70-60

GEOLOGICAL
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DEPARTMENT OF ENERGY,
MINES AND RESOURCES

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SOME DEVONIAN CHAROPHYTES FROM WESTERN CANADA

H. M. A. Rice

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1970

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ABSTRACT

Charophytes are small, bushy, calcareous algae that live in fresh or brackish water. Their tiny round fruiting bodies have been recovered from rocks as old as Lower Devonian and may help in correlating rock units.

Studies of fourteen collections of Devonian charophytes in the paleontological collection of the Geological Survey of Canada have yielded three, possibly four species, and these are described in this report.

Chovanella burgessi Peck and Eyer occurs in six of the collections and five of these also contain *Eochara wickendeni* Choquette. All of these are from strata reported to be of Givetian (late Middle Devonian) age. *Moellerina greenei* Ulrich, occurs in two collections both believed to be of Frasnian (early Upper Devonian) age. The remaining six collections contain charophytes that closely resemble *M. greenei* but seem to be smaller and also to resemble, in many aspects, *Karpinskya bilineata* Peck. They are designated *?Moellerina greenei* and are from formations reported to range in age from Eifelian to Frasnian (early Middle Devonian to early Upper Devonian).

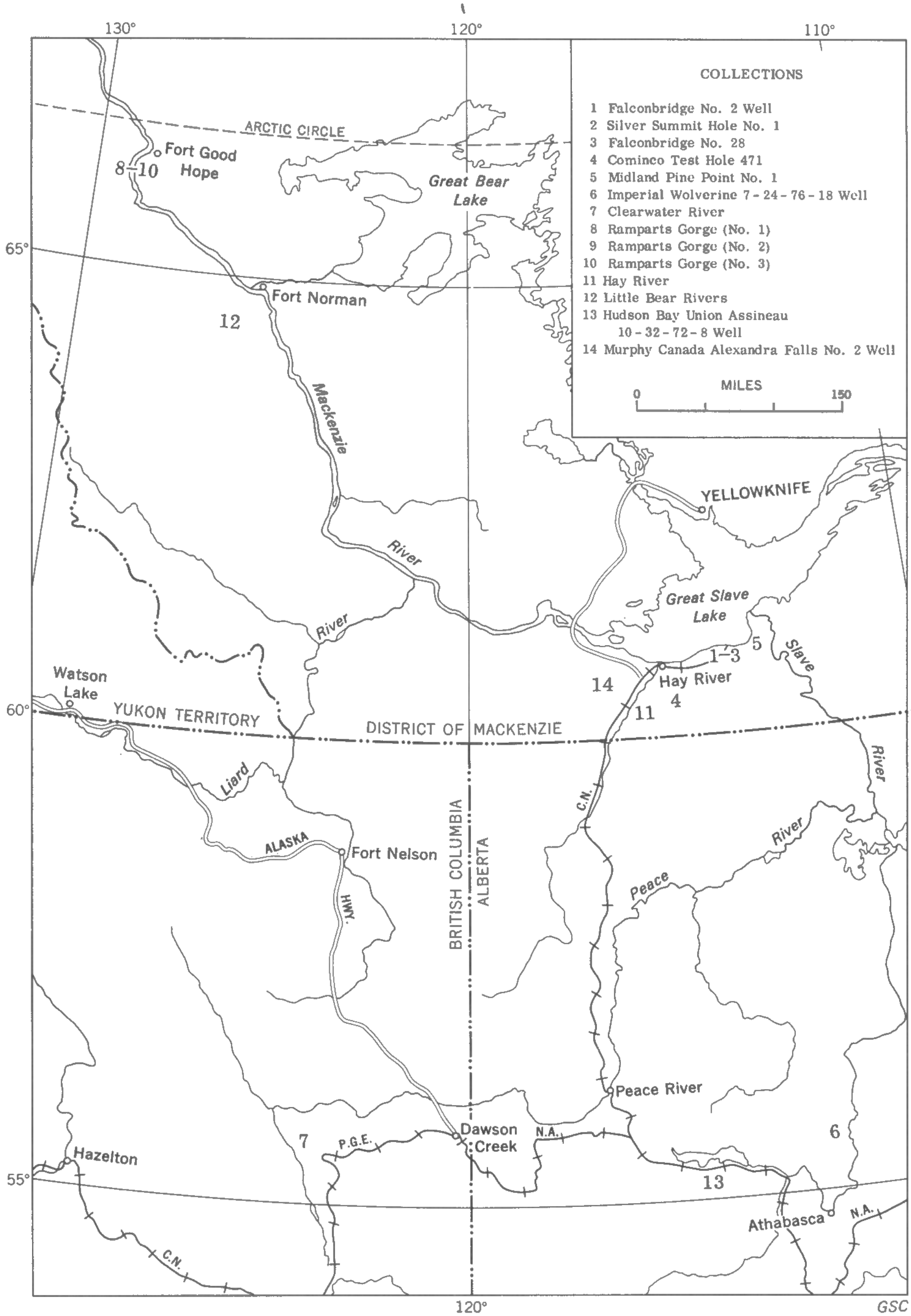

Figure 1. Index map showing localities.

SOME DEVONIAN CHAROPHYTES FROM WESTERN CANADA

INTRODUCTION

Fourteen collections of charophytes from the Devonian of northwestern Canada, stored with the Geological Survey of Canada, are the subject of this report (*see* Fig. 1).

All on the staff of the Geological Survey who are concerned with the stratigraphy and micropaleontology of the Devonian, in both Ottawa and in Calgary, have been so helpful that the author's feelings are best expressed by a collective expression of appreciation. Nonetheless, a special acknowledgment must go to the collectors whose patience and scientific curiosity led them to pick out these minute forms despite the fact that their practical value at the time appeared doubtful.

The kindness of Helen R. Belyea in preparing Table 1 is most greatfully acknowledged.

THE NATURE OF CHAROPHYTES

Modern charophytes are small bushy plants from a few inches to two feet high closely related to the green algae. They grow entirely submerged in still or slowly moving bodies of fresh or brackish water; no living marine forms are known.

