1. CALL TO ORDER

A regular meeting of the Board of Aldermen was convened at 7:00 p.m. on Tuesday, March 21, 2017, at City Hall located at 8880 Clark Avenue, Parkville, Missouri, and was called to order by Mayor Nanette K. Johnston. City Clerk Melissa McChesney called the roll as follows:

Ward 1 Alderman Diane Driver	- present
Ward 1 Alderman Tina Welch	- present
Ward 2 Alderman Jim Werner	- present
Ward 2 Alderman Dave Rittman	- present
Ward 3 Alderman Robert Lock	- present
Ward 3 Alderman Douglas Wylie	- absent with prior notice
Ward 4 Alderman Marc Sportsman	- present
Ward 4 Alderman Greg Plumb	- present

A quorum of the Board of Aldermen was present.

The following staff was also present: City Administrator Joe Parente
Kevin Chrisman, Police Chief
Alysen Abel, Public Works Director
Stephen Lachky, Community Development Director
Matthew Chapman, Finance/Human Resources Director
Tim Blakeslee, Assistant to the City Administrator
Chris Williams, City Attorney

Mayor Johnston led the Board in the Pledge of Allegiance to the Flag of the United States of America.

Mayor Johnston observed a moment of silence for Toni Anderson.

2. CITIZEN INPUT

A. Park University Fossil Presentation

Scott Hageman, Tim Northcutt, Patty Ryberg and Brian Hoffman from Park University presented information about a new fossil that was found by amateur paleontologist Tim Northcutt on university property. A handout was distributed during the meeting attached as Exhibit A. They stated that Parkvillia northcutti was considered to be a link between conifers and ferns and the earliest evidence of seeds.

B. Downtown property owner comments on Parkville Old Towne Market Community Improvement District slate

Mike Emmick, owner of Edward Jones and 3 properties downtown, said that he moved his business to downtown in 2009 and many of the Parkville Old Towne Market Community Improvement District (POTMCID) members were on the Board of Directors at that time. He served for a period of time but resigned. He said that many in downtown would like to get involved with the POTMCID but were told there were not any positions on the Board. Emmick noted that it was hard to get involved when people were not able to make a difference.

Hilary Murray, property owner of 109 Main and 111 Main, said that she bought the properties because her family lived in Parkville and downtown had amenities that most commercial developers would like to recreate but were unable to because of time. She noted that with the current POTMCID slate downtown was not moving the vision forward. Murray said there were opportunities to create more transparency and it would be beneficial to conduct an audit to analyze how the money was being spent. She said that in the past good decisions were made and she would like to see it continue to move forward.

Alderman Sportsman commented on the lack of transparency of the POTMCID and Alderman Plumb said that it was a separate government entity and the City did not have oversight. Mayor Johnston said that the rejection of the slates was not because of a personality conflict and it was not a fair and balanced board.

Mayor Johnston recognized members of the Boy Scouts of America. One scout from Troop 314 was working on his Communications merit badge and one scout from Troop 333 was working on his Citizenship in the Community merit badge.

3. CONSENT AGENDA

A. Approve the minutes for the March 7, 2017, regular meeting

B. Receive and file the January Municipal Court report

C. Receive and file the financial report for the month ending February 28, 2017

D. Receive and file the crime statistics for January 2017

E. Approve the second reading of an ordinance to amend Parkville Municipal Code chapters 515, 520 and 700 and to repeal Section 850.200 to revise the development fee structure associated with the construction of public improvements

F. Approve the second reading of an ordinance to repeal Parkville Municipal Code Chapter 840 and Section 850.010 and to amend Chapter 800 regarding zoning and building/construction fees

G. Approve Resolution No. 17-010 to set zoning, building/construction and Public Works-related development fees in the Schedule of Fees

H. Approve the second reading of an ordinance to amend the established 9 Highway Corridor Community Improvement District, direct the City Clerk to report the amendment of the district to the Missouri Department of Economic Development and authorize certain documents and prescribing other matters relating thereto

I. Approve the purchase and installation of a new Mitel 250 Phone System with Electronic Office Systems for Parkville City Hall, the street shop and Parks headquarters

J. Approve the purchase of a new Ford Taurus All Wheel Drive Police Interceptor Sedan vehicle to be used as a patrol vehicle from Thoroughbred Ford

K. Approve a professional services agreement with TranSystems for the design of the Downtown Streetlight Project

L. Approve accounts payable from March 2 through March 17, 2017

At the request of Alderman Sportsman, item 4K was removed from the consent agenda for further discussion and a separate motion.

IT WAS MOVED BY ALDERMAN SPORTSMAN AND SECONDED BY ALDERMAN DRIVER TO **APPROVE THE CONSENT AGENDA AND RECOMMENDED MOTIONS FOR EACH ITEM, AS AMENDED**. ALL AYES BY ROLL CALL VOTE: PLUMB, WERNER, DRIVER, WELCH, RITTMAN AND SPORTSMAN. MOTION PASSED 7-0.

K. **Approve a professional services agreement with TranSystems for the design of the Downtown Streetlight Project**

Public Works Director Alysen Abel stated that the City previously had an informal agreement with the Main Street Parkville Association (MSPA) for maintenance of the downtown street lights that expired in May 2016. The City was responsible for basic repairs and maintenance including light bulbs, rewiring and light globes. Staff hoped to enter into an agreement with MSPA to capture maintenance over a longer period of time.

Abel said that in fall 2016 downtown merchants approached the City and requested that the street lights be extended to Main Street. Staff reached out to TranSystems, who completed the design of the Downtown Entryway Beautification Project, to prepare a design to replace 22 existing lights which was estimated at $12,500. Abel noted that the existing brick sidewalk would also have to be replaced, but it was not part of the deign process.

Abel said that the City applied for a grant through the POTMCID and instead received a check from MSPA for the total amount to cover the cost of the design; MSPA then submitted a grant application to the POTMCID for reimbursement of the funds. The POTMCID approved the grant application for MSPA on March 7, 2017, and the only expense to the City would be to replace the brick sidewalk. She noted that staff would have a better idea of the unit prices after the bid opening on March 29 from the curb and sidewalk bid.

Alderman Sportsman said that the Finance Committee discussed the item on March 13 and was concerned because of the uncertainty that the POTMCID would not cover the cost of the specialty lights after the first year. The Committee wanted a longer-term commitment from the POTMCID.

The consensus of Board was to postpone approval of the agreement until the City received assurance from the POTMCID Board that it would fund the additional cost of the specialty lighting.

IT WAS MOVED BY ALDERMAN SPORTSMAN AND SECONDED BY ALDERMAN DRIVER TO **POSTPONE APPROVAL OF THE PROFESSIONAL SERVICES AGREEMENT WITH TRANSYSTEMS FOR THE DESIGN OF THE DOWNTOWN STREETLIGHT PROJECT**. ALL AYES; MOTION PASSED 7-0.

4. ACTION AGENDA

A. Approve the first reading of an ordinance to amend Parkville Municipal Code Chapter 150, Section 150.150 regarding the removal of dead trees

Assistant to the City Administrator Tim Blakeslee stated that in June 2016 staff received a complaint of dead trees on private property downtown. Per the Parkville Municipal Code, the Community Land and Recreation Board (CLARB) could compel their removal within 60 days. At its March meeting, CLARB voted to approve the removal of the dead trees from the property but did not understand why they were involved in the process. CLARB recommended moving the process to code enforcement in the Community Development Department. Blakeslee added that a certified arborist would help determine if trees were dead and deem them hazardous.

IT WAS MOVED BY ALDERMAN SPORTSMAN AND SECONDED BY ALDERMAN DRIVER TO APPROVE BILL NO. 2924, AN ORDINANCE **AMENDING SECTION 150.150 OF THE PARKVILLE MUNICIPAL CODE REGARDING DEAD TREE REMOVAL**, ON FIRST READING AND POSTPONE THE SECOND READING TO APRIL 4, 2017. ALL AYES; MOTION PASSED 7-0.

