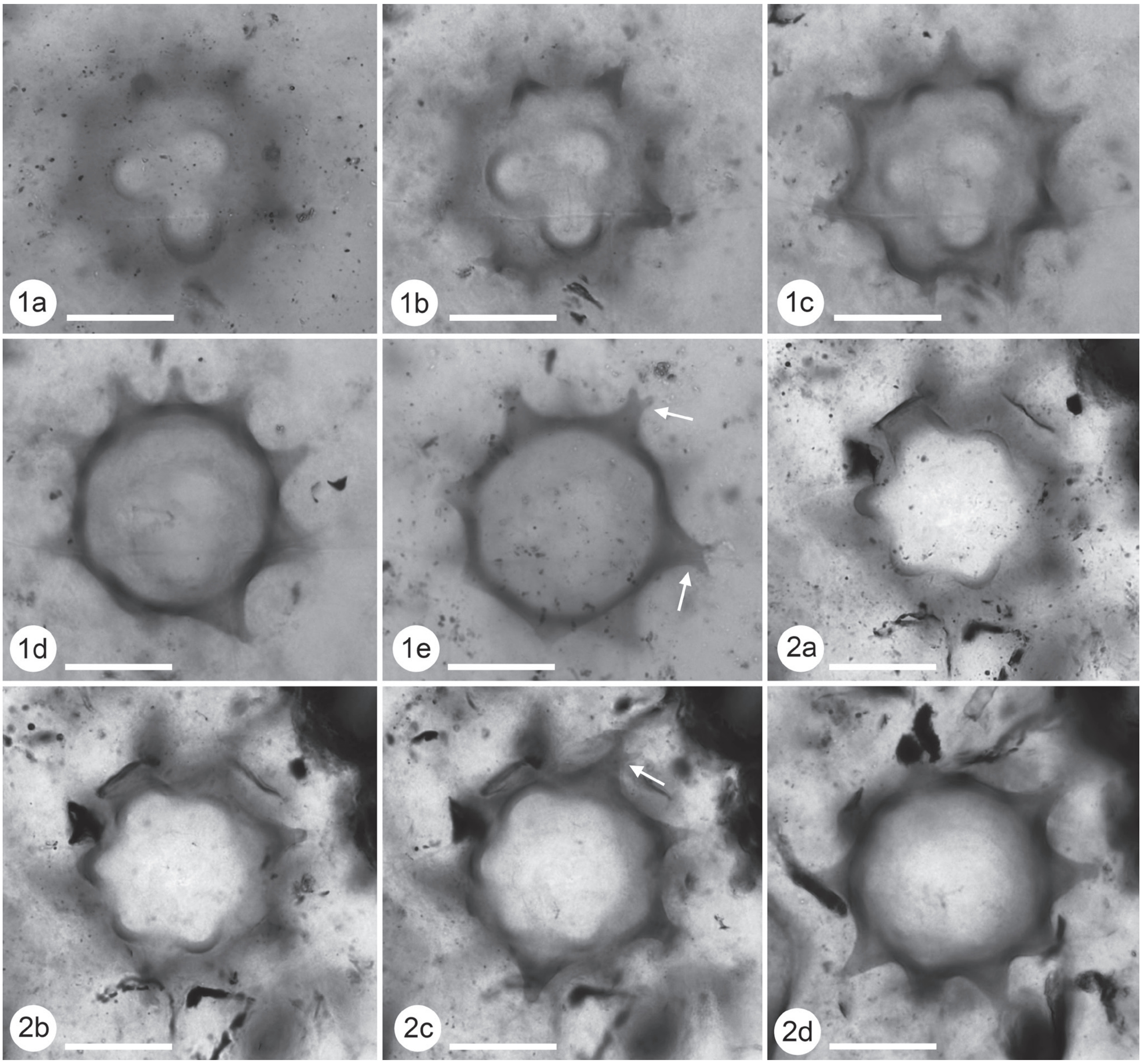
Chert deposits are among the most important sources of information about fossil microorganisms. While the Early Devonian Rhynie chert is perhaps the most widely known example of a chert deposit containing a diversity of microorganisms (e.g., Taylor & Krings 2005), there are several other cherts that contain microorganisms preserved in a similar manner. However, these cherts have received considerably less attention, and thus represent an important source of new data on ancient microbial activity. Some of the most interesting cherts come from several Carboniferous sites in central France, and were initially studied by the French paleobotanist Bernard Renault.