A feature of prime importance to the paleontologist is that some species secrete lime which may form beds of freshwater limestone on the death of the plant. Moreover in the female fruiting bodies, the gyrogonites, the lime may be preserved in situ and the gyrogonite remain in identifiable form in rocks as old as Devonian. It is therefore with these gyrogonites that we are concerned.

During growth the primary germ cell, the oospore, of the plant is enveloped by a series of cells each of which originates at the base and extends to near the apex, in all modern forms with a left hand, sinistral, spiral. Round the summit of some species a ring of small cells, each continous with a main spiral cell, surrounds the apex like a small crown. This is known as the coronula. During calcification fine-grained calcite is deposited in the spiral cells of certain species, sometimes as a thin band along the inner wall of the cell, sometimes filling the whole cell. In some species it is deposited in the cells of the coronula also. After the death of the plant and disintegration of the organic matter the course of the spiral cells is preserved by its lime filling as spiral ridges winding up the surface of the gyrogonite, their shape and position being determined by that of the original cell and to some extent by the degree of calcification. It should be noted that this calcification seems to depend more on the specific nature of the charophyte than on the alkalinity of the water in which it grew.

Original manuscript submitted: 8 January, 1970
Final version approved for publication: 15 July, 1970

Dr. H.M.A. Rice (1900-1970) formerly Chief Scientific Editor,
Geological Survey of Canada, died on September 9th.

		STAGE	Southeastern British Columbia	Pine Pass Map-area British Columbia	Lesser Slave Lake Central Alberta	Great Slave Lake Southern District of Mackenzie	Keele River – Ramparts River Lower Mackenzie	Northeastern Alberta
DEVONIAN	UPPER	Frasnián			Ireton Formation	Escarpment Mbr.	Imperial Formation	Hay River Formation / Waterways Formation
					Beaverhill Lake Group	Hay River Formation	Canol Formation	
	MIDDLE	Givetian			Elk Point Group: Fort Vermilion Member	Slave Point Formation	Ramparts Formation	Slave Point Fm.
					Elk Point Group: Watt Mountain and Gilwood Formations	Watt Mountain Formation		Watt Mountain Fm.
						Sulphur Point Formation		Sulphur Point Fm.
			? Harrogate	Pine Point Formation	Elk Point Group: Muskeg and Methy equivalents	Horn River Formation	Hare Indian Formation	Muskeg Fm. / Prairie Formation
					?	Pine Point Formation		Keg River Formation
		Eifelian	Cedared / Mount Forster	unnamed argillaceous sandy carbonate	sandstone	Chincaga Formation: Upper Mbr.	Hume Formation	Chinchaga Formation
						Chincaga Formation: Lower Mbr.	Gossage Formation / Bear Rock Fm.	