B. Adopt an ordinance to repeal Ordinance No. 2822 and approve an agreement with the Missouri Department of Transportation for maintenance of Highway 45 from Route 9 to Route K

Public Works Director Alysen Abel said that when staff was involved in the initial stages of the Highway 45 Widening Project – Phase C it was discovered that there was not an agreement for maintenance of the Phase B. In November 2015 the Board approved an agreement for maintenance of Phase B but found out it was not the most current version of the Missouri Department of Transportation (MoDOT) agreement and needed to be redone. Staff was not comfortable with the indemnification clause because it did not follow state statutes. The revised agreement resolved the issue and was acceptable to the city attorney. The second concern with the revised agreement related to insurance because the amount far exceeded what the City had in its contract documents. Abel noted there was very little flexibility in the MoDOT agreements and the only time the City would run into an insurance issue was when a full replacement of the trail was required.

The agreement included right-of-way mowing and asphalt trail maintenance from Route 9 to Route K.

IT WAS MOVED BY ALDERMAN SPORTSMAN AND SECONDED BY ALDERMAN DRIVER TO APPROVE BILL NO. 2925, AN ORDINANCE **REPEALING ORDINANCE NO. 2822 AND AUTHORIZING A MAINTENANCE AGREEMENT WITH THE MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION OF THE DEPARTMENT OF TRANSPORTATION FOR THE WIDENING OF ROUTE 45-PHASE B IN PLATTE COUNTY**, ON FIRST READING. ALL AYES; MOTION PASSED 7-0.

IT WAS MOVED BY ALDERMAN SPORTSMAN AND SECONDED BY ALDERMAN DRIVER TO APPROVE BILL NO. 2925 ON SECOND READING BY TITLE ONLY TO BECOME ORDINANCE NO. 2894. ALL AYES BY ROLL CALL VOTE: PLUMB, WERNER, DRIVER, WELCH, RITTMAN AND SPORTSMAN. MOTION PASSED 7-0.

C. Receive and file the Lewis Street and Missouri Highway 45 Traffic Engineering Assistance Program report prepared by Affinis Corp

Public Works Director Alysen Abel stated that the City received Traffic Engineering Assistance Program funds from MoDOT to study the median break at Lewis Street south of Route 45. Affinis Corp completed the study that included three recommendations to address the traffic issues.

Lee Baer, Affinis Corp, provided an overview of the three concepts and associated costs; attached as Exhibit B. He said all three options would maintain a Level of Service A and the main concern was safety at the intersection and median break.

IT WAS MOVED BY ALDERMAN SPORTSMAN AND SECONDED BY ALDERMAN DRIVER TO **RECEIVE AND FILE THE LEWIS STREET AND MISSOURI HIGHWAY 45 TRAFFIC ENGINEERING ASSISTANCE PROGRAM REPORT PREPARED BY AFFINIS CORP AND TO DIRECT STAFF TO INCLUDE THE CONSTRUCTION OF CONCEPT 2 IN THE 2018 CAPITAL IMPROVEMENT PROGRAM AS THE BUDGET ALLOWS.** ALL AYES; MOTION PASSED 7-0.

D. Approve a small construction services agreement with Capital Trucking for the 2017 Street Sweeping Program

Public Works Director Alysen Abel stated that the City hired a third-party contractor to clean the city streets annually in the spring and fall. A bid opening was held on March 7 and three bids were received. The City had worked with two of the bidders in the past but not with Capital Trucking, the low bidder. Staff reached out to them to find out about their operations and learned that they were new to the operation, had one sweeper and it would take approximately two weeks to complete the sweeping.

The Finance Committee directed staff to acquire references. Staff received favorable comments and found out from the company that they had not worked for a municipality before but swept construction sites and worked with private companies to sweep parking lots. Staff was hesitant because of the company's lack of experience in the process and that they would only work with one truck and one operator. The agreement with the contractor included provisions regarding Correction of Work and Termination that offered additional protection for the City in case any issues arose. She noted that agreement set the maximum hours at 60 hours for both seasons.

IT WAS MOVED BY ALDERMAN SPORTSMAN AND SECONDED BY ALDERMAN DRIVER TO **APPROVE THE SMALL CONSTRUCTION SERVICES AGREEMENT WITH CAPITAL TRUCKING FOR THE 2017 STREET SWEEPING PROGRAM IN AN AMOUNT NOT TO EXCEED $15,600**. ALL AYES; MOTION PASSED 7-0.

6. STAFF UPDATES ON ACTIVITIES

City Administrator Joe Parente said that he and Mayor Johnston attended the Platte County Commission meeting where they approved outreach grants for the Friends shelter and Phase 2 of the English Landing Park restroom renovations.

Public Works Director Alysen Abel reminded the Board that the grand re-opening of the restrooms in English Landing Park was scheduled for March 30.

Police Chief Kevin Chrisman commented on the issues that occurred in Platte Landing Park and thanked everyone for their help.

Mayor Johnston noted that Assistant to the City Administrator Tim Blakeslee attended a meeting with international students about involvement in the community.

7. MAYOR, BOARD OF ALDERMEN & COMMITTEE REPORTS & MISCELLANEOUS ITEMS

Alderman Sportsman said that the National Council for Home Safety and Security ranked Parkville as one of 50 safest cities in Missouri. Police Chief Kevin Chrisman credited the community for reporting suspicious activity.

Mayor Johnston said she and City Administrator Joe Parente attending a Platte County Commission meeting and Platte County Economic Development Council meeting. She also toured the streets and parks facilities and attended the Banneker Foundation Breakfast, Feed Northland Kids event, Mid-America Regional Council Total Transportation Policy Committee meeting, Kansas City Rising two year update and a community meeting regarding the Broadway Bridge repair and replacement project. She also noted that she and Public Works Director Alysen Abel were part of a panel discussion at Park University regarding women in male-dominated professions.

Alderman Welch said planned to have conversations with staff and the Mayor about surveillance in the parks.

8. ADJOURN

Mayor Johnston declared the meeting adjourned at 8:38 p.m.

The minutes for Tuesday, March 21, 2017, having been read and considered by the Board of Aldermen, and having been found to be correct as written, were approved on this the fourth day of April 2017.

Submitted by:

Melissa McChesney
City Clerk Melissa McChesney

SEAL OF THE CITY OF PARKVILLE
PLATTE
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MISSOURI

Review of Palaeobotany and Palynology 234 (2016) 136–146

Contents lists available at ScienceDirect

Review of Palaeobotany and Palynology

journal homepage: www.elsevier.com/locate/revpalbo

A new Pennsylvanian pollen organ from northwestern Missouri with affinities in the Lyginopteridales

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ARTICLE INFO

Article history:
Received 5 April 2016
Received in revised form 17 June 2016
Accepted 21 June 2016
Available online 25 June 2016

Keywords:
Lyginopteridaceae
Pennsylvanian
Pollen organs
Seed ferns
Pteridosperms

ABSTRACT

An Upper Pennsylvanian locality (Bonner Springs Shale, Kansas City Group, Middle Missourian) in western Missouri contains a diverse and well-preserved fossil assemblage of both plants and arthropods. The plants are preserved as impressions and compressions, and include fertile and vegetative remains of various sphenopsids, lycopsids, ferns, seed ferns, cordaites and conifers. The discovery of a branching system with lyginopterid pollen organs, *Parkvillia northcuttii*, demonstrates that this group of Paleozoic seed ferns was more diverse and complex than previously known. The fertile structure is characterized by multiple levels of branching with the penultimate branches alternately arranged; ultimate rachises bearing 6–10 alternately arranged, slightly flattened, shield-shaped synangia. Synangia are approximately 5 mm in diameter and each consists of a cap with up to 18 sporangia attached to the abaxial surface. The radial and trilete pollen is ornamented by grana and coni. Also in the assemblage are small radially symmetrical ovules and sphenopterid foliage, suggesting that this assemblage contains multiple lyginopterid taxa. The orientation of sporangia and features of the synangia, together with the three-dimensional branching, indicate a morphological pattern that has not been recognized within the Lyginopteridaceae.

