629. EARLY AND MIDDLE PENNSYLVANIAN FUSULINIDS FROM SOUTHERN BRITISH COLUMBIA, CANADA AND NORTHWESTERN WASHINGTON, U.S.A.*

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Introduction

In southern British Columbia and northwestern Washington there is a widespread sequence of Upper Paleozoic rocks ranging in age from Middle Devonian (in Washington) to Late Permian. A group of limestone lenses and pods within this sequence contains Early to Middle Pennsylvanian fusulinids (DANNER, 1966, 1970a). In some areas these limestones may also contain in part a Late Mississippian (Late Chesterian=Viséan) fauna. This paper is the first description of these fusulinid faunas in southern British Columbia and northwestern Washington and is part of a continuing project on the description of Paleozoic faunas of this area. The Early Pennsylvanian fusulinid faunas of southern British Columbia and northwestern Washington are characterized by Millerella marblensis, M. sp., Eostaffella columbiana SADA & DANNER, n. sp., E. sp. A, E. sp. B, E. spp.,

* Received June 18, 1973; read Oct. 28, 1972 at Matsuyama.
Ozawainella ? sp. and Endothyranopsis ? sp. Associated microfaunas not described in this paper include Endothyra spp., Climacammia sp., Textularia sp., Tetrataxis sp., Komia sp., pteropods and algae. These fossils closely resemble the Early Pennsylvanian faunas of North America described by THOMPSON (1948) and ROSS & SABINS (1965), and also the Japanese Early Pennsylvanian faunas by IGÓ (1957) and SADA (1964, 1965, 1967). In the western Cordillera of North America they have been reported in the Fort St. James area (THOMPSON, 1965), northwestern Washington (SKINNER & WILDE, 1966) and northern California (HARBAUGH, 1955; SKINNER & WILDE, 1965).

The Middle Pennsylvanian fusulinid fauna is much rarer and is characterized by Eoschubertella ? sp. from Vancouver Island and Nankinella plummeri THOMPSON from the Kamloops area of British Columbia and the San Juan Islands of Washington. The genus Eoschubertella is a typical representative of early Middle Pennsylvanian age and is abundant in Middle Pennsylvanian rocks of America, Europe and Asia. In the western Cordilleran region it has been reported previously from the Fort St. James area of central British Columbia (THOMPSON, 1965) and from the Ballenas Islands off the east coast of Vancouver Island (J.E. MULLER, personal communication in MONGER & ROSS, 1971). Nankinella plummeri was originally described by THOMPSON (1947) from the early Middle Pennsylvanian Marble Falls Limestone, Llano Uplift, Texas. The genus is widespread in rocks ranging in age from Early Pennsylvanian to Late Permian in Europe, Asia and North America but to our knowledge no Early Pennsylvanian species has been described from North America. Unnamed species have been described previously in Middle Pennsylvanian rocks of the western Cordilleran region in the Fort St. James area of central British Columbia (THOMPSON, PITRAT & SANDERSON, 1953) and from southeastern Alaska (DOUGLASS, 1971).

Acknowledgments: Part of the field work by DANNER was conducted under grants of the National Research Council of Canada, the National Advisory Committee of the Geological Survey of Canada and the University of British Columbia. Some of the field work in northwestern Washington was performed while DANNER was employed by the Division of Mines and Geology of the State of Washington Department of Conservation. Re-examination and description of the material were undertaken by SADA while he was at the University of British Columbia under a grant of the National Research Council of Canada. John W. SKINNER aided in preliminary identification of some of the fusulinids and furnished information on the location of one of the Pennsylvanian fusulinid localities east of Kamloops, British Columbia. We wish to thank all of the many property owners who kindly permitted access on their lands and collection of material. We also wish to acknowledge the numerous students of the University of British Columbia and Boy Scouts of the 80th University Hill Troop who served as field assistants over a period of several years in the search for Pennsylvanian fossil localities and who helped pack out a large quantity of limestone samples. We give special thanks to T. NEUFELDT, P. GARVIN, E. HUNTER and F. GLASS who prepared several hundred thin sections in preliminary work on this project. Further work on this project was carried out while DANNER was visiting Professor at Hiroshima University under the aus-
Stratigraphy and Discussion of Fauna

The Pennsylvanian limestones studied in this paper are in the lower part of the eastern facies of the Cache Creek Group in south central British Columbia. In southwestern British Columbia and northwestern Washington they are in the middle part of the Chilliwack Group and on the San Juan Islands in northwestern Washington they are in the middle part of an as yet not formally named sequence which is correlative with the British Columbia central “oceanic” facies of the Cache Creek Group. On Vancouver Island the Pennsylvanian limestones are in the lower part of the Sicker Group.

