



Research Papers

The genus *Fryopsis* Wolfe (al. *Cardiopteris* Schimper): A taxonomic revision

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ABSTRACT

The classification of Mississippian compression remains is often problematic due to poor definitions of genera and unclear delimitation of individual species.

The name of the Mississippian genus *Cardiopteris* Schimper 1869 is a homonym of *Cardiopteris* Wallich ex Royle 1834 and was replaced by the name *Fryopsis* Wolfe 1962. However, the new name was only introduced for *Fryopsis polymorpha*, which was designated as type species. The other species assigned to *Cardiopteris* Schimper never have been transferred formally to *Fryopsis*. A conspecificity of *Fryopsis polymorpha*, *Cardiopteris frondosa* and *Cardiopteris hochstetteri* has often been discussed but never been proven.

In this contribution the distinctive characters described in the literature for the three “species” – primarily size, position, and form of the pinnules – are reviewed critically. Morphometric analyses of previously described specimens and a substantial number of unpublished ones show that there are no distinct differences in leaf size. Moreover, alternate pinnules are not restricted to *Cardiopteris hochstetteri* as was previously thought, and individual “species” are not characterized by a typical leaf shape. Thus, a distinction into different species cannot be maintained. *Cardiopteris frondosa* and *Cardiopteris hochstetteri* are conspecific with *Fryopsis polymorpha*. Most of the other species described in *Cardiopteris* belong to other genera, have been recognized as synonyms of other taxa, or have to be regarded as species dubiae. *Cardiopteris altaicus* Radčenko 1985 is formally transferred to *Fryopsis*.

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1. Introduction

Mississippian floras are comparatively rare and thus poorly known in comparison to Late Devonian and especially in comparison to Pennsylvanian floras. In recent years much work has been done on anatomically preserved material (e.g., Decombeix et al., 2005; Galtier, 2004; Galtier et al., 1994, 1998a; Galtier and Scott, 1979, 1985; Meyer-Berthaud, 1990; Rowe and Galtier, 1989, 1990), but the classification of Mississippian compression remains is still problematic. Several genera have been described but these are often very poorly defined. Moreover, the delimitation of individual species is often unclear. The resulting lack of a uniform classification and nomenclature makes comparisons of floras from various parts of Europe and North America extremely difficult or even impossible. To date, only very few taxa have been described and defined in sufficient detail (e.g., Knaus, 1994; Rowe, 1988, 1992). A uniform classification of compression remains, based on well-defined taxa, is a prerequisite for interregional comparisons.

Schimper (1869) established the genus *Cardiopteris* to include two species originally accommodated in *Cyclopteris* Brongniart 1828: *C. frondosa* and *C. polymorpha*. *Cyclopteris* is a genus for relatively large, (semi-)circular pinnules with a fan-shaped dichotomising

venation, occurring in the basal part of neuropterid fronds. However, *Cyclopteris frondosa* Goepfert 1847 and *Cyclopteris polymorpha* Goepfert 1860 are not related to neuropterids. Schimper (1869) regarded *Cyclopteris hochstetteri* Ettingshausen 1865 as a synonym of *Cyclopteris polymorpha*. However, Stur (1875) did not agree and retained *Cyclopteris hochstetteri* as a separate species that he transferred to *Cardiopteris*. In later years several other species of *Cardiopteris* were described. Most of these species appear to belong to other genera. Only *Cardiopteris frondosa*, *C. polymorpha* and *C. hochstetteri* are still regularly used, but it is unclear whether they represent different species.

Wolfe (1962) introduced the name *Fryopsis* to replace *Cardiopteris* Schimper because the latter name is a later homonym of *Cardiopteris* Wallich ex Royle 1834. He designated *Fryopsis polymorpha* (Goepfert) Wolfe as type species but refrained from formally introducing new names for the other species. Even though illegitimate, the name *Cardiopteris* Schimper is still frequently used (e.g., Corsin et al., 1973; Haydukiewicz and Muszer, 2002; Purkyňová, 1970; Remy and Remy, 1977).

This contribution is based on a systematic study of over 90 specimens of *Fryopsis*, including type material and many previously unfigured specimens. Morphometric analyses show that *Fryopsis polymorpha*, *Cardiopteris hochstetteri* and *Cardiopteris frondosa* are conspecific. The other species described in *Cardiopteris* are critically reviewed; only a single species can be retained and this form is formally transferred to *Fryopsis*.

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2. Material and methods

Ninety-three specimens of *Fryopsis* (16 voucher specimens, 77 so far undescribed) from the following collections were investigated:

- Senckenberg Naturhistorische Sammlungen Dresden (Senckenberg Natural History Collection Dresden, Germany)
- Museum für Naturkunde Chemnitz (Natural History Museum Chemnitz, Germany)
- Museum für Naturkunde Berlin (Natural History Museum Berlin, Germany)
- Bundesanstalt für Geowissenschaften und Rohstoffe Berlin–Spandau (Federal Institute for Geosciences and Natural Resources, Berlin–Spandau, Germany)
- Geologische Bundesanstalt Wien (Geological Survey, Vienna, Austria)
- Naturhistorisches Museum Wien (Natural History Museum Vienna, Austria)

The material is from Mississippian localities (for more precise ages and references see Table 1) in (1) Germany: Borna-Hainichen, Chemnitz-Glösa, the Kossberg near Plauen, Doberlug-Kirchhain, Saalfeld, (2) the Czech Republic: Stará Ves (Altendorf¹), Zálužné (Mohradorf), Lhotka (Nitschenau), (3) Poland: Czerwieńczyce (Rothwaltersdorf), Daleszów (Leppersdorf), Konradów (Conradsthal), Modłecin (Friedersdorf), Stary Zdrój (Altwasser), Marciszów (Merzdorf), Kamionki (Steinkunzendorf), Sokolec (Falkenberg), Niedamirów (Kunzendorf) and (4) France: Thann in the Vosges, Vosges (exact locality unknown).