1. Introduction

Initially discovered in 1988, the fossil locality on the campus of Park University in Parkville, Missouri, USA, has generated a diverse and well-preserved assemblage of Upper Pennsylvanian plants and animals (Tim Northcutt, personal communication; Krings et al., 2006). A number of typical Carboniferous floral components have been recognized, including sphenophytes (*Annularia, Asterophyllites, Calamites, Calamostachys, Sphenophyllum*), lycopsids (*Asolanus, Lepidocarpon, Lepidophylloides, Lepidophyllum, Lepidostrobophyllum, Lepidostrobus,* isolated megaspores), ferns (*Alloiopteris, Asterotheca, Pecopteris*), seed ferns (*Alethopteris, Aphlebia, Neuropteris, Odontopteris, Sphenopteris,* various-sized ovules), cordaites (*Cardiocarpus, Cordaitanthus, Cordaites* leaves), and at least one type of walchian conifer. Animal remains are less frequently encountered but several taxa have been identified and can be attributed to the Paleodictyoptera, Blattodea, and Plecoptera. As a result of the abundance, completeness, and detailed preservation of the plant specimens from these various groups, it would now be possible in future studies to more accurately reconstruct a number of the individual organisms, and to offer a hypothesis about some of the interactions that took place within this Pennsylvanian ecosystem.

Detailed preservation of the morphology and, in some instances, anatomy are the result to a large degree of the finely structured matrix at this locality which varies from slightly coarse-grained, sand-sized particles to fined-grained silt. Plant fossils found within the finer-grained sediments often show greater morphological details and in some instances are three-dimensionally preserved within a limonitic matrix. Interestingly, some specimens are also well preserved within the coarser-grained sediments. The delicate nature of a number of plant parts including certain types of fern pinnae, together with the size, organization, and absence of acute disarticulation suggests that the plant remains underwent minor transport and were deposited by relatively calm depositional cycles close to where they grew.

Since the initial recognition of seed ferns there have been numerous reports of pollen organs from multiple localities around the world and new discoveries are continuing to demonstrate an extraordinary diversity in organization and morphology (e.g., Kidston, 1884, 1906;

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http://dx.doi.org/10.1016/j.revpalbo.2016.06.003
0034-6667/

Sellards, 1902; Halle, 1942, Andrews and Mamay, 1948; Skog et al., 1969; Eggert and Taylor, 1971; Thomas and Crampton, 1971; Jennings, 1976; Millay and Taylor, 1977, 1978; Mapes and Schabilion, 1981; Rothwell, 1981; Brousmiche, 1982; Mapes, 1982; Stubblefield et al., 1982; Stidd et al., 1985; Meyer-Berthaud and Galtier, 1986; Meyer-Berthaud, 1989; Laveine et al., 1993; Drinnan and Crane, 1994; Orlova et al., 2009; Pacyna and Zdebska, 2010; Feng et al., 2014; Barthel and Brauner, 2015). Details regarding the morphology of compression/impressions, and in some cases the anatomy of permineralized specimens, has made it possible to assign disparate organs to one of a number of well-defined seed fern families (e.g., Lyginopteridaceae, Medullosaceae, Callistophytaceae) (Taylor et al., 2009). Although these groups share various structural reproductive characteristics, assignment of taxa is often based primarily on the type of pollen found within the sporangia. Lyginopterid seed ferns produce small circular trilete prepollen grains (Millay et al., 1978) with a uniformly homogeneous sporoderm, a thin nexine, and a thicker exine. Medullosan seed ferns produce large elliptical pollen grains characterized by an alveolate exine (Millay et al., 1978; Stidd, 1981; Meyer-Berthaud and Galtier, 1986; Dunn, 2006), while callistophytalean seed ferns produce distinct saccate grains (Rothwell, 1981; Taylor and Taylor, 1987). Pollen grains isolated from the sporangia of the pollen organs reported here are of the lyginopterid type. Additional features of the branching system and organization of the synangia support the inclusion of the reproductive structure reported here as a new pollen organ type within the Lyginopteridaceae.

2. Geological setting

The Bonner Springs Shale represents the cap of the Upper Pennsylvanian (Kasimovian; Missourian; Text Fig. 1). The sequence varies in thickness in the Kansas City area (USA) from 30 cm to over 21 m with a common thickness of 5 to 10 m (O'Connor, 1971; Knapp and French, 1991). This shale is currently understudied when compared with other units in the Kansas City Group but the lower half of the unit has been generally described as being composed mainly of continental clastics and detritus deposited during a time of maximum regression. The upper sequence is interpreted to have been deposited in a nearshore marine environment with isolated reports of limestone, conglomerates, and coal seams in the uppermost portions of some sections (Text Fig. 1; O'Connor, 1971; Merriam and Merriam, 1991). The paleoecological setting has been interpreted as nonmarine to nearshore marine, depending on the location within the deltaic complex which corresponds to a shale unit of a Kansas cyclothem (Heckel, 1986). This variability in facies corresponds to the occurrence of floral components in the lower section and invertebrates, such as gastropods and pelecypods, in the uppermost portions (O'Connor, 1971; Gentile, 2011).

Specimens collected at the Park University locality to date include at least 16 plant genera, three orders of hexapods including Paleodictyoptera, Blattodea, and Plecoptera, and a few trace fossils that are present in both the marine and terrestrial sediments. The preservation of cuticle on some specimens suggests a unique depositional environment and a detailed stratigraphic analysis of the locality indicates an 8 m thick section that is interpreted as a shallow, tidally influenced estuarine setting. The sediments at the locality show distinct laminations throughout the section that are similar in appearance to varves. In the absence of any evidence suggesting a lacustrine setting, these sediments are interpreted as tidally derived laminations in an estuary that was juxtaposed to a Carboniferous ecosystem dominated by arborescent lycopsids, ferns and seed ferns. The plant fossil material is well preserved and often distributed in clusters that sometimes include insect remains, suggesting that minimal, low-energy transport occurred.

Details of the laminations reflect neap-spring tidal cycles that would bring high rates of sediment deposition and rapid burial of decaying organics. This is in part supported by leaf specimens (e.g., *Lepidophylloides*, *Cordaites*) which are commonly contorted three-dimensionally through the deposits as a result of their long length. The lack of disruption of the leaf laminae further suggests that bioturbation was minimal. Daily or monthly tides in a mud, silt, sand-rich environment that produces alternating fine-coarse laminations could result in turbid waters, thus making the environment inhospitable for epifaunal invertebrates. The absence of infaunal invertebrates in these tidal settings is most likely due to anoxic pore water (Feldman et al., 1993). Salinity fluctuations or stratification have also been suggested as producing tidally dominated deposits with cyclic tidal rhythmites (Feldman et al., 1993; Wells et al., 2007), which would apply to the Late Pennsylvanian Midcontinent Seaway where an estuary would experience microtidal fluctuations (<2 m tidal range; Wells et al., 2007). Further support for large salinity fluctuations inhibiting water-body mixing would be further evidence that stratification of sediments would occasionally be marked by coarse sandstone lenses (Wells et al., 2007).

At the 4 m level in the section there is a 30 cm thick sandstone deposit that does appear to represent a variation in deposition because it contains the only in situ flora at the locality where multiple *Calamites* stems are all oriented in a NE-SW trend. This is suggested to represent a storm deposit within a single event with subsequent rapid burial. Fossils are also present above this deposit in the Bonner Springs Shale; however, the upper 4 m is not as fossiliferous and the sediment includes increasing percentages of sand with a higher content of mica, suggesting closer proximity to a deltaic complex.

3. Materials and methods

The fossil material generally occurs as impression-compressions but a number of pollen organs are three-dimensionally preserved in limonite which makes it possible to examine some anatomical features. This was accomplished by removing some of the pollen organs from the matrix and embedding them in Ward's Bio-Plastic™ liquid casting plastic. The cured blocks were trimmed, cut into approximately 1 mm thick wafers on a Buehler IsoMet® low speed saw, and mounted on glass slides with Eukitt (O. Kindler GMBH & Co.) mounting medium for microscopic examination and imaging. Several specimens were dégaged to elaborate additional morphological features of individual synangia and the three-dimensional organization of the branching system. Images were taken with a Nikon D300s digital single-lens reflex camera using high-intensity fluorescent polarized light sources. Micromorphological and anatomical details were captured with a Leica DC500 digital camera on a Leica MZ 16 stereo dissecting microscope. Scanning electron microscope images were captured with a LEO 1550. All images were processed with Adobe Photoshop CS2. Materials are housed at the Department of Natural and Physical Sciences, Park University, Parkville, Missouri, USA, under the acquisition numbers PUPC (Park University Paleobotanical Collection) 3001–3037 and the Division of Paleobotany, Biodiversity Institute (KUPB), University of Kansas, Lawrence, Kansas, USA, under the acquisition number P 4218.