The Upper Pennsylvanian cherts from Grand-Croix (Saint-Etienne Basin, France) are widely known for their exquisitely preserved terrestrial plants (see Galtier 2008). Co-occurring with the plants in these deposits is a diverse assemblage of microorganisms. Although some of these fossils were described as early as the late 19th century (Renault 1896, 1900), the microorganisms from Grand-Croix have not attracted subsequent scholarly interest, and thus remain largely unknown.

Two interesting specimens of an unusual, hitherto unknown microfossil (Figs 1,2) were recently identified in a thin section of Grand-Croix chert that was prepared by Renault or one of his co-workers during the late 19th or early 20th century. The slide is today housed in the Muséum National d'Histoire Naturelle (Laboratoire de Paléontologie) in Paris (France) under accession number REN-2195. The specimens occur isolated within the chert matrix and are associated with fungal hyphae and an accumulation of degrading plant fragments. The fossils are spherical and approximately 55 µm in diameter (including projections); the wall is up to 3.2 µm thick. Extending from the wall are prominent conical projections, up to 9 µm high and proximally 7 µm wide, with simple (Fig. 1c,d) or forked (Figs 1e[arrows],2c[arrow]) tips. Projections are uniformly distributed over the entire surface of the sphere. The proximal portion of the projections is hollow, whereas the distal portion and tip appear to be solid. The wall of the projections corresponds in thickness to that of the sphere.

If these microfossils were found in a palynological sample, they would probably be referred to the acritarchs because of their uncertain affinities. Acritarchs represent a heterogeneous group of organic-walled microfossils that consist of a central cavity enclosed by a single- or multi-layered wall; symmetry, shape, structure, and ornamentation may be highly variable. The central cavity is closed or communicates with the exterior by varied means, including pores, slit-like or irregular ruptures, and circular openings (Martin 1993; Montenari & Leppig 2003). The majority of acritarchs have been described from marine and brackish water strata, but there are also reports from non-marine deposits (Mullins & Servais 2008). Many acritarchs have ornamented surfaces that resemble the surface ornament of the Grand-Croix microfossils (see Tappan 1980).

*Author for correspondence and reprint requests: E-mail: m.krings@lrz.uni-muenchen.de




**Figures 1 & 2:** Two specimens of the microfossil from the Upper Pennsylvanian Grand-Croix cherts in different focal planes; arrows in 1e and 2c indicate wall projections with forked tips; the lobed structures seen in 1a–c and 2a,b result from the removal of the projections and parts of the fossil during the preparation of the thin section; each lobe represents the former position of a projection base; scale bars = 20 µm.

Pirozynski (1976) hypothesized that certain forms of acritarchs may represent the remains of peronosporomycetes, a suggestion that at the time received little attention. The Peronosporomycetes (Oomycota in older treatments) are fungal-like microorganisms that thrive as saprotrophs and parasites of plants, animals, and other fungi (Dick 2001). Although they were likely among some of the first eukaryotes on Earth, the fossil record of peronosporomycetes remains very incomplete. To date only one peronosporomycete has been described from the Carboniferous. This organism, *Combresomyces cornifer* Dotzler et al. from the upper Visean (Mississippian) of central France, occurs as a spherical oogonium with antler-like surface extensions positioned on hollow projections of the oogonial wall (Dotzler et al. 2008). Although they are considerably larger, the wall projections of the fossils from Grand-Croix reported here are reminiscent of the projections seen in *C. cornifer*. Moreover, several extant peronosporomycetes (especially members of the genus *Pythium* Pringsh.) are known to possess oogonia that are characterized by a surface ornament composed of prominent projections (Dick 1969; Van der Plaats-Niterink 1981).