Specimens were photographed with a Nikon D100 digital camera. Contrast was enhanced by using polarized light, dry or under ethanol. Details showing the venation and transverse marks on the rachis were photographed in normal artificial light. Contrasts were adjusted using the contrast and dodging functions of Adobe Photoshop. Measurements for morphometric analyses were made from the digital pictures. The values of the specimens illustrated by Schimper (1869, pl. 35, figs. 1–4) were taken from the full-scale drawings in the publication. Diagrams were created in PAST (PALaeontological STATistics).

3. Systematic part

About 30 species have been described in *Cardiopteris* or transferred to this genus. Many of these belong to other genera, are synonyms of other taxa, or have to be regarded as species dubiae.

3.1. *Cardiopteris* species that cannot be accommodated in *Fryopsis*

3.1.1. Species transferred to other genera and species recognized as synonyms

Several species that have originally been classified in *Cardiopteris* or have been transferred to that genus were later formally transferred to other genera or regarded as synonyms. The category includes:

- *Cardiopteris askyzensis* Zalesky 1932: This species has been transferred to *Cardiopteridium* Nathorst by Zalesky (1934). However, this assignment is also questionable.
- *Cardiopteris densa* Tchirkova: According to Jongmans and Dijkstra (1958, p. 519) this species has been transferred to *Cardioneura* Zalesky by Zalesky (1934). However, neither Zalesky (1934) nor Jongmans and Dijkstra (1958) give a reference to Tchirkova's original publication.

Table 1
Stratigraphical distribution of *Fryopsis*.

Locality	Age	Reference
Borna-Hainichen	late Viséan	Kerp et al., 2006
Chemnitz-Glösa	late Viséan	Schneider et al., 2005
the Kossberg near Plauen	Viséan	Kerp et al., 2006
Doberlug-Kirchhain	late Viséan	Kerp et al., 2006
Saalfeld	late Tournaisian to early Viséan	Kerp et al., 2006
Stará Ves	late Viséan	Hartung and Patteisky, 1960
Zálužné	late Viséan	Hartung and Patteisky, 1960
Lhotka	late Viséan	Hartung and Patteisky, 1960
Czerwieńczyce	Viséan	Zimmermann, 1958
Daleszów (part of Kamienna Góra = Landeshut)	Viséan (for Landeshut)	Zimmermann, 1958
Konradów	late Viséan	Žakova, 1960
Modłecin (sediments covering the Gneiss block of the Sowie Mountains; pers. comm. A. Setlik, 2011)	middle to late Viséan	Žakova, 1963
Stary Zdrój	late Viséan (for the Chwalibóg mine)	Zimmermann, 1958
Marciszów	late Viséan	Žakova, 1958, Table 1
Kamionki	late Viséan	Žakova, 1958
Sokolec	early Viséan	Zimmermann, 1958
	late Viséan	Žakova, 1958, 1963
Niedamirów	Culm	Stur, 1875
	= Viséan	Zimmermann, 1958
Thann/Vosges	late Upper Viséan to Namurian?	Galtier et al., 1998b

- *Cardiopteris elegans* Kurtz 1921: This species has been placed in the synonymy of *Nothorhacopteris argentinica* (Geinitz) Archangelsky by Archangelsky et al. (1995).
- *Cardiopteris karagandensis* Zalesky 1932: This species is based on a single, small, unidentifiable fragment and was transferred to *Cardioneura* by Zalesky (1934).
- *Cardiopteris tomiensis* Zalesky 1933: This species has been transferred to *Cardioneura* by Zalesky (1934).
- *Cardiopteris vesca* Zalesky 1933: This species has been transferred to *Cardioneura* by Zalesky (1934).
- *Cardiopteris zuberi* Szajnoch 1888: This species has been designated as the type of the genus *Zuberia* Frenguelli by Frenguelli (1944) and subsequently been transferred to *Dicroidium* Gothan by Archangelsky (1968).
- *Cardiopteris nana* (Eichwald) Kidston 1893–94: The species has originally been described as *Cyclopteris nana* Eichwald 1860 and was transferred to *Cardiopteridium* by Nathorst (1914). Kidston (1893–1894, 1901) and Crookall (1932) erroneously referred to this species as *Cardiopteris nana*.
- *Cardiopteris spetsbergense* (Nathorst) Petrenko, 1961: The species has originally been described as *Cardiopteridium spetsbergense* by Nathorst (1914). The name *Cardiopteris spetsbergense* has erroneously been used by Petrenko (1961).
- *Cardiopteris cardiopteroides* (Schmalhausen) Petunnikov 1909: The species has originally been described as *Neuropteris cardiopteroides* Schmalhausen 1877–78. After being transferred to *Cardiopteris* by Petunnikov (1909) it was transferred to *Angaropteridium* by Zalesky (1932).
- *Cardiopteris schmalhauseni* Kurtz 1921: *Cardiopteris schmalhauseni* is a later synonym of *Cardiopteris cardiopteroides*, which was originally described as *Neuropteris cardiopteroides*, and was transferred to *Angaropteridium* by Zalesky (1932).

¹ Many of the specimens studied are from old collections and most of the German locality names on the collection labels do not exist anymore. Because older authors refer to the German names, they are given here between brackets.

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