4. Systematic description

Class: Spermatopsida Serbet and Rothwell, 1995
Order: Pteridospermales Sporne, 1974
Family: Lyginopteridaceae Takhtajan, 1953
Parkvillia Serbet et al., gen. n.
Generic diagnosis:

Three-dimensionally branching fertile frond lacking sterile foliage; fertile pinnae alternate with penultimate branches bearing alternately arranged synangia-bearing units. Synangia radial consisting of whorls of 12–18 laterally fused sporangia embedded within ground tissue; central area of pollen organ consisting of a chamber subtended by thin

tissue that seals distal part of synangia; synangia attached proximally by a short stalk. Prepollen within synangia trilete with homogenous wall.
Etymology: Named for the town of Parkville and Park University where the specimens were discovered.
Type species: *Parkvillia northcuttii*
Parkvillia northcuttii - Serbet et al., sp. n. (Plates I, II, Figs. 2, 3J, 4, 5)
Specific diagnosis:

Pinnate fertile frond with at least four levels of division. Primary axis 2.5 cm in diameter with a single lateral with fertile pinnae each consisting of short laterals bearing a terminal synangium on a reduced stalk. Lateral fertile rachises with various morphologies: first diverging axis 5.0 mm in basal diameter, with alternately arranged penultimate rachises that have alternate synangia attached by short stalks; larger axis with up to 4 diverging fertile rachises. Each axis with alternately arranged, pinnately compound fertile units. Synangia 4 × 6 mm each consisting of a proximal cap, middle thick brim area, and thin distal triangular flaps covering sporangia; synangium slightly oblong to elongate, outer surface with numerous orbiculate gland-like structures. Each synangium radial with up to 18 sporangia, each 1.5 mm long and 0.5 mm wide arranged in a single whorl and laterally embedded within the tissues of the cap. Pollen circular, 45 μm in diameter, and ornamented by coni and grana.
Holotype (*hic designatus*): Specimen PUPC 3000 (part), PUPC 3001 (counterpart) (Plate I, 1, 2; Plate II, 1, 2; Text Figs. 2, 3J, 5).
Paratypes: Specimens PUPC 3005 (not figured), 3007 (Plate I, 3; Plate II, 3, 4), 3008 (Plate II, 11–13), 3021 (Plate II, 10; Text Fig. 1, 2).
Etymology: Named in honor of Timothy Northcutt, amateur collector, who brought the material to our attention and for his continuing diligence and expertise in excavating the Park University Locality.
Repositories: Department of Natural and Physical Sciences, Park University, Parkville, Missouri 64152, USA; Division of Paleobotany, Biodiversity Institute (KUPB), University of Kansas, Lawrence, Kansas 66045, USA.
Collection Locality: Campus of Park University, Parkville, Missouri, USA. (39° 11′ 30.89″ N, 94° 40′ 34.26″ W).
Age: Late Pennsylvanian
Stratigraphic horizon: Bonner Springs Shale (Kansas City Group, Missourian Stage)

5. Description

Several specimens make it possible to characterize the organization of the fertile rachises and the morphology of the attached pollen organs. The most complete specimen is represented by a three-dimensional structure that shows an unusual and complex branching pattern (Plate I, 1, 2). The primary axis is 2.5 cm wide at the base and tapers distally to approximately 2.0 cm in the most complete specimen. This axis gives rise to secondary rachises (Plate I, 1). The axis illustrated in Plate I, 1 at A appears to be in a subtending position (see also Text Fig. 1, 1); however, we believe that this position is the result of it being flattening and somewhat displaced during preservation. This lateral axis also has several alternately arranged fertile segments (Plate I, 1, at black arrows) and is nearly identical in morphology to those found on the main fertile region (Plate I, 1, C–E). A small incomplete pinna (Plate I, 1 at B) is attached to the main axis in the same area as the fertile branches, but the complete morphology of this structure remains unclear.

The large axis bears at least four fertile units (Plate I, 1 at A, C–E) that diverge from one side. Each of these penultimate branches (Plate I, 1 at A, C–E) average 1.5 mm in diameter at the base and produce smaller, alternately arranged fertile segments (ultimate rachises). Individual segments typically have six alternately arranged synangiate pollen organs, however, up to ten synangia occur on some specimens. (Plate I, 3). These pollen-bearing units are sometimes preserved as three-dimensional limonitic structures (Plate II, 1–4, 7–10) or more commonly as coalified compression/impressions (Plate I, 2). Because the large fertile frond (Plate I, 1) has been uncovered at different levels within the matrix we interpret the axis as three-dimensional rather planar (Plate I, 1; Text Fig. 5 – each color represents a different level, red being the most superficial and blue being the deepest). No laminar structures are present on any of the rachises of *Parkvillia northcuttii*.

The synangiate pollen organs are approximately 5 mm in diameter at the widest point (Plate II, 2, 4) and attached by a centrally positioned short stalk that arises from a dome-shaped apex (Plate II, 2, at arrow), suggesting that the individual pollen organs were radially symmetrical. Individual pollen organs include a cap (C), the equatorial ring (= brim, B), and a base (T; Plate II, 1). Epidermal cells of the cap radiate outward from the region of the stalk and appear thickened (Plate II, 3). The equatorial ring subtends the cap producing a prominent ridge (Plate II, 1, 4). Distal to the ring (base) is a whorl of triangular-like projections that have a thin papery appearance (Plate II, 3, 4). On some pollen organs these flaps are mostly closed (Plate II, 4) although some are more open (Plate II, 3). Sporangia are arranged in a whorl (Plate II, 2). Evenly distributed on the outer surface of the pollen organ are small gland-like structures (Plate II, 14). These structures may have functioned as a first line of defense against herbivores and pathogens (Biere et al., 2004)

Each synangium consists of up to 18 sporangia, each 1.5 mm long and 0.5 mm wide (Plate II, 2, 5), arranged in a whorl on the interior lower surface of the cap (Plate II, 1, 2, 10). The proximal ends of the sporangia are embedded within the cap and attached to each other laterally (Plate II, 7). In several specimens the inner most region of each pollen sac shows an area of thin-walled cells that may represent a dehiscence zone involved in pollen dispersal (Plate II, 9, at arrow).

Isolated pollen sacs show elongate surface striations that represent the impression and coalified remains of epidermal cells (Plate II, 5). Plate II, 6 is an exposed in-situ pollen cluster that was removed from a pollen sac and prepared for SEM. Although the preservation of the individual grains was less than optimal they do show some morphological features like those produced by other lyginopterid pollen organs. Pollen grains are approximately 45 μm in diameter and based on overall symmetry, appear to be trilete (Plate II, 11). Surface features are poorly preserved but do show ornamentation features such as coni (Plate II, 12). The pollen grain wall appears to be homogeneous (Plate II, 13).

One of the interesting aspects of the Parkville site is that a number of the plants demonstrate multiple preservational modes, some showing internal preservation. As a result it is possible to correlate coalified compression specimens with those that demonstrate degrees of internal preservation. For example, somewhat more tangential serial sections indicate that the synangia are actually embedded within the tissues of the cap (Plate II, 7, triangular area) and that the individual sporangia are circular and form a ring around a hollow central area (Plate II, 7). In a transverse section of a synangium midway through the cap, the sporangia are more elongate indicating that their orientation was not pendulous (Plate II, 10; Text Fig. 4). The region of dehiscence is indicated by a longitudinal zone on the inner surface of each pollen sac, i.e., oriented toward the central region of the pollen organ (Plate II, 9). Thus the central, distal area of the synangium was open and pollen dispersed into the cavity prior to exiting the pollen organ (Plate II, 10 at C). Under laying the cavity and sporangia is a thin layer of tissue that acts as a sealing and dispersal mechanism. This layer of tissue becomes segmented (Plate II, 4, 8) and ultimately provides an opening for the dispersal of pollen.

