

GEOLOGY STUDIES

Volume 15: Part 1 October 1968

CONTENTS

A program for generation of synthetic stratigraphic sections	Robert F. Blakely and Paul Edwin Potter	3
Techniques for obtaining fabric data from coarse clastic sediments	Alan R. Smith	13
Middle and Upper Cambrian stratigraphy in the autochthon and allochthon of northern Utah	Richard J. Rigo	31
Structural development of the Toquerville-Pintura segment of the Hurricane Cliffs, Utah	Robert A. Watson	67
Gravitational gliding in the Flagstaff Formation near Soldier Summit, Utah	Mounir T. Moussa	77
Geology of the Desert Mountains intrusives, Juab County, Utah	Donald F. Kattelman	85
Note on the distribution and morphology of the fern genus <i>Astralopteris</i>	Samuel R. Rushforth and William D. Tidwell	109
Early Pennsylvanian crinoids from the south-central Wasatch Mountains of central Utah	Alan T. Washburn	115
Publications and maps of the Geology Department		133

Brigham Young University Geology Studies

Volume 15: Part 1 — October 1968

Contents

A program for generation of synthetic stratigraphic sections	Robert F. Blakely and Paul Edwin Potter	3
Techniques for obtaining fabric data from coarse clastic sediments	Alan R. Smith	13
Middle and Upper Cambrian stratigraphy in the autochthon and allochthon of northern Utah	Richard J. Rigo	31
Structural development of the Toquerville-Pintura segment of the Hurricane Cliffs, Utah	Robert A. Watson	67
Gravitational gliding in the Flagstaff Formation near Soldier Summit, Utah	Mounir T. Moussa	77
Geology of the Desert Mountains intrusives, Juab County, Utah	Donald F. Kattelman	85
Note on the distribution and morphology of the fern genus <i>Astralopteris</i>	Samuel R. Rushforth and William D. Tidwell	109
Early Pennsylvanian crinoids from the south-central Wasatch Mountains of central Utah	Alan T. Washburn	115
Publications and maps of the Geology Department		133

A publication of the
Department of Geology
Brigham Young University
Provo, Utah 84601

Editor

J. Keith Rigby

Associate Editors

Morris S. Petersen, Lehi F. Hintze, W. Kenneth Hamblin

Brigham Young University Geology Studies is published annually by the department. *Geology Studies* consists of graduate student and staff research in the department, and occasional papers from other contributors.

Distributed October 15, 1968

Price \$4.00

Notes on the Distribution and Morphology of the Fern Genus *Astralopteris*

SAMUEL R. RUSHFORTH AND WILLIAM D. TIDWELL

Department of Botany, Brigham Young University

ABSTRACT.—The Cretaceous fern genus *Astralopteris*, previously reported from the Dakota Sandstone of Utah and Colorado, has been uncovered at two additional localities. One new locality is in the Dakota Sandstone in northeastern Arizona, and the second is in the younger Frontier Formation of Wyoming. Specimens of *Astralopteris* from these localities have contributed additional information on the soriation of this genus. Sori of *Astralopteris* have been found to be indusiate with each sorus containing from seventeen to twenty-one sporangia arranged in a circle around a central placenta. Sporangia are annulate, with vertical annulus. A costal aerole has been observed in both fertile and sterile pinnules. Veinlets arising from this aerole and from the major secondary veins converge beneath the sori.