An alternative interpretation views the Grand-Croix microfossils as prasinophyte phycomata. Prasinophytes are single-celled, flagellate green algae. The life history of several species includes a unique non-motile stage that is characterized by the formation of a cyst-like structure termed the phycoma. Phycomata are resistant structures, and thus may be well-preserved as fossils (Teyssèdre 2006). However, the alga remains metabolically active during the phycoma stage and eventually undergoes vegetative reproduction. As a result, the phycoma increases in size over time (Tappan 1980). Because of the thick walls (>3 µm) of the Grand-Croix fossils it appears unlikely that the affinities lie with the prasinophytes. Moreover, excystment structures, which occur in prasinophyte phycomata in the form of a rupture along a preformed line of weakness within the outer wall layer (Colbath & Grenfell 1995), have not been observed in any of the Grand-Croix fossils.

Although the affinities of the microfossils from Grand-Croix remain elusive, they provide additional information about the biodiversity of microorganisms in this Late Pennsylvanian continental ecosystem. We anticipate that additional specimens will be discovered as work on the microbial life preserved in the Grand-Croix cherts continues. This will hopefully lead to a more accurate picture of this intriguing microorganism, and help to more completely understand the full extent of the biodiversity in the Grand-Croix paleoecosystem.

## Acknowledgments

This study was supported by the National Science Foundation (EAR-0542170 to T.N.T. and M.K.) and the Alexander von Humboldt-Foundation (V-3.FLF-DEU/1064359 to M.K.). We thank J. Dejax and D. De Franceschi (Paris, France) for making the Renault collection available and for their continued support.

## References

Colbath, G. K. & Grenfell, H. R. (1995): Review of biological affinities of Paleozoic acid-resistant, organic-walled eucaryotic algal microfossils (including "acritarchs"). – Review of Palaeobotany and Palynology, **86:** 287–314.

Dick, M. W. (1969): Morphology and taxonomy of the Oomycetes, with special reference to Saprolegniaceae, Leptomitaceae and Pythiaceae. – New Phytologist, **68:** 751–775.

Dick, M. W. (2001): Straminipilous fungi. Systematics of the Peronosporomycetes including accounts of the marine straminipilous protists, the Plasmodiophorids and similar organisms; Dordrecht, Boston, London (Kluwer Academic Publishers), 670 pp.

Dotzler, N., Krings, M., Agerer, R., Galtier, J. & Taylor, T. N. (2008): *Combresomyces cornifer* gen. sp. nov., an endophytic peronosporomycete in *Lepidodendron* from the Carboniferous of central France. – Mycological Research, **112:** 1107–1114.

Galtier, J. (2008): A new look at the permineralized flora of Grand-Croix (Late Pennsylvanian, Saint-Etienne basin, France). – Review of Palaeobotany and Palynology, **152:** 129–140.

Martin, F. (1993): Acritarchs: a review. – Biological Reviews, **68:** 475–537.

Montenari, M. & Leppig, U. (2003): Die Acritarcha: ihre Klassifikation, Morphologie, Ultrastruktur und paläoökologische/paläogeographische Verbreitung. – Paläontologische Zeitschrift, **77:** 173–194.

Mullins, G. L. & Servais, T. (2008): The diversity of Carboniferous phytoplankton. – Review of Palaeobotany and Palynology, **149:** 29–49.

Pirozynski, K. A. (1976): Fossil fungi. – Annual Review of Phytopathology, **14:** 237-246.

Renault, B. (1896): Bassin Houiller et Permien d'Autun et d'Épinac. Fascicule IV: Flore fossile, deuxième partie. Études des Gîtes Minéraux de la France; Paris (Imprimerie Nationale), 578 pp.

Renault, B. (1900): Sur quelques microorganisms des combustibles fossils; Saint-Étienne (Société de l'Imprimerie Théolier. J. Thomas et Cie), 460 pp.

Tappan, H. (1980): Palaeobiology of Plant Protists; San Francisco CA (W.H. Freeman and Company), xxi + 1028 pp.

Taylor, T. N. & Krings, M. (2005): Fossil microorganisms and land plants: Associations and interactions. – Symbiosis, **40:** 119–135.

Teyssèdre, B. (2006): Are the green algae (phylum Viridiplantae) two billion years old? – Carnets de Géologie, **2006/03:** 1–15.

Van der Plaats-Niterink, A. J. (1981): Monograph of the genus *Pythium*. – Studies in Mycology, **21:** 1–242.