5.1. Associated foliage and ovules

Several types of Lyginopterid fronds with pinnules of *Sphenopteris* and exhibiting varying sizes and level of complexity occur at the Parkville site (Plate III, 1). Some of these are found in the same layers

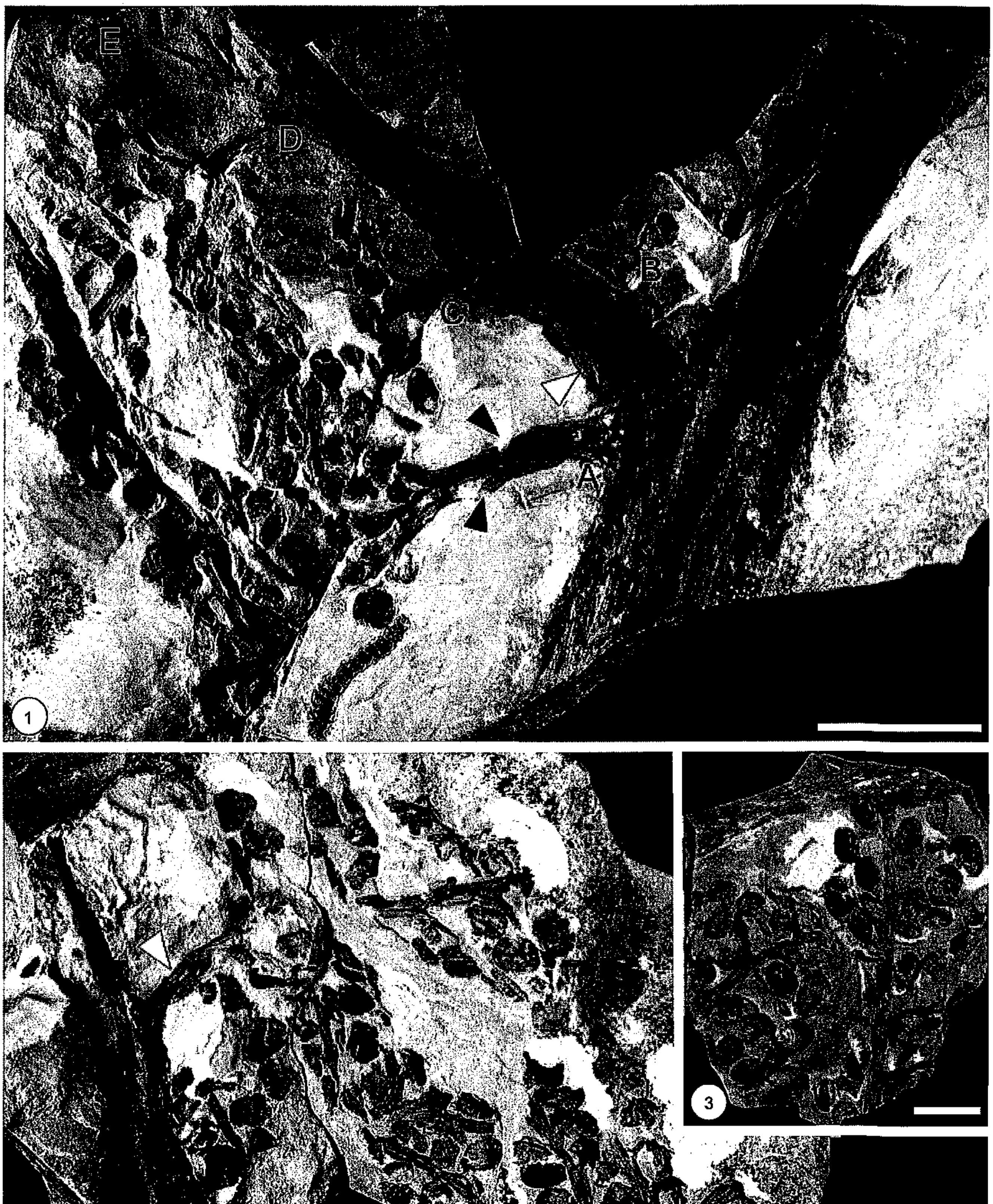

Plate I.

as the pollen organs, along with small ovoid lyginopterid-type ovules, 3–4.5 mm wide by 2–6.5 mm long (Plate III, 2, 3, 4). Although the pollen organs are not organically attached to any of these foliage remains, this relationship of seeds and foliage is a characteristic of lyginopterid seed ferns (Seward, 1917). The small isolated ovules that co-occur with *Parkvillia* are perhaps most similar to the permineralized ovules *Conostoma oblongum* based on size (Long, 1977). Both the Parkville and *Conostoma* seeds have a dome-shaped pollen chamber (Plate III, 4 at PC) and a cylindrical micropyle (Plate II, 4 at arrow).

6. Discussion

6.1. Frond morphology

The three-dimensionally branching fertile rachises described here document the presence of a complex lyginopterid pollen-producing structure. Morphology and a limited number of anatomical features of *Parkvillia* are similar to those of *Crossotheca*, *Feraxotheca* (Millay and Taylor, 1979), *Potoniea* (Schultka, 1995) and *Canipa* (Skog et al., 1969). Other features, however, fall outside the circumscription of these genera. The largest and most informative specimen from Parkville represents a small portion of a much larger frond system that consisted of a robust primary axis (2.5 cm in diameter) bearing at least four major and one minor laterally attached rachises, all demonstrating a three-dimensional branching system (Text Fig. 5). The basal-most axis (Plate I, 1 at A) is positioned below and slightly offset from the larger axis (Plate I, 1 white arrow) and a smaller incomplete axis occurs at B (Plate I, 1). Attached to the penultimate rachises A, C, D and E (Plate I, 1) are up to fourteen alternately arranged ultimate axes each with up to ten alternately arranged synangiate pollen organs (Plate I, 3; Text Fig. 2). The exact morphology of the small laterally positioned segment seen at B (Plate I, 1) could not be determined as a result of incomplete preservation. The overall structure demonstrated by these Parkville fossils, however, indicates that our current understanding of Paleozoic seed fern frond architecture is most likely based on fragmentary specimens and the actual diversity of reproductive frond organization is far more complex.

Our present interpretations of the general organization of lyginopterid pollen organs remain incomplete. The largest basal diameters for fertile fronds thus far recorded is for *Potoniea* (= *Paripteris*; Text Fig. 3E; Laveine et al., 1993) at 5 mm, and *Canipa* (Fig. 3H; Skog et al., 1969) and *Triphyllopteris* (Fig. 3A; Skog and Gensel, 1980) both of which have rachises up to 4 mm. Skog et al. (1969) have reported that isolated rachises occurring on the same rock surface measure up to 3 cm in diameter, which is similar in size to the primary axis of *Parkvillia*. None of the larger rachises associated with *Canipa* have yet to be found attached to the smaller synangia-bearing rachises (Skog, 1969). The wide range of lyginopterid frond architecture includes a vegetative planar system terminating as a single fertile unit (as in *Triphyllopteris*), a fertile unit produced within the axil of a forking leaflike structure (*Diplopteridium*), and penultimate fertile segments that replace vegetative pinnules in *Crossotheca* (Text Fig. 3I). The architecture of the fertile frond of *Parkvillia* differs by having the ultimate and penultimate fertile rachises arising from a naked branch (i.e., rachises lacking vegetative laminae).

Dégagement of the matrix surrounding the largest and most complete specimen (Plate I, 1) and mapping the positions of rachises and pollen organs (Text Fig. 5) indicate that penultimate rachises (Plate I, 1 at A, C, D, E) diverge at one level, but that distally these rachises are exposed at different levels within the matrix. This configuration suggests that the three-dimensional morphology of *Parkvillia* is an accurate reflection of fertile frond morphology prior to burial. In contrast, fertile fronds of *Canipa* (Skog et al., 1969), *Crossotheca* (Kidston, 1906; Stubblefield et al., 1982) and *Telangiopsis* (Text Fig. 3B; Eggert and Taylor, 1971) typically occur on a single plane or surface of the matrix and thus reflect that the branch system bearing the pollen organs was more planar in organization. On several specimens of *Crossotheca* (Kidston, 1906) and *Feraxotheca* (Text Fig. 3G; Millay and Taylor, 1977, 1978), there are sterile pinnules on the fertile fronds. This contrasts with *Parkvillia*, in which there is no evidence of foliage on any of the ultimate rachises.