(1) Possible Late Mississippian limestones

Limestones that might be of Late Mississippian age have so far proved to be very rare in the study area. An as yet undescribed species of the Late...
Mississippian (Viséan) coral *Hexaphyllia* has been found in our collections from the limestones cropping out near the community of Rayleigh north of Kamloops, British Columbia. This form, along with a different species of *Hexaphyllia* from the Late Mississippian Coffee Creek Formation of central Oregon (SADA & DANNER, 1973) is the only known occurrence of *Hexaphyllia* in North America. At the Rayleigh locality we also found *Eostaferella cambriana*, *E. kanmerai*, *Millerella*? sp. and endothyroid foraminifera which may indicate that part of the limestone is of Early Pennsylvanian age.

Some of the limestones exposed in the Kendall limestone quarries on the west side of Red Mountain in northern Whatcom County, Washington, appear to contain only endothyroid foraminifera and this is also true of a small limestone lens located north of the road to the Devonian limestones of the Red Cross quarry on Orcas Island, Washington. It is possible that these exclusively *Endothyra*-bearing limestones may be of Late Mississippian age.

(2) Early Pennsylvanian limestones

*Eastern Cache Creek Facies in Southern British Columbia*

Limestones containing an Early Pennsylvanian fauna are widespread in the area north and east of the city of Kamloops in south central British Columbia. The first indication of Pennsylvanian age limestone was when M. Y. WILLIAMS (in COCKFIELD, 1948) tentatively identified the Early Pennsylvanian brachiopods, *Neospirifer cameratus*? and *Rhynchora magnicosta*, from this area but there is no indication of just where these brachiopods were collected. Later, fusulinids of Early Pennsylvanian age were found in limestone at Harper Ranch (John W. SKINNER, 1965, written communication). Subsequently we have found Pennsylvanian fusulinids in limestones in the cliffs along the South Thompson River, in the hills and meadows northeast and above the Harper Ranch, on the eastern side and top of Mount Harper and in numerous limestone lenses in the hills along the east side of the North Thompson River north of the city of Kamloops.


Early Permian limestones characterized by large *Pseudoshuwagerina* overlie the Early Pennsylvanian limestone in the Kamloops area. However, some of
the smaller Early Pennsylvanian limestone bodies form discrete lenses surrounded by clastic sediments. East of the North Thompson River one of these limestone lenses is inverted with beds containing Early Pennsylvanian fusulinids overlying beds containing Early Permian fusulinids. The contact is a paraconformity and is marked by a layer of chert pebbles and a zone of silicification.

At Keremeos, British Columbia in the Blind Creek Formation we have found very small primitive forms of Eostaffella, E. sp. B, along with Endothyra and Millerella marblensis. The Keremeos limestone also contains a coral identified as of Permian or Late Carboniferous age and a coral that resembles a Late Mississippian species (Smith, 1935). The late Donald Angold (personal communication) stated that there were two divisions of the limestone of the Blind Creek Formation, one with abundant corals and the other containing a few poorly preserved brachiopods. His limestone specimens in which we have found Eostaffella, Millerella and Endothyra came from the non-coral part of the Formation so it is likely that the Blind Creek Formation consists of an Early Pennsylvanian limestone overlain by an Early Permian limestone.

**Chilliwack Group in British Columbia and Washington**

Large and small bodies of well-bedded partly argillaceous limestone of Early Pennsylvanian age are found in the Chilliwack Group in southwestern British Columbia and northwestern Washington.
In the Chilliwack area of British Columbia (Monger, 1966) they seldom exceed 100 feet in thickness but may be as much as 600 feet thick or more in Washington State (Danner, 1966) and extend in discontinuous outcrops for at least 65 miles southeastward into the Northern Cascade Mountains. The Pennsylvanian limestones are overlain by coarse- to medium-grained volcanic arenites, greywackes and cobble conglomerates. Some of the clastics contain plant fragments identified as Lepidodendron and Calamites by G. E. Rouse and may be of Later Pennsylvanian age. The clastics are in turn overlain by Permian fusulinid limestones of Early Leonardian age.

The Early Pennsylvanian limestones of the Chilliwack Group contain a fauna similar to that of the eastern facies of the Cache Creek Group exposed near Kamloops, British Columbia and it includes Eostaffella columbiana, E. kamerai, Millerella sp., Ozawainella sp., Tetrataxis sp., Textularia sp., Climacamina sp., numerous endothyroids, large crinoid columnals, coral, bryozoan and large brachiopods. The puzzling algae or stromatoporoid Komia is locally abundant.