GSC

Table I. Formational nomenclature in areas where Charophytes were collected

Diagram prepared by Helen R. Belyea.

The coronula cells are less commonly calcified than the spiral cells and in fossil gyrogonites in which no coronula can be recognized there is no means of being certain that one was ever present.

This brief summary is intended only to clarify the descriptions to follow. For more complete discussion the reader is referred to Peck (1934), Peck and Morales (1966), and Kesling and Boneham (1966).

CLASSIFICATION

It has been mentioned that the outer cells of all modern charophyte gyrogonites spiral to the left or sinistrally. However in some Paleozoic gyrogonites these cells and the related ridges follow a meridional course direct from base to apex, and some have a right hand, dextral, spiral. These characters have been used for a primary classification: order CHARALES, the only one with modern representatives, to include all those with sinistrally spiralling ridges, order SYCIDIALES for all with meridional ridges, and order TROCHILISCALES for those with dextrally spiralling ridges (Kesling and Boneham, 1966, p. 182). Others, however, have preferred to divide the Charophyta into two orders only, expanding the order SYCIDIALES to include the Trochiliscaceae (Peck and Morales).

Grambast (1962) stated that the division Charophyta consists of one living family, and nine extinct families. This report is concerned with three of the latter, Palaeocharaceae, Sycidiaceae, and Trochiliscaceae, and with one genus in each.

DESCRIPTIVE TERMINOLOGY

The morphological features most used in describing the fossil charophytes considered here are given below.

Size. This was measured to the nearest five microns which is well within the accuracy with which the end points can be recognized. Two dimensions are considered: the length, which is the axial distance from the base to the apex (length of polar axis, LPA, Peck and Morales), and the width (longest equatorial diameter, LED).

Shape. This can be expressed by the ratio between the length and the width, which indicates whether the gyrogonite is long and thin or squat and broad. Certain terms are commonly used to express different shapes and these and their limits are shown on Figure 6.

Some species of charophytes have unsymmetrical gyrogonites, the greatest diameter being near the apex or near the base, but this seems of little significance in the species being considered, in all of which the greatest width is about midway between the apex and the base.

Some gyrogonites have been markedly distorted during the compression of the host sediments as they changed to rock, so that the shape and measurements recorded may not always be those of the original gyrogonite. In practice it seems rather easy to tell if much distortion has occurred and the writer is confident that the measurements recorded are substantially correct.

BIOSTRATIGRAPHIC SIGNIFICANCE OF PALEOZOIC CHAROPHYTES

Charophytes may be important guide fossils in the Upper Paleozoic as their gyrogonites are large enough to be readily seen in rock specimens under low magnification and are generally not difficult to extract by hand from the rock matrix. Most are not difficult to identify and, from the limited information at present available, they seem to be useful age indicators.