6.2. Morphology and position of sporangia

The distinctive type of reproductive structure in *Parkvillia* underscores that the lyginopterid seed ferns evolved multiple types of pollen-producing, synangia-bearing structures (Millay and Taylor, 1981). Fossil evidence to date suggests at least three different levels of organization for these units (Meyer-Berthaud, 1989), with the earliest form constructed of a few simple basally fused or unfused sporangia terminating a single stalk (*Telangium*/*Telangiopsis*, *Crossotheca*, *Feraxotheca*; simple-type of Millay and Taylor (1979)). The second pattern (aggregate-type of Millay and Taylor (1979)) consists of a number of basally fused sporangia that can form several clusters of synangia, each terminating in a single stalk (*Schopfiangium*). The third type is a compound synangiate unit partially embedded in tissue (e.g., *Potoniea*). Although many pollen organs fall neatly into one of these categories, several other types are more problematic. The most commonly recognized pollen organs attributable to the lyginopterids such as *Crossotheca*, typically lack the necessary anatomical details to properly characterize the organization of the sporangia and determine whether they are fused in a single whorl or into distinct synangia that form multiple whorls. *Parkvillia* adds to this diversity in demonstrating a single whorl of laterally fused sporangia oriented somewhat horizontally and enveloped by accessory tissue. This type of morphology is currently unknown in other pteridosperm pollen organs and further expands our knowledge of the reproductive organization in the Lyginopteridaceae.

7. Conclusions

The general organization of the sporangia in both the lyginopterid and medullosan seed ferns typically (Rothwell and Eggert, 1986) consists of tube-like sporangia that are oriented vertically, allowing for pollen dispersal toward the center of the ring of sporangia and then downward. Dehiscence takes place along a specialized zone of thin-walled cells. Although the mechanism for pollen dispersal in *Parkvillia* is essentially the same as that found in all other lyginopterids, it is the orientation of the sporangia within the pollen organ and how these structures are sealed prior to the release of pollen that is unusual. Rather than the typical vertical orientation, the sporangia are aligned in a more horizontal position. In addition,

Plate I. *Parkvillia northcuttii* general morphology.

1. Compression/impression showing the overall morphology of the largest specimen. Holotype (Part) PUPC 3001. Scale = 2 cm (A–E indicate the positions of fertile rachises; arrows indicate positions of missing fertile segments).
2. Counterpart of specimen from Plate I, 1. Lateral axis (at arrow) corresponds to lateral axis C in Plate I, 1. Holotype (Counterpart) PUPC 3002. Scale = 2 cm.
3. Two penultimate frond segments with alternating ultimate rachises with alternately arranged synangiate pollen organs. Paratype PUPC 3007a. Scale = 1 cm.

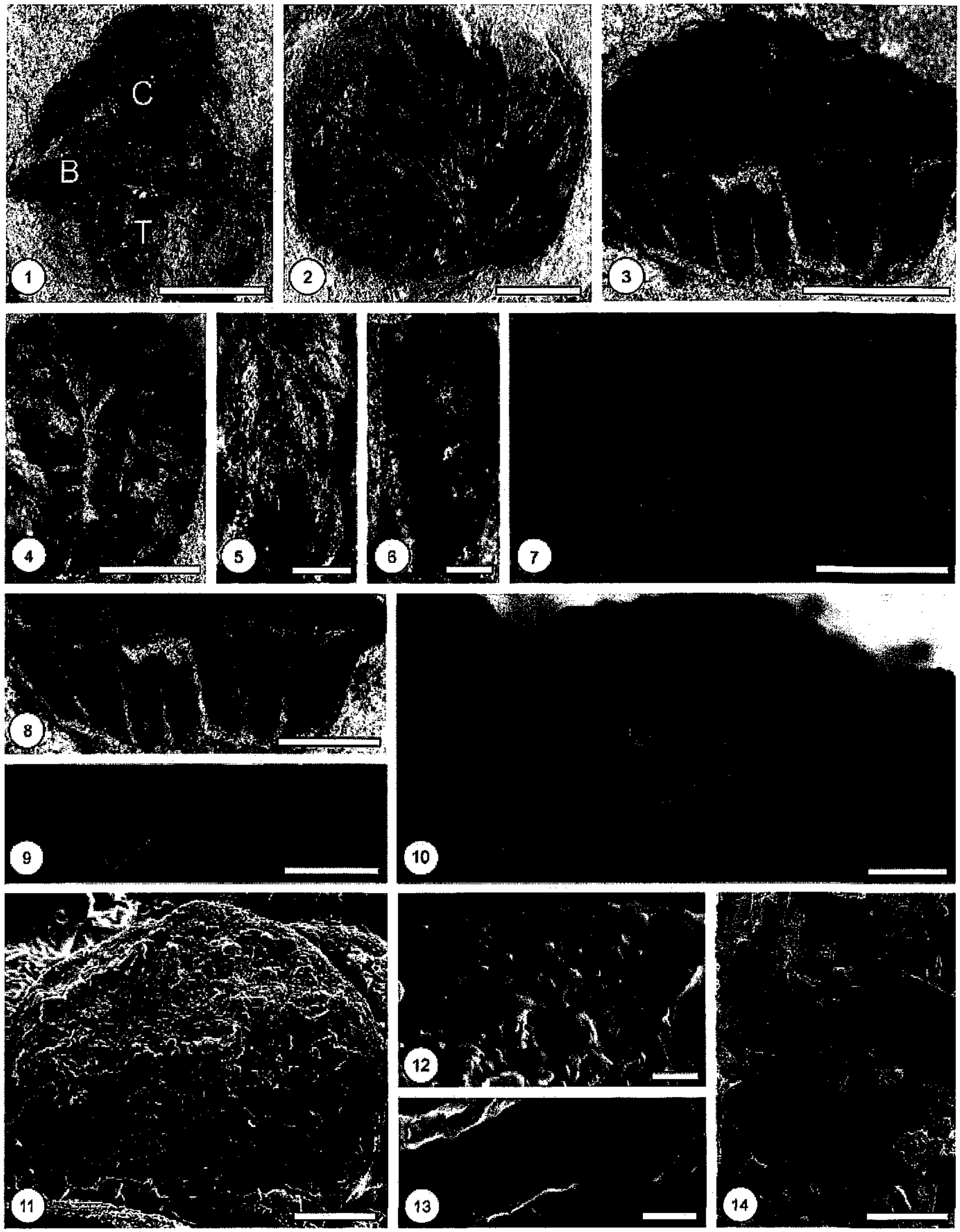

Plate II.

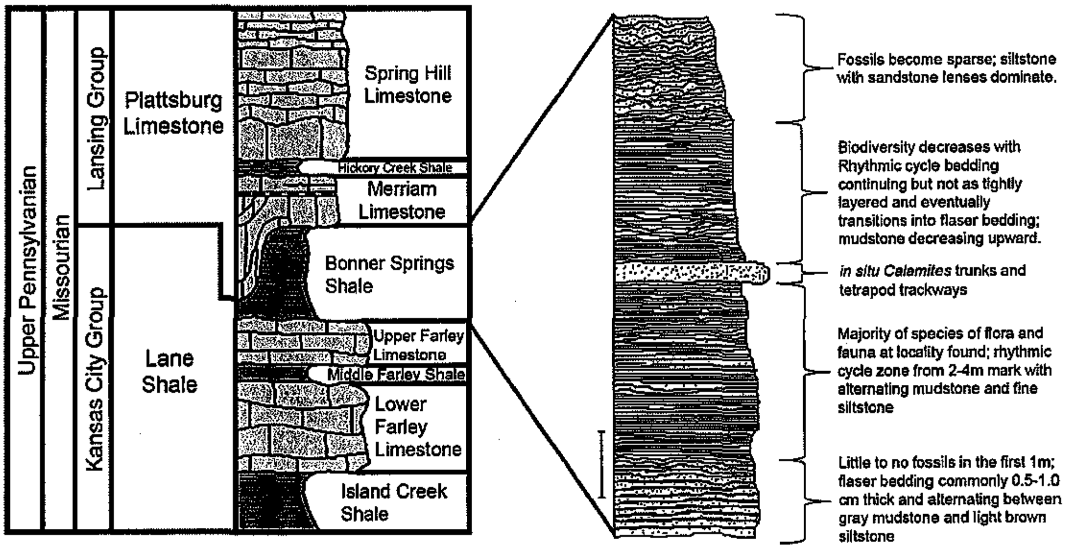

Fig. 1. Generalized section of Upper Pennsylvanian strata of the Kansas City and Lansing Groups exposed at the Park University Locality. Simplified stratigraphic column indicates the various facies within the Bonner Springs Shale. Scale = 1 m.

the sporangia are covered with tissue and the underside of the synangia has a thin layer of tissue that becomes segmented near maturity. This synangiate morphology creates an internal space that may serve to protect the pollen prior to dissemination. This organization may aid in the dispersal of large clumps of pollen at a single time by eliminating the compactness of sporangia, as in *Potoniea*, during the dehiscence phase of pollen dispersal.