San Juan Islands, Washington

On the San Juan Islands in northwestern Washington numerous small limestone bodies contain an Early Pennsylvanian fauna. They are overlain on Orcas Island by a sequence of sedimentary and volcanic rocks containing the Early and Late Permian faunas and on San Juan Island by volcanic and sedimentary rocks containing a Late Permian fauna. The Late Permian faunas on both islands contain Neoschwagerina and other Tethyan fusulinids correlative with the middle or "oceanic" facies of the Cache Creek Group (Danner, 1970b; Monger & Ross, 1971). The Early Pennsylvanian limestones contain Eostaffella spp., Millerella? sp., Ozawainella sp., Endothyra sp., Tetrataxis sp., Textularia sp., Climacamina sp., large crinoid columnals and corals. We have not been able to obtain well enough oriented material to identify the species of Eostaffella. On San Juan Island at Roche Harbor Eostaffella sp. is associated with mats of filamentous algae in limestone interbedded with radiolarian cherts.

Text-fig. 4. Map showing the fossil localities on San Juan Islands in Washington.

(3) Middle Pennsylvanian

Kamloops area and Vancouver Island, British Columbia; Orcas Island, Washington

Nankinella plummeri Thompson was found in limestones of the eastern facies of the Cache Creek Group in the hills and meadowland areas above and east of the Harper Ranch near Kamloops, British Columbia. Our collections containing it all come from the largest outcrop area of Pennsylvanian limestone overlain by Early Permian limestone or Triassic volcanic rocks and not from the small lenses of Pennsylvanian limestone in clastic rocks. Nankinella plum-
meri is associated with *Endothyra* spp. in these limestones.

On Vancouver Island *Eoschubertella* was collected from a limestone bed on the west side of Horne Lake and *Eostaffella*? sp. from limestone talus blocks below the limestone cliffs on Mount Mark on the north side of Horne Lake. *Endothyra* sp. also occurs in these limestones. It had been suspected for several years that Pennsylvanian rocks occur on Vancouver Island (DANNER, 1960, 1965) although YOLE (1963) could find only evidence of Early Permian age. More recently the Middle Pennsylvanian fusulinids *Wedekindellina* and *Eoschubertella* have been reported from North Balenas Island just off the east coast of Vancouver Island in Georgia Strait (J. E. MULLER in MONGER & ROSS, 1971). A

Pennsylvanian fusulinid fauna is also known to occur in the central “oceanic” facies of the Cache Creek Group in limestones near the town of Clinton in central British Columbia but it will be discussed in a later paper when the study of this area is completed.

On Orcas Island, Washington, our samples containing *Nankinella* came from a small lens of argillaceous limestone on the northeast slopes of Mount Constitution about 550 feet above sea level. The limestone contains a microfauna of *Eostaffella* sp., *Millerella*? sp., *Endothyra* sp., and crinoid columnals, bryozoa, corals and one species of trilobite.

The thin sections used in this study are deposited in the stratigraphic-paleontologic collections of the University of British Columbia, Department of

Table 1. Distribution of species of fusulinids and other microfossils by samples from the Pennsylvanian limestone in British Columbia and Washington.

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<th>LOCALITY</th>
<th>MICROFAUNA</th>
<th><em>Eostaffella</em> rhenana, sp.</th>
<th><em>E. kanmerai</em></th>
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<th><em>Millerella</em> ? sp.</th>
<th><em>Nankinella</em> ? sp.</th>
<th><em>Onysella</em> ? sp.</th>
<th><em>O. lanceolata</em></th>
<th><em>O. scutata</em></th>
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* As the sample containing *Hexaphyllia* sp. from Rayleigh is different from the sample containing Early Pennsylvanian fusulinids, the species is not associated with *Eostaffella columbiana*, *E. kanmerai*, *Millerella marbensis* and *M. sp.*
Geological Sciences.

**Fossil Localities**

**British Columbia**

*Keremeos.*—Blind Creek Limestone. Top of hill southeast of the town of Keremeos.

*Rayleigh.*—Road cut on east side of Yellowhead Highway about 8 miles north of the city of Kamloops and just north of the community of Rayleigh in SW\(^1/4\) section 34, T. 21, R. 17.

*Aspen Park.*—Several small limestone bodies about 4\(^1/2\) miles north on the Yellowhead Highway from the city of Kamloops. About one mile up hillside between 2000 and 2500 feet in altitude. Near north boundary of Kamloops Indian Reserve No. 1 and southeast for 1/4 mile. Part of these same limestone bodies contain Early Permian fusulinids.


*South Thompson #1.*—Lens of limestone cropping out on south-facing cliff 1/4 mile north of South Thompson River and the river road along east section line of NE\(^1/4\) section 3, T. 20, R. 16.

*South Thompson #2.*—Breached anticlinal bed of limestone cropping out along east section line of section 2, T. 20, R. 16, on top of terrace above South Thompson River Valley about 1\(^1/2\) mile north of South Thompson River and the river road.