CONTENTS

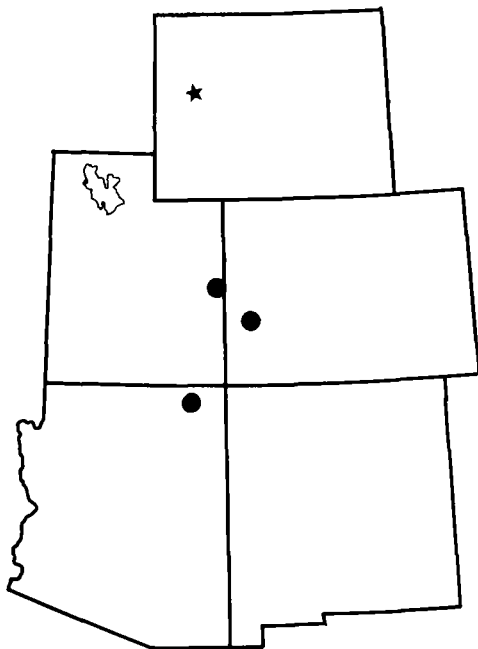
TEXT	page	a major secondary vein (a) of <i>Astralopteris coloradica</i> (Brown) Reveal, Tidwell, and Rushforth	111
Introduction	109		
Description	109		
Soral morphology	110		
Distribution	112		
Acknowledgments	113		
References Cited	113		
Text-figures	page	Plates	following page
1. Geographical distribution of <i>Astralopteris</i> as presently known	110	1. <i>Astralopteris coloradica</i> (Brown) Reveal, Tidwell, and Rushforth	112
2. Epidermal pattern on the upper (?) leaf surface near		2. <i>Astralopteris coloradica</i> (Brown) Reveal, Tidwell, and Rushforth	112
		3. <i>Astralopteris coloradica</i> (Brown) Reveal, Tidwell, and Rushforth	112

INTRODUCTION

The genus *Astralopteris* was proposed by Tidwell, Rushforth, and Reveal (1967) for the placement of sterile and fertile pinna fragments from Utah and Colorado which had originally been placed by R. W. Brown (1950) in the extant genus *Bolbitis*. The transfer of the sterile material described by Brown to *Astralopteris* was necessary when fertile pinnules discovered in eastern Utah demonstrated soriation that disallowed the placement of this Cretaceous fern in the modern genus *Bolbitis* (Aspidaceae).

DESCRIPTION

Astralopteris is presently monotypic, consisting of the single species *A. coloradica* (Brown) Reveal, Tidwell, and Rushforth. This species is characterized by having large coriaceous pinnules (up to 10 mm long on some observed specimens) arranged alternately or oppositely on a rather stout rachis which commonly ranges between 1.5 mm and 3 mm in width. Pinnule attachment is by a single point at the pinna base, grading into a complete basal attachment upward and then to rounded sinuses near the pinna apex. The



TEXT-FIGURE 1.—Geographical distribution of *Astralopteris* as presently known: 1, near Westwater, Grand County, Utah; 2, near Naturita, Montrose County, Colorado; 3, Longhouse Valley, Navajo County, Arizona; and 4, Little Sheep Mountain, Sublette County, Wyoming.

pinnules are linear and are commonly 7 to 12 times as long as broad. The pinnules have strong midveins. Numerous secondary veins arise from these midveins at acute angles and immediately become perpendicular to them (Plate 3, fig. 2). Soral disposition is in a single row on each side of the midvein between the major secondary veins. The structure of the sorus and sporangia have not formerly been reported because only soral impressions rather than actual sori were preserved on previously described material.

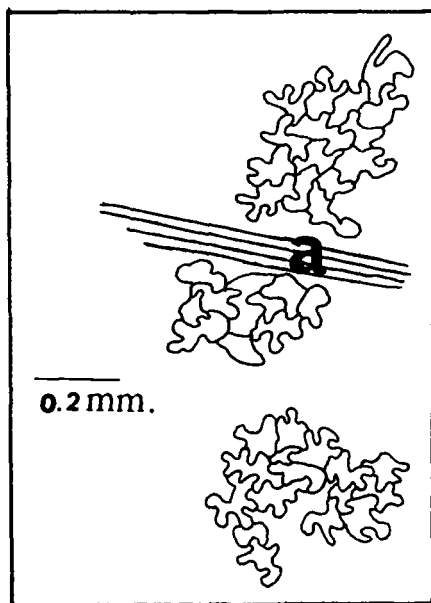
Soral Morphology.—The sori of *Astralopteris*, as mentioned above, are arranged linearly on each side of the midvein and are disposed between the major secondary veins of the pinnule. Anastomosing veinlets converge at the placenta of the sorus creating a mass of vascular tissue in the lamina beneath the sorus. Soral attachment is at a point approximately one-fourth of the distance from the midvein to the laminar margin.