The position of pollen organs on a pinnate branching system, the synangiate morphology of these structures, and the production of small circular pollen is typical for almost all lyginopterid pollen organs including *Parkvillia, Feraxotheca* (Millay and Taylor, 1977, 1978), *Crossotheca* (Sellards, 1902; Kidston, 1906; Andrews and Mamay, 1948; Brousmiche, 1982; Stubblefield et al., 1982), *Potoniea* (Schultka, 1995), and *Canipa* (Skog et al., 1969)(Text Figs. 3F, G, H, I, J). *Telangium* (Benson, 1904; Jennings, 1976; Matten and Fine, 1994), *Telangiopsis* (Eggert and Taylor, 1971; Jennings, 1976; Mamay, 1992, Orlova et al., 2009), *Triphyllopteris* (Skog and Gensel, 1980), *Cornutheca* (Rowe, 1992), and *Potoniea* (= *Paripteris*; Laveine et al., 1993) all have sporangia borne on a dichotomizing unit (Text Figs. 3A, B, C, D, E). Based on these currently known types thought to be produced by lyginopterid seed ferns, *P. northcuttii* is distinct because of the organization of synangia on a complex frond, and the position of sporangia within an enclosing structure subtended by thin flaps of tissue.

Recent studies have indicated that the pollen organ *Sterzelitheca chemnitzensis* (Feng et al., 2014; Barthel and Brauner, 2015) is similar in organization to *P. northcuttii*. However, this Late Pennsylvanian Early Permian taxon has been interpreted to belong to the Medullosaceae. Pollen has not been extracted from the sporangia to confirm its designation and the possibility exists that this fertile structure belongs to the Lyginopteridaceae.

This study expands the diversity of lyginopterid seed ferns and further demonstrates the general absence of unifying characters that can be utilized to define this group (Millay and Taylor, 1979; Meyer-Berthaud, 1989; Dunn, 2006). Although individual plant parts such as ovules, leaves, and pollen organs can be assigned to the Lyginopteridaceae with a certain degree of confidence, only the unequivocal reconstruction of whole plants will ultimately clarify the

Plate II. Synangia, pollen, and surface morphology of *Parkvillia northcuttii*.

1. Lateral view of a single synangiate pollen organ showing three part morphology. Holotype PUPC 3001. Scale = 2 mm. C = cap, B = brim, T = basal tips below sporangia.
2. Dorsal view of compressed pollen organ demonstrating the orientation of sporangia within the cap. Most of the covering tissue of the cap is absent. Arrow indicates the point of attachment of the stalk. Holotype PUPC 3002. Scale = 2 mm.
3. Lateral view of compressed pollen organ showing the extended basal tips. Each tip is typically associated with a pollen sac. Paratype PUPC 3007a. Scale = 2 mm.
4. Ventral view of compressed pollen organ showing the extent of the brim and the basal tips prior to their extension. Paratype PUPC 3007a. Scale = 2 mm.
5. Outer morphology of an individual pollen sac in longitudinal orientation. Note basal part of sac with elongate cells. PUPC 3004. Scale = 500 μm.
6. In situ cluster of pollen from individual pollen sac. Paratype PUPC 3008a. Scale = 500 μm.
7. Transverse section of two empty sporangia. Pollen sacs are laterally fused and embedded in tissue of the pollen organ. PUPC 3025 #4. Scale = 500 μm.
8. Lateral view of a synangium showing the elongate finger-like projections. Paratype PUPC 3007a. Scale = 2 mm.
9. A slightly oblique transverse section of sporangia indicating inner, differentiated sporangial wall interpreted to represent area of dehiscence (at arrow). PUPC 3022 #3. Scale = 500 μm.
10. Transverse section of a pollen organ slightly proximal to the brim. Individual sporangia are horizontally oriented (C = central hollow area of pollen organ. Compression of specimen has reduced the size of this area). Paratype PUPC 3021 #3 bot. Scale = 500 μm.
11. Scanning electron micrograph of an isolated circular pollen grain from pollen cluster depicted in Plate II, Fig. 6. Paratype PUPC 3008. Scale = 10 μm.
12. SEM of pollen surface with poorly preserved coni. Paratype PUPC 3008. Scale = 1 μm.
13. SEM of fractured wall of pollen grain showing the homogenous nature of the exine. Paratype PUPC 3008. Scale = 1 μm.
14. SEM of the outer surface of a pollen organ with numerous randomly distributed globose structures. Paratype PUPC 3028. Scale = 60 μm.

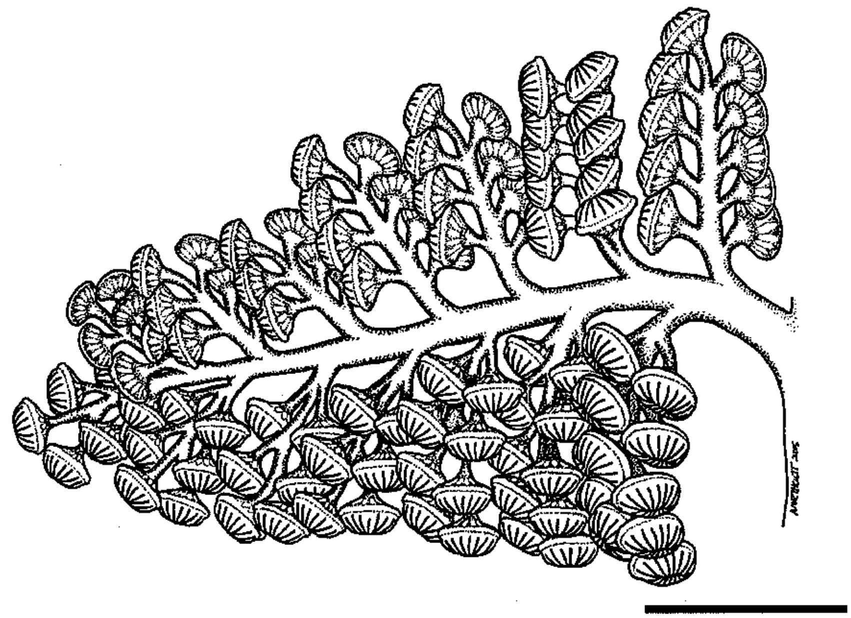

Fig. 2. Proposed reconstruction of the fertile frond of *Parkvillia northcuttii*.

group. The fossil remains of *Parkvillia* have indicated that some lyginopterids reached complex levels of pollen organ organization late in their evolutionary history. The discovery of the reproductive structures of early seed-bearing plants continues as new specimens expand our knowledge of the diversity of these groups. Although many taxa assigned to the Lyginopteridaceae have been documented, whole-plant concepts developed by Oliver and Scott (1904; *Sphenopteris-Lagenostoma-Lyginodendron*) and Jennings (1976; *Rhodea-Telangium-Telangiopsis-Heterangium*) currently provide the best examples for interpreting isolated remains as belonging to the Lyginopteridaceae. In some cases the validity of assigning fossils with synangiate reproductive organs and trilete "spores" to seed ferns has been questioned (Brousmiche, 1982). In others, the whole plant concept has failed to demonstrate unequivocally that the sum of the parts actually belong together (Meyer-Berthaud, 1989). Conclusions derived from our study have suggested that the validity of interpretations lies in our fundamental understanding of morphological features that can be seen within fossil specimens and subsequently used in determining their relationships.