*North McGregor Creek.*—Small knob of limestone exposed at base of hills north side of McGregor Creek valley, east end of Harper Ranch in SE\(^1/4\) section 12, T. 20, R. 16, about 1\(^1/2\) miles north of South Thompson River at an altitude of approximately 1700 feet.

*Upper Harper Ranch.*—NE\(^1/4\) section 7, T. 20, R. 15 in meadowlands in hills above east end of Harper Ranch at an altitude of between 3000 and 3100 feet. Low ridges of limestone north of small alkaline lakes.

*Robins Lake.*—Limestone outcrops around shores of Robins Lake, an alkalie Lake in the NW\(^1/4\) of section 8, T. 20, R. 15 in the hills above the South Thompson River at an altitude between 3200 and 3300 feet.

*Liumpiont Ridge.*—Bedded argillaceous limestone exposed up a stream bed near the base of the steep slope forming the north side of Liumpiont Ridge. Above the south side of a meadow area used for camping which is about 1/4 mile up and south of Liumpiont Lake. There was a cabin in the meadow in 1959. Altitude about 4600 feet. Liumpiont Ridge is the southwestern extension of Church Mountain.

*West Side Horne Lake.*—Limestone exposed in outcrops along logging road above west side of Horne Lake.

*North Side Horne Lake.*—Talus blocks of limestone at base of Mount Mark along logging road on north side of Horne Lake.

**Washington**


*Red Mountain.*—Limestone outcrop on the top of Red Mountain near its northern end in the SW\(^1/4\) section 12, T. 40 N., R. 5 E.

*Upper Kendall Quarry.*—Top of north end of large limestone quarry used for cement rock. Section 14, T. 40 N., R. 5 E.

*Lower Kendall Quarry.*—In east wall of abandoned limestone quarry in the SW\(^1/4\) section 14, T. 40 N., R. 5 E.

*Wright, Orcas Island.*—Small area of limestone outcrop in the NB\(^1/4\) section 19, T. 37 N., R. 1 W., at an estimated altitude of 900 feet on the northwest side of Mount Constitution. Southeast of a large swampy area and about 1/4 mile south of Day Lake Road.

*Double Hill #2, Orcas Island.*—A 40 foot high limestone knob on a north-facing slope about the center of the SE\(^1/4\) of section 15, T. 37 N., R. 2 W., on the west side of the southern part of Double Hill. It is about 300 feet northwest and downslope from the pass between Double Hill and Lookout Mountain and about 120 feet north of the Double Hill #2 limestone deposit.
Mount Constitution, Orcas Island.—North-east slope of Mount Constitution in the SW$^{1}/_{4}$ section 16, T. 37 N., R. 1 W., just west of the junction of a main logging road with two abandoned spur roads. Knob-like exposure of limestone.

Orcas Knob, Orcas Island.—Small limestone lenses and pods and large limestone clastics in volcanic breccia in cliffs on west side of Orcas Knob in the SE$^{1}/_{4}$ section 30, T. 37 N., R. 2 W. between top of knob and Soderberg limestone quarries (Devonian age) at west base of Orcas Knob.

Red Cross Quarry Road, Orcas Island.—Small outcrop of oolitic limestone on vegetation covered ridge north above road into Red Cross limestone quarry (Devonian age) in the NE$^{1}/_{4}$, SE$^{1}/_{4}$ section 20, T. 37 N., R. 2 W. East of House.

Roche Harbor, San Juan Island.—Southeast side of northernmost limestone quarry at Roche Harbor in the NE$^{1}/_{4}$ section 23, T. 36 N., R. 4 W.

Systematic Description

Family Ozawainellidae THOMPSON & FOSTER, 1937

Genus Millerella THOMPSON, 1942

Millerella marblensis THOMPSON

Pl. 37, figs. 6-12, 14


1954. Millerella marblensis, SKINNER & WILDE. Jour. Paleont., vol. 28, no. 4, p. 449, pl. 49, fig. 3.


Description.—The shell of Millerella marblensis THOMPSON is discooidal and shows rounded periphery and umbilicated poles. The shell of five volutions illustrated as fig. 8 on Pl. 37 (South Thompson 22-39-a) is 100 microns in length and 400 microns in width, having a form ratio of 0.25. The outer two or three volutions are completely evolute. The spherical proclocus of a specimen measures 20 microns in its outside diameter. The radius vectors of the 1st to the 5th volution of a specimen are 30, 60, 100, 140 and 210 microns, respectively. The spirotheca consists of a tectum and inner and outer tectoria and its thickness of the last volution is about 20 microns. The septa are closely spaced. The chomata are small and primitive.

Remarks.—As pointed out by THOMPSON (1948, p. 76) Millerella marblensis has a fairly broad specific variation in its shell-shape and size. In the shell-shape and the internal characteristics, the present specimens are identified
with *M. marblensis* described by Thompson from the Lower Pennsylvanian rocks of Texas and New Mexico (1942, 1948), Arkansas and Kansas (1944).