The placenta of the sorus is rather large and is expanded laterally to form a large peltate indusium which is somewhat dense near the center, becoming thinner and more delicate toward the periphery. Cells at the center of the indusium are more or less isodiametric and are commonly hexagonal or pentagonal. This general cell shape is also common near the edge of the indusium, although these cells are larger and more elongated radially (Plate 2, fig. 1). The indusium covers the sporangia completely and is often reflexed

until the undersurface is near or upon the lamina of the pinnule. Some sori appear to be nonindusiate, although the majority have the protective covering. At maturity, indusia were shed with their stalks, leaving the sporangia surrounding a cavity at the center of the sorus. Certain fertile specimens observed have soral impressions in which neither indusia nor sporangia were present. It is possible that either the entire sori were shed at maturity, or they were not preserved.

Mature sori with their indusia are rather large and essentially uniform in size for the entire length of the pinnule. They commonly range between 1.4 mm and 1.9 mm in diameter. Sori are circular, and each contains from seventeen to twenty-one sporangia, which are radial around the central placenta. Sporangia are annulate, with the annuli having a vertical position. Individual annular cells become broader toward the periphery of the sorus, causing the annuli to be closely appressed throughout their entire length (Plate 3, fig. 1). This creates a rather crowded condition within the sorus. Annular cells are commonly aligned between the sporangia, giving the appearance of a series of progressively larger concentric rings proceeding toward the edge of the sorus (Plate 2, fig. 2; Plate 3, fig. 1). It is impossible with present material to determine whether the sporangia are sessile or stalked.

Sori are not found at the extreme apex or base of the pinnule. Proceeding apically, they are normally encountered basally between the third and fourth major secondary veins, and are present for approximately 6/7 of the length of the pinnule (Plate 1, fig. 1).



TEXT-FIGURE 2.—Epidermal pattern on the upper (?) leaf surface near a major secondary vein (a) of *Astralopteris coloradica* (Brown) Reveal, Tidwell and Rushforth.

Soral venation has previously been reported as arising from both the midvein and the major secondary veins and converging at the sorus (Tidwell, *et al.*, 1967). Subsequent examination of pinnule transfers of fertile material has brought to light soral venation which differs slightly from that formerly reported.

A costal aerole is present on both sterile and fertile specimens. This aerole arises very near the point of origin of the secondary vein from the midrib and parallels the midvein (Plate 3, fig. 1C). This veinlet is quite prominent and merges with the next secondary vein apically at its point of origin. The result is the formation of a plexus of vascular tissue just above the midrib which is formed from the merge of the two costal aeroles with the major secondary vein (Plate 3, fig. 1B). Arising from this aerole are veinlets which lead to the sorus. These veinlets merge beneath the sorus with other veinlets which have originated directly from the major secondary veins forming the mass of vascular tissue previously described.

The habit of major secondary veins changes near the pinnule apex. Immediately apical from the last sorus on the pinnule (or perhaps somewhat before), the veins tend to be acute with respect to the midvein, until they assume approximately an angle of 45° or slightly less (Plate 3, fig. 2). The midvein remains prominent to the tip of the pinnule.

A marginal vein which entirely girdles the pinnule at its extreme margin is present. Occasionally, however, a thin portion of laminar tissue is observed external to this vein, although this is rare. The outermost ultimate veinlets of the pinnule merge with this marginal vein, producing at their junction a slightly expanded area of vascular tissue (Plate 2, fig. 2; Plate 3, fig. 1).

Distribution.—*Astralopteris* has been reported previously from two locations, both in the Dakota Sandstone (Text-fig. 1). These are located near Naturita, Montrose County, Colorado, which is the site of original collection, and near Westwater, Grand County, Utah. Although the Dakota Sandstone is variable in age throughout the western United States, a comparison of the floras from these two locations indicates that they are similar in age.