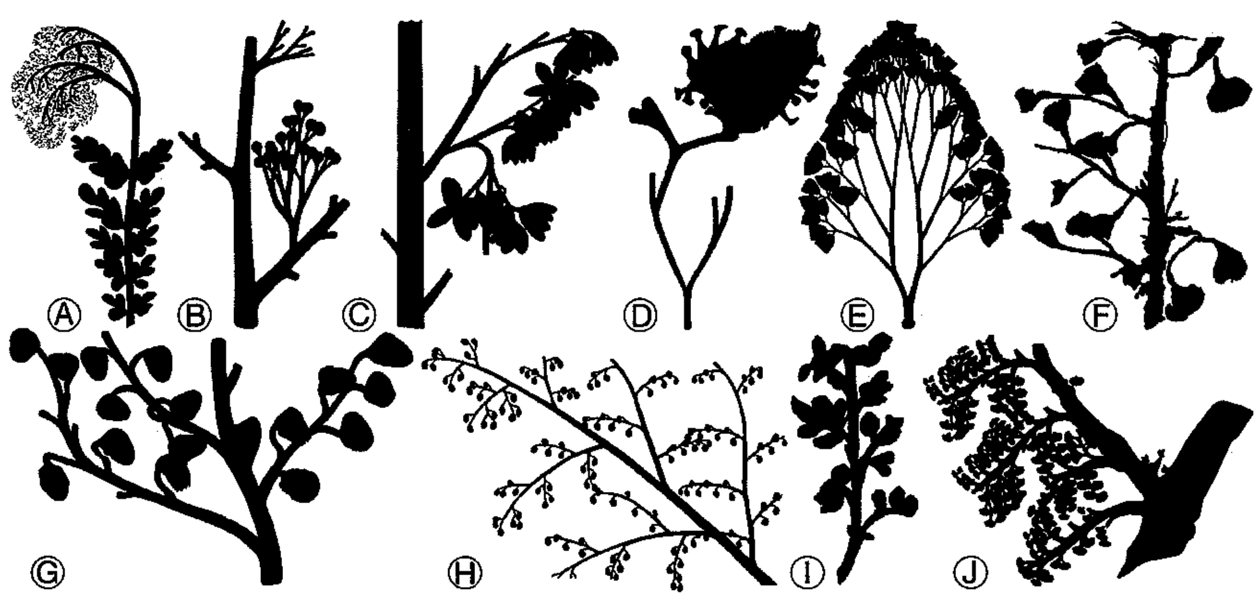

Fig. 3. Silhouetted representations of various lyginopterid fertile fronds depicting general morphologies (not to scale). A. *Triphyllopteris* (Skog and Gensel, 1980) B. *Telangiopsis* (Jennings, 1976) C. *Telangiopsis* (Orlova et al., 2009) D. *Cornutheca* (Rowe, 1992) E. *Paripteris* (Laveine et al., 1993) F. *Potoniea* (Schultka, 1995) G. *Feraxotheca* (Millay and Taylor, 1977, 1978) H. *Canipa* (Skog et al., 1969) I. *Crossotheca* (Kidston, 1906) J. *Parkvillia* (this paper).

Fig. 4. Diagrammatic representation of a transverse section near the equatorial region of a synangiate pollen organ (from Plate II, figure 10). Sporangia are oriented horizontal to the plane of section. PUPC 3021.

Acknowledgments

We thank Dave Holberg (Parkville Stone) who initially reported the Parkville Locality and allowed Timothy Northcutt access for his multiple visits which ultimately led to the discovery of the material described in this study. Mr. Northcutt is also acknowledged for providing the reconstruction of *Parkvillia northcuttii*. We also thank Dr. Patricia Ryberg, Park University, for providing the material to complete this study. We also acknowledge the assistance of Dr. Andrew B. Schwendemann, Lander University, with SEM imaging. We would also like to thank two reviewers for their constructive suggestions. This study was funded in part by NSF grant ANT-1142495 to E.L. Taylor and T.N. Taylor and support for S. Hageman and B.L. Hoffman was through the Park University Faculty Development Endowed Fund. The completion of this study was made possible by the continued support of the Division of Paleobotany, Biodiversity Institute, University of Kansas (Lawrence, KS) and the Department of Natural and Physical Sciences, Park University (Parkville, MO) for granting continued access to the locality.

Fig. 5. Diagrammatic representation of the combination of the part and counterpart of the holotype of *Parkvillia northcuttii* illustrating the three-dimensional organization of this branching system. Pollen organs in red indicate the upper level; those in green indicate the middle level and those in blue, the lowermost level. PUPC 3001, 3002.

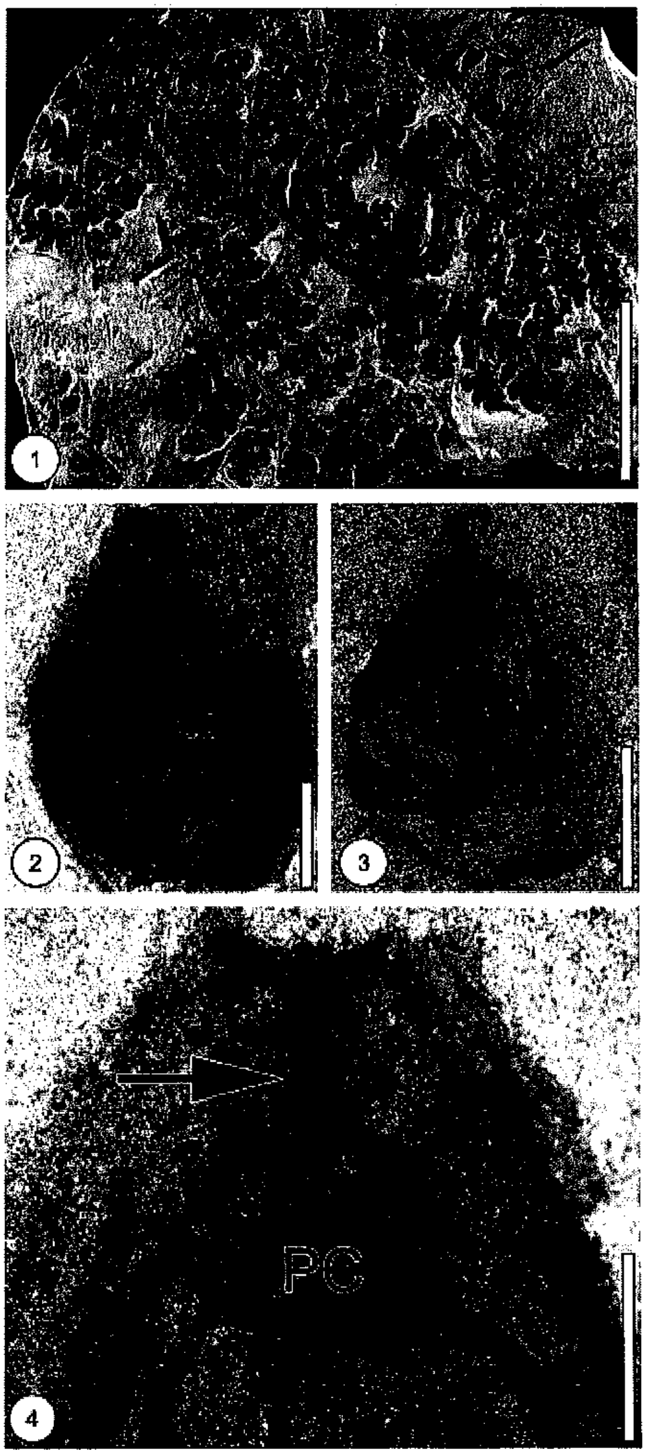

Plate III. Associated foliage and ovules.

1. Compression/impression of *Sphenopteris*-type foliage. P 4218. Scale = 1 cm.
2. Compression/impression of a small isolated lyginopterid-type ovule/seed. PUPC 3029a. Scale = 2 mm.
3. Compression/impression of lyginopterid-type ovule/seed showing various aspects of the internal morphology. PUPC 3030a. Scale = 1 mm.
4. Higher magnification of apical portion of lyginopterid-type ovule showing the bell-shaped configuration of the pollen chamber (PC) and the long narrow micropylar tube (arrow). PUPC 3030b. Scale = 1 mm.

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