**Occurrence:** *M. marblensis* was found at the following localities: South Thompson #2, Harper Ranch, Robins Lake, North McGregor Creek, Rayleigh, Aspen Park, Keremeos and Mount Constitution on Orcas Island.

**Genus Eostaffella RAUSER-CHERNOUSSOVA, 1948**

*Eostaffella columbiana* SADA & DANNER, n. sp.

Pl. 35, figs. 1-8; Pl. 36, figs. 1-5

**Description:** The shell of *Eostaffella columbiana* SADA & DANNER, n. sp. is large for the genus and discoidal in shape with subangular to rounded periphery, slightly umbilicated poles and convex lateral slopes. The mature shells of five to six volutions are 250 to 370 microns in length and 680 to 950 microns in width, giving the form ratios of 0.26 to 0.49. The shell of the holotype is 300 microns in length and 820 microns in width, possessing a form ratio of 0.37. The inner and outer volutions are involute but the last one is partly evolute. The proloculus is large. Its outside diameter ranges from 40 to 60 microns in eight specimens. The radius vectors of the 1st to the 6th volution of eight specimens are 40-60, 60-120, 140-190, 210-310, 340-450 and 520 microns, respectively. The spirotheca is fairly thick and is composed of a tectum and inner and outer tectoria in the inner volution but in the outer ones it consists of a tectum, inner and outer tectoria and a discontinuous thin lighter layer. The thickness of the spirotheca of the 1st to the 2nd volution is less than 10 microns and of the 3rd to the 5th volution is 10 to 30 microns, respectively. The septa are fairly thick and planer throughout the shell. They bend anteriorly. The septal counts of the 1st to the 5th volution of a typical specimen illustrated as fig. 5 on Pl. 36 (South Thompson #2-48-b) are 5, 12, 16, 18 and

| Table 2. Measurements of *Eostaffella columbiana* SADA & DANNER, n. sp. |
|---|---|---|---|---|---|---|---|
| Slide | Pl. | fig. | L. | W. | R. | Prol. | Radius vector |
| Upper Harper Ranch 93-a | 35 | 1 | 0.30 | 0.82 | 0.37 | 0.06 | 0.06 0.11 0.19 0.28 0.45 |
| Upper Harper Ranch 93-b | 35 | 2 | 0.37 | 0.80 | 0.46 | 0.06 | 0.05 0.10 0.18 — 0.43 |
| Harper Ranch 4-c | 35 | 3 | 0.37 | 0.76 | 0.49 | 0.05 | 0.06 0.12 0.19 0.31 0.41 |
| Harper Ranch 1-a | 35 | 6 | 0.35 | 0.78 | 0.45 | 0.05 | 0.05 0.10 0.16 0.27 0.45 |
| Harper Ranch 4-b | 35 | 7 | 0.36 | 0.78 | 0.46 | 0.06 | 0.06 0.11 0.16 0.27 0.45 |
| South Thompson #2-30-a | 35 | 4 | 0.27 | 0.68 | 0.40 | 0.05 | 0.05 0.09 0.15 0.24 0.36 |
| South Thompson #2-26-c | 35 | 5 | 0.23 | 0.47 | 0.49 | 0.05 | 0.05 0.06 0.17 0.27 |
| Harper Ranch 62-66 | 36 | 1 | 0.25 | 0.95 | 0.26 | 0.04 | 0.04 0.08 0.14 0.21 0.34 0.52 |

(Measurements in mm)
19, respectively. The chomata are distinctly developed. The tunnel angles of the 1st to the 4th volutions are 25, 25, 26 and 27 degrees, respectively, in a specimen illustrated as fig. 3 on Pl. 35 (Harper Ranch 4-c).