Recently, one of the authors (Rushforth) examined some of Roland Brown's collections from the western United States which are on deposit in the Smithsonian Institute, Washington, D.C. These collections are the property of the United States Geological Survey and the United States National Museum. Among the collections were specimens of *Astralopteris* from two locations not previously reported. These locations significantly extend the geographic and stratigraphic distribution of this genus.

Katich and Williams collected *Astralopteris* in 1951 from the Dakota Sandstone of the Navajo Indian Reservation in Longhouse Valley, Arizona, and Kayenta, Navajo County, Arizona (Text-fig. 1). These fossils were obtained from a mudstone layer three to six inches thick located approximately forty feet above the base of the Dakota Sandstone and thirty to forty feet below the *Gryphaea* zone in the basal Mancos Shale.

The other site from which *Astralopteris* was obtained is perhaps somewhat more significant in that it extends the stratigraphic distribution of this genus into younger rocks. This location is in the Frontier Formation on the south slope of Little Sheep Mountain near the Green River Lakes, Sublette

EXPLANATION OF PLATE 1

ASTRALOPTERIS COLORADICA (BROWN) REVEAL, TIDWELL,
AND RUSHFORTH

- FIGS. 1-2.—*Astralopteris coloradica* (Brown) Reveal, Tidwell, and Rushforth. 1. Portion of sterile pinnule (4X). BYU 1417. 2. Portion of a fertile pinnule (4X). BYU 1418. 3. An outer margin of pinnule lamina illustrating merging major secondary veins (a) into a marginal vein (b) (50X). BYU 1575. Note the anastomosing veinlets between the major secondary veins.

EXPLANATION OF PLATE 2

ASTRALOPTERIS COLORADICA (BROWN) REVEAL, TIDWELL,
AND RUSHFORTH

- FIGS. 1-2.—*Astralopteris coloradica* (Brown) Reveal, Tidwell, and Rushforth. 1. Indusium illustrating isodiametric cells near center and elongate cells near the periphery (50X). 2. Sorus with indusium removed (50X). BYU 1575.

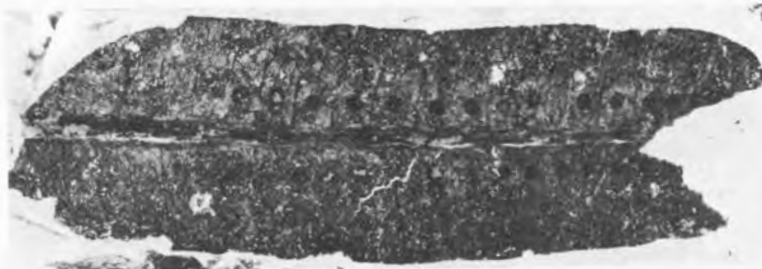
EXPLANATION OF PLATE 3

ASTRALOPTERIS COLORADICA (BROWN) REVEAL, TIDWELL,
AND RUSHFORTH

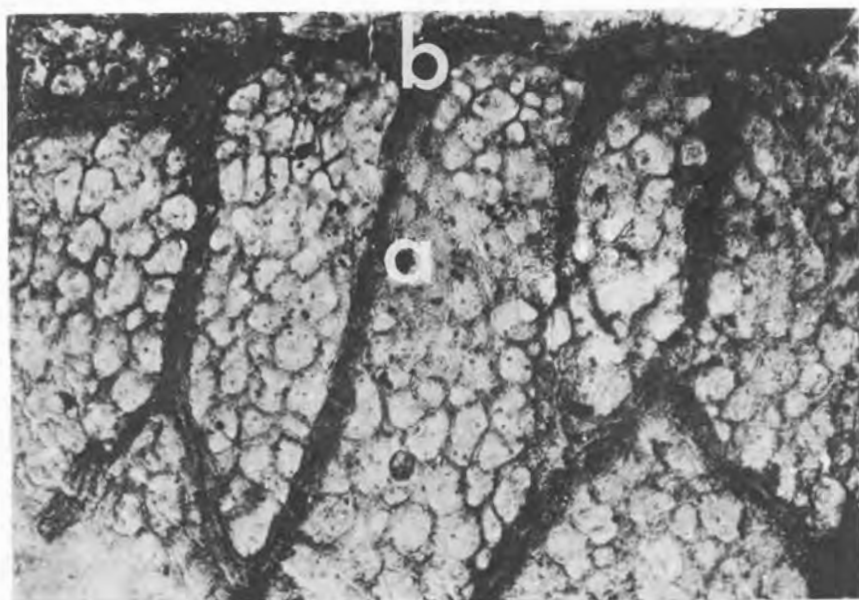
- FIGS. 1-2.—*Astralopteris coloradica* (Brown) Reveal, Tidwell, and Rushforth. 1. Enlargement of an indusium and a sorus with (a) midvein and (b) bifurcation of a major secondary vein into two (c) costal aroles. 2. Pinnule illustrating division of the midvein into major secondary veins and their merging into marginal veins.