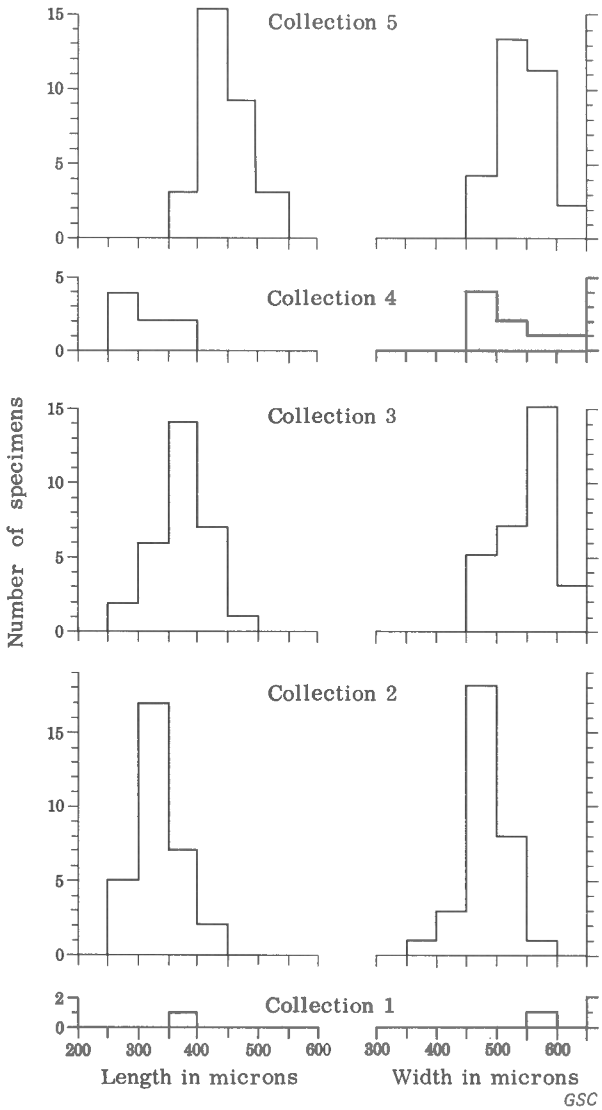

Figure 2. Eochara wickendeni. Size distribution.

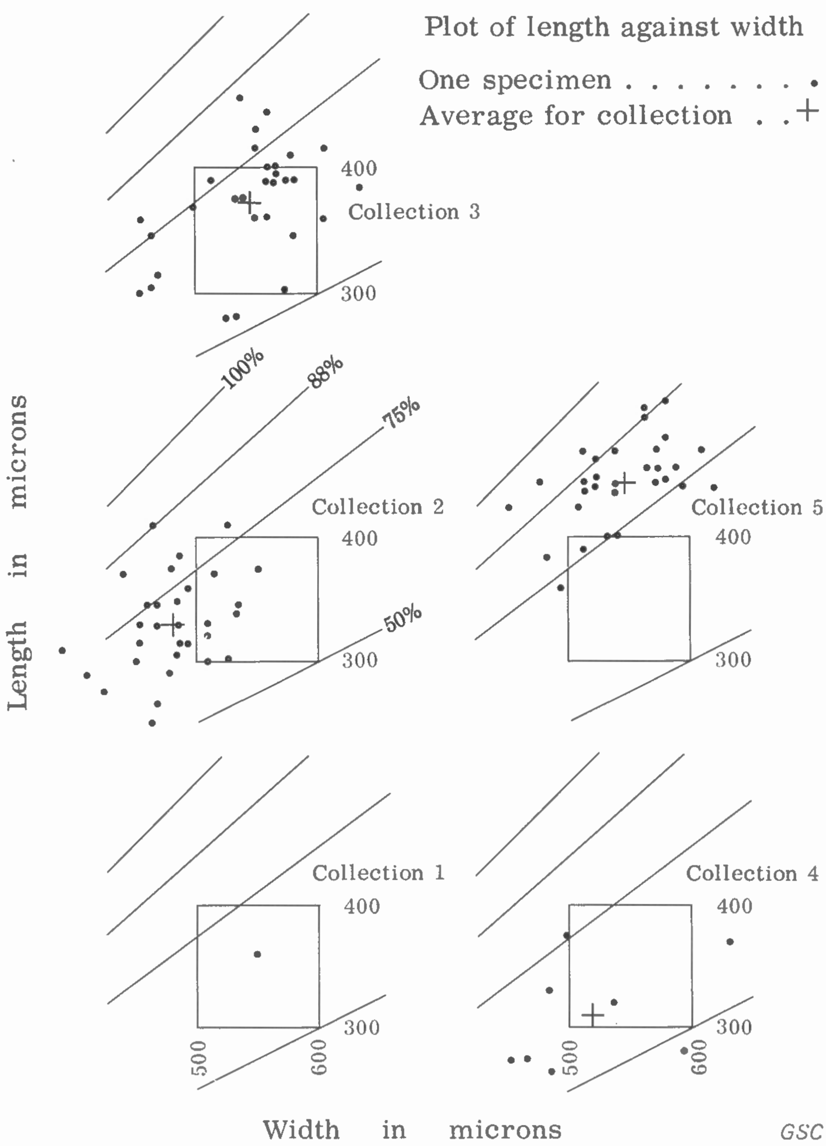

Figure 3. Eochara wickendeni.