Remarks:—A large number of the sectioned specimens are referable to the present new species. They show a fairly wide range of variation in the length of the axis of coiling and the height of the chambers in the outer two or three volutions. In the general shape of the shell Eostaffella columbiana SADA & DANNER, n. sp. somewhat resembles Eostaffella circuli which was described by THOMPSON (1945, pp. 46-47, pl. 1, figs. 15-18) from the Pennsylvanian Belden formation in Northwest Colorado and East Utah, and by THOMPSON (1948, p. 77, pl. 24, figs. 16-18) from Powwow Canyon, Hueco Mountain, Texas. However, E. columbiana, n. sp. is distinguished from E. circuli in having larger shell, larger proloculus and more rapid expansion of the shell in the outer volutions. The present species has a close resemblance to Eostaffella gigantea (KANMERA) (1952, pp. 172-173, pl. 12, figs. 4-14) from the Kakisako formation of Southwest Japan, but they are easily distinguished by smaller shell of E. columbiana, n. sp., larger form ratio, smaller proloculus and thicker spirotheca of the last volution. E. columbiana, n. sp. is somewhat allied to Eostaffella japonica (KANMERA) (1952, pp. 170-172, pl. 11, figs. 1-19: pl. 12, figs. 1-3) from Japan. However, the more slender shell, smaller form ratio and smaller proloculus of E. japonica serve to distinguish it from E. columbiana, n. sp. Eostaffella columbiana, n. sp. resembles Eostaffella britishensis described by ROSS (1967, pp. 715-716, pl. 79, figs. 6-10) from locality 2B-15-63-54, 9 miles south of Trout Lake, British Mountains, Yukon. However, the former species is smaller in size and has smaller proloculus and smaller form ratio. Eostaffella columbiana differs from Eostaffella thompsoni (ANISGARD & CAMPAU) (1963, p. 102, pl. 9, figs. 1-15, pl. 10, figs. 1-7, pl. 11, figs. 1-4) in that it has a smaller shell, smaller form ratio, smaller tunnel angles and larger number of volutions.

Occurrence:—Eostaffella columbiana was found abundantly at many localities including: South Thompson #1, South Thompson #2, Rayleigh, Aspen Park, Harper Ranch, Upper Harper Ranch, Robins Lake #1, Liumption Ridge, in British Columbia and Black Mountain in Washington State.

Eostaffella kanmerai (IGO)

Pl. 37, figs. 1-3, 5, 18-19


Description:—The shell of Eostaffella kanmerai (IGO) is discoidal in shape with subangular to rounded periphery and depressed at the umbilicated poles. The lateral slopes are distinctly convex. Shells with five volutions measure 190 to 230 microns in length and 390 to 680 microns in width, giving the form ratios of 0.29 to 0.43. The inner volu-
tions are involute but the last one or two volutions become partly evolute.

The spherical proloculus measures 30 to 40 microns in the outside diameter. The radius vectors of the 1st to the 5th volution of seven specimens are 40-50, 70-100, 110-130, 190-330 and 280-380 microns, respectively.

The spirotheca is fairly thick in the outer two volutions and consists of a tectum and inner and outer tectoria and its thickness of the 1st to the 5th volution of seven specimens is 10 to 20 microns. The thickness of the proloculus wall ranges from 10 to 15 microns. The septa are thin and slightly bent anteriorly. The chomata are low and slightly asymmetrical. The tunnel angles of the 1st to the 3rd volution of a specimen (Pl. 37, fig. 1: North McGregor Creek 11-a) are 20, 24 and 25 degrees, respectively.

Table 3. Measurements of *Eostaffella kanmerai* (Igo).

<table>
<thead>
<tr>
<th>Slide</th>
<th>Pl.</th>
<th>fig.</th>
<th>L</th>
<th>W</th>
<th>R</th>
<th>Prolo</th>
<th>Radius vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>North McGregor CK. 11-a</td>
<td>37</td>
<td>1</td>
<td>0.23</td>
<td>0.56</td>
<td>0.41</td>
<td>0.04</td>
<td>0.05 0.08 0.13 0.21 0.30</td>
</tr>
<tr>
<td>South Thompson #2-18-b</td>
<td>37</td>
<td>3</td>
<td>0.19</td>
<td>0.56</td>
<td>0.34</td>
<td>0.04</td>
<td>0.04 0.07 0.11 0.19 0.28</td>
</tr>
<tr>
<td>South Thompson #2-18-a</td>
<td>37</td>
<td>2</td>
<td>0.20</td>
<td>0.68</td>
<td>0.29</td>
<td>0.03</td>
<td>0.05 0.10 0.15 0.24 0.38</td>
</tr>
<tr>
<td>South Thompson #2-26-b</td>
<td>37</td>
<td>19</td>
<td>0.19</td>
<td>0.55</td>
<td>0.34</td>
<td>0.04</td>
<td>0.05 0.09 0.18 0.31 0.38</td>
</tr>
<tr>
<td>South Thompson #2-27-a</td>
<td>---</td>
<td>---</td>
<td>0.19</td>
<td>0.58</td>
<td>0.33</td>
<td>0.04</td>
<td>0.05 0.09 0.18 0.33 0.33</td>
</tr>
</tbody>
</table>

(Measurements in mm)

Remarks:—*Eostaffella kanmerai* was originally described by Igo (1957) from the Ichinotani formation in Central Japan, and then it was described from the Pennsylvanian limestones of Ateetsu (Sada, 1964) and Taishaku (Sada, 1967, 1969) in West Japan. The specimens described above are quite identical with the types and the hypotypes of Japan in the shell-shape, the size, the form ratio, the number of volutions, the expansion of the shell, the spirothecal thickness, the proloculus diameter, the tunnel angles and the septal counts. *Eostaffella kanmerai* somewhat resembles *Eostaffella circuli* described from Utah and Colorado (Thompson, 1945, pp. 46-47, pl. 1, figs. 15-18) and from Texas (Thompson, 1948, p. 77, pl. 24, figs. 16-18). However, *E. kanmerai* can be easily distinguished from *E. circuli*, for the former species has a shorter axial length, smaller form ratio, smaller proloculus, smaller chomata, higher chambers and fewer septa for corresponding volutions, thinner spirotheca and larger tunnel.

Explanation of Plate 35

All figures x 100

Figs. 1-8. *Eostaffella columbiana* Sada & Danner, n. sp.

2-8. Axial sections of paratypes: Slides-Upper Harper Ranch 93-b, Harper Ranch 4-c, South Thompson #2-30-a, South Thompson #2-26-c, Harper Ranch 1-a, Harper Ranch 4-b and Harper Ranch 1-b, respectively.
angle.

Occurrence:—Eostaffella kanmerai was collected at the following localities: Rayleigh, Harper Ranch, South Thompson #1, South Thompson #2, North McGregor Creek and Liumpton Ridge.

Eostaffella sp. A

Pl. 37, figs. 15-17

Descriptive remarks:—The shell of Eostaffella sp. A is moderate for the genus and discoidal in shape, having a broadly rounded periphery and slightly umbilicated poles. The specimen illustrated as fig. 17 on Pl. 37 (South Thompson #2-34-a) is 250 microns long and 430 microns wide, giving a form ratio of 0.58. The shell is involute in the inner volutions but the last one is partly evolute. The proloculus diameter is uncertain due to secondary mineralization. The spirotheca is composed of a tectum and inner and outer tectoria. The thickness of the spirotheca of the penultimate and the last volutions is about 10 microns. The cho mata are obscure.

In the shell-shape, the number of volutions and some internal characteristics of the shell, the present species has a resemblance to Eostaffella sp. B described by SADA (1964, pp. 232-233, pl. 21, figs. 18-20; pl. 22, figs. 5-7) from the Pennsylvanian beds of the Atetsu Limestone in West Japan. However, more perfect specimens are necessary for the definite determination of the species.

Occurrence: —Eostaffella sp. A was obtained from the following localities: South Thompson #2, Harper Ranch and North McGregor Creek.

Eostaffella sp. B

Pl. 36, figs. 6-7

Descriptive remarks: —We have obtained a small species referable to the genus Eostaffella from the Pennsylvanian beds of the Blind Creek Limestone at Keremeos, B.C. and from the area around Kamloops, B.C. However, we cannot determine the accurate specific name, because the specimens are very poor in preservation. The shell of Eostaffella sp. B is small and discoidal in shape with subangular to rounded periphery and convex lateral slopes. The shell illustrated as fig. 7 on Pl. 36 (Keremeos, B.C. S.W. 2-3-a) is 80 microns in length and 210 microns in width, giving a form ratio of 0.38. The inner volutions are involute but the last one becomes partially evolute. The proloculus diameter and the radius vectors are uncertain due to the poor preservation of the shell. The spirotheca is composed of a tectum and inner and outer tectoria, and the spirothecal thickness of the last volutions is about 10 microns. The cho mata are indistinctly developed.

Occurrence: —Eostaffella sp. B is common in the following localities: South Thompson #1, South Thompson #2, Harper Ranch and Keremeos Limestone.

Family Staffellidae MIKLUKHO-MAKLAY, 1949

Genus Nankinella LEE, 1933

Nankinella plummeri THOMPSON

Pl. 37, fig. 4


Description:—The shell of Nankinella plummeri THOMPSON is minute and discoidal in shape, having the angular periphery in maturity, convex lateral slopes and slightly umbilicated poles. The mature shell of six volutions illustrated as fig. 4 on Pl. 37 is 450 microns in length and 1050 microns in width. The form ratio is 0.43. The outside diameter of the proloculus is 50 microns. The radius vectors of the 1st to the 6th volution of the illustrated specimen are 60, 100, 180, 260, 400 and 600 microns, respectively. The spirothecal thickness of the outer volutions is less than 30 microns. The spirotheca is composed of three layers. The chomata are low. Their tunnel sides are steep and poleward slopes are very gentle. The tunnel angles of the 3rd to the 5th volution are 16, 17 and 18 degrees, respectively.

Remarks:—In the shell-shape, the form ratio, the height of the chambers, the features of the chomata, and the number of volutions, the present form closely resembles Nankinella plummeri described by THOMPSON (1947) from the Marble Falls limestone, Llano Uplift, Texas. They may be conspecific.

Occurrence:—Nankinella plummeri was collected from the following localities: Upper Harper Ranch, Robins Lake and Mount Constitution on Orcas Island.