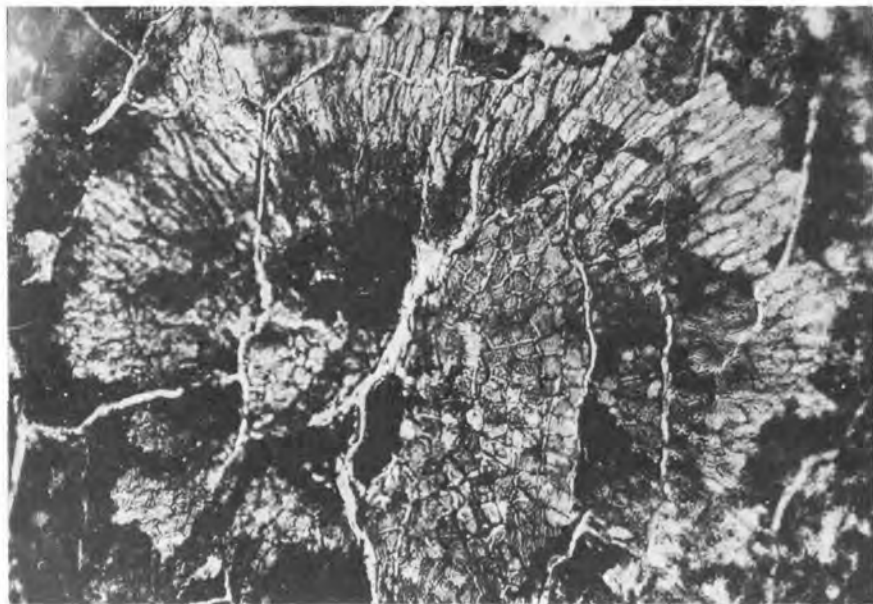
1



2



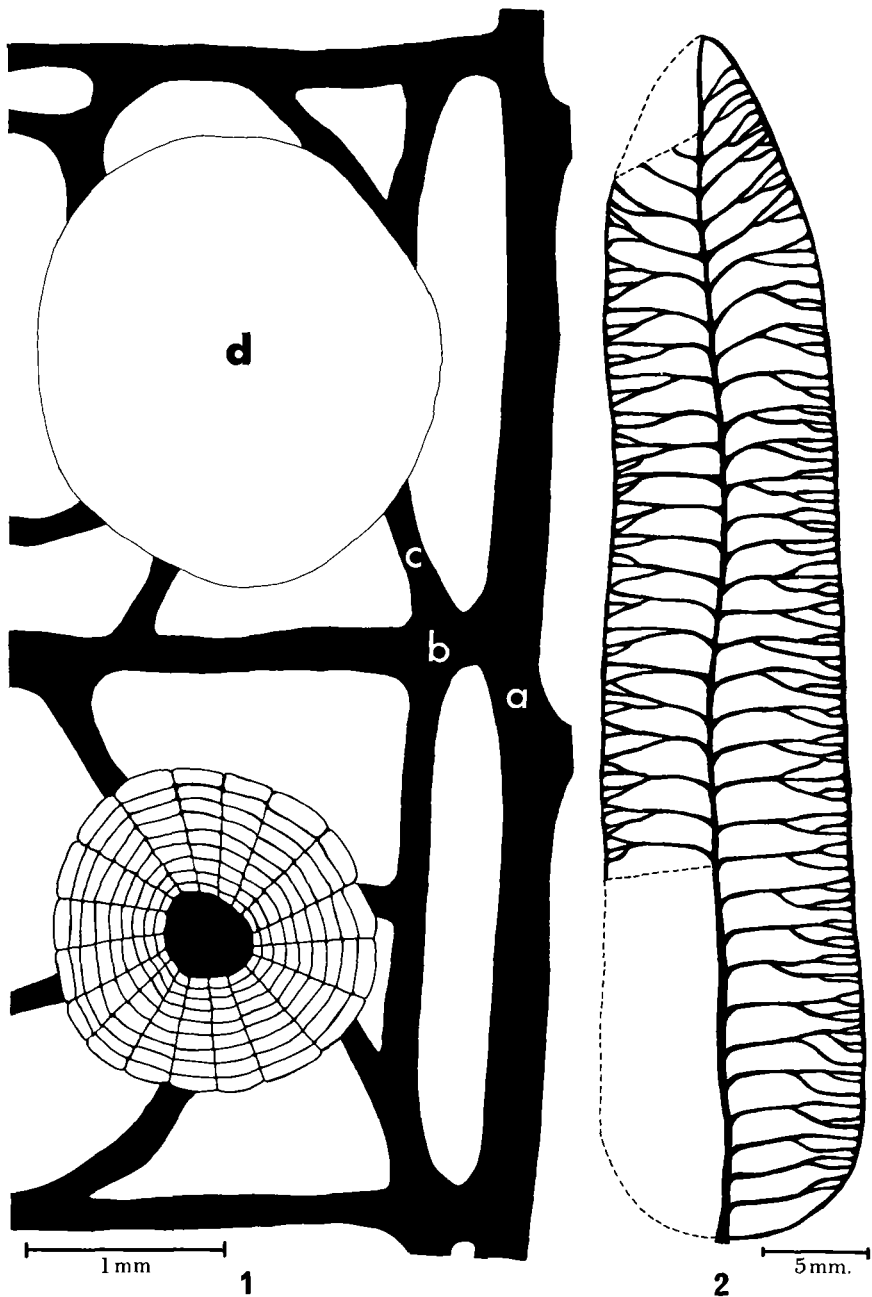
3



1



2



County, Wyoming. These specimens were collected by Love, Richmond, Pierce, and Reynolds.

Brown had examined the specimens collected at the latter site, and had tentatively labeled them as representing a new species of *Bolbitis*. However, the venation of the available specimens was imperfectly preserved, and it is impossible to ascertain any appreciable difference from *Astralopteris coloradica*. In addition, the external morphology of these specimens is essentially equivalent to that of the forms from the Dakota Sandstone, and, based upon present material, it is the opinion of the authors that the two forms are identical and referable to *A. coloradica*. Further collections of the Frontier Formation are soon to be undertaken, and it is hoped that more specimens of *Astralopteris* will be obtained.

Acknowledgments.—The authors wish to thank Dr. S. H. Mamay of the U. S. Geological Survey for the loan of a specimen of *Astralopteris*, and to Miss M. E. Hayball for technical aid in preparation of the figures. This study was financed in part by Brigham Young University Research Grant 115-77-482 to William D. Tidwell.

REFERENCES CITED

- Abbott, M. L., 1950, A paleobotanical transfer method: Jour. Paleont., v. 24, p. 619-621.
- Brown, R. W., 1950, Cretaceous plants from southwestern Colorado: U. S. Geol. Survey Prof. Paper 221-D, p. 45-65.
- Tidwell, W. D., S. R. Rushforth, and J. L. Reveal, 1967, *Astralopteris*, A new Cretaceous fern genus from Utah and Colorado: Brigham Young Univ. Geol. Studies, v. 14, p. 237-240.

Manuscript received May 10, 1968.