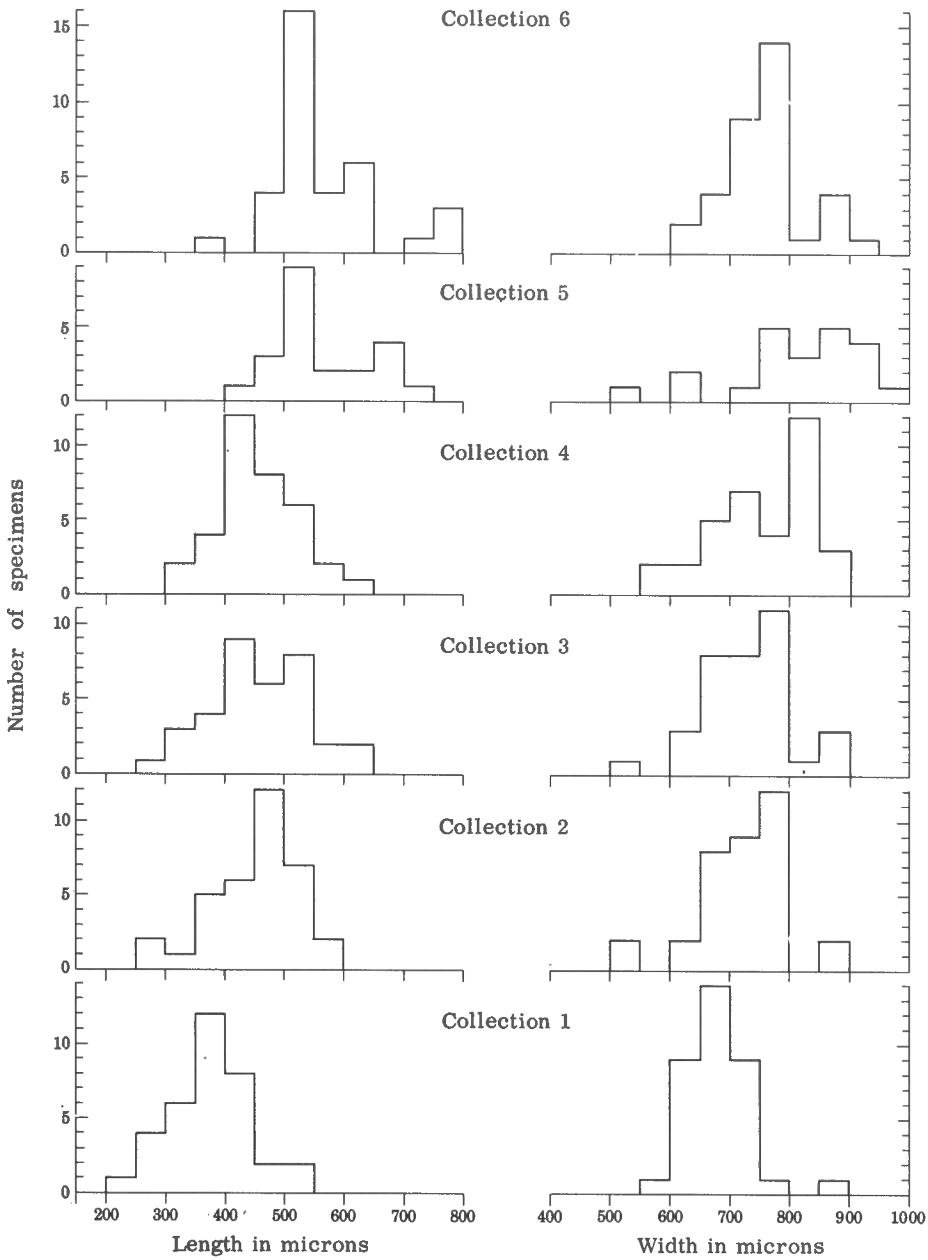

Figure 4. Chovanella burgessi. Size distribution.