Subfamily Eoschubertellinae
SKINNER, 1931

Genus Eoschubertella THOMPSON, 1937

Eoschubertella ? sp.

Pl. 37, fig. 13

Description:—The shell of Eoschubertella ? sp. is small for the genus and inflated fusiform in shape and has bluntly pointed polar ends and straight axis of coiling. The shell of the specimen illustrated as fig. 13 on Pl. 37 (Westsie of Horne Lake, Vancouver Island 5-16 (V. I-1)) is 600 microns in length and 450 microns in width. The form ratio is 1.32. The proloculus of the shell is invisible due to the secondary mineralization. The spirotheca is composed of a tectum and inner and outer tectoria. The spirothecal thickness measures about 20 microns in the penultimate and ultimate volutions. The chomata are distinct in all but the last volution. The tunnel sides of the chomata are nearly vertical but the pole-

Explanation of Plate 36

All figures x100

Figs. 1-5. Eostaffella columbiana SADA & DANNER, n. sp.
1. 3. Axial sections of paratypes: Slides-Harper Ranch 62-66 and South Thompson #2-54, respectively.
2. 4-5. Sagittal sections of paratypes: Slides-Upper Harper Ranch 93-c, South Thompson #2-26-a and South Thompson #2-48-b, respectively.

Figs. 6-7. Eostaffella sp. B
6-7. Axial sections: Slides-Keremeos B.C.S.W. 2-4-a and Keremeos B.C.S.W. 2-3-a, respectively.

Fig. 8. Endothyranopsis ? sp.
ward slopes are gentle. The tunnel angle is about 20 degrees in the penultimate volution.

Remarks:—The present species is incompletely known owing to the scantiness of the material and it is difficult to determine the generic affinities with certainty. In the general shell-shape and some internal characteristics of the shell, however, the single specimen described above has similarities to species placed in *Eoschubertella*. So we refer it to that genus with question as *Eoschubertella*? sp. The specific comparison will be postponed until more information is obtained.

Occurrence:—*Eoschubertella*? sp. is common in the Pennsylvanian rocks at the westside of Horne Lake on Vancouver Island.

Family Endothyridae BRADY, 1884

Subfamily Endothyranopsinae

REYTLINGER, 1958

Genus *Endothyranopsis* CUMMINGS, 1955

*Endothyranopsis*? sp.

Pl. 36, fig. 8

Description:—The shell of *Endothyranopsis*? sp. is large and subglobular in shape with broad and rounded periphery and depressed umbilicated poles. The axis of coiling rotates in the inner volutions. The specimen (Harper Ranch 25-2-b) illustrated as fig. 8 on Pl. 36 is 50 microns long and 70 microns wide. The shell is tightly coiled in the inner volutions but rapidly expands in the last volution. The proloculus is small and its outside diameter measures 4 microns. The spherites is thin and consists of a tectum and inner and outer layers composed of granules of calcite bounded by calcareous cement.

Remarks:—The present species has similarities to the type species of genus *Endothyranopsis*, *E. crassa* BRADY, in the general shell-shape and some internal characteristics. However, the present species differs from the type species in having three layered wall composed of a distinct tectum and inner and outer layers which consist of granules of calcite bounded by calcareous cements. Therefore, the present species is referred to the genus *Endothyranopsis* with question.

Occurrence:—*Endothyranopsis*? sp. was obtained from the following localities: South Thompson 2 and Harper Ranch.

References


ROSS, C. A. (1964) : Late Paleozoic fusulinids from northern Yukon Territory. Ibid., vol. 41, pp. 709-725, pls. 79-86.

Explanation of Plate 37

All figures ×100 except for Figs. 4 and 13

Figs. 1-3, 5, 18-19. *Eostaffella kanmerai* (IGO)
1-3, 18-19. Axial sections: Slides-North McGregor Creek 11-a, South Thompson #2-18-a, South Thompson #2-18/b, South Thompson #2-42-a and South Thompson #2-26-b, respectively.

Fig. 4. *Nankinella plumeri* THOMPSON

Figs. 6-12, 14. *Millerella marblensis* THOMPSON
11-12. Sagittal sections: Slides-South Thompson #2-52-a and South Thompson #2-48-a, respectively.

Figs. 15-17. *Eostaffella* sp. A
15-17. Axial sections: Slides-North McGregor Creek 11-b, Harper Ranch 67-72-a and South Thompson #2-34-a, respectively.

Fig. 13. *Eoschubertella* ? sp.
13. Axial section: Slide-West Side Horne Lake Vancouver Island 5-16(V.I. -1) ×51.6.

Fig. 20. *Endothyra* sp.
Slide-North McGregor Creek 11-c.
629. Pennsylvania fusulinids from B. C. & Washington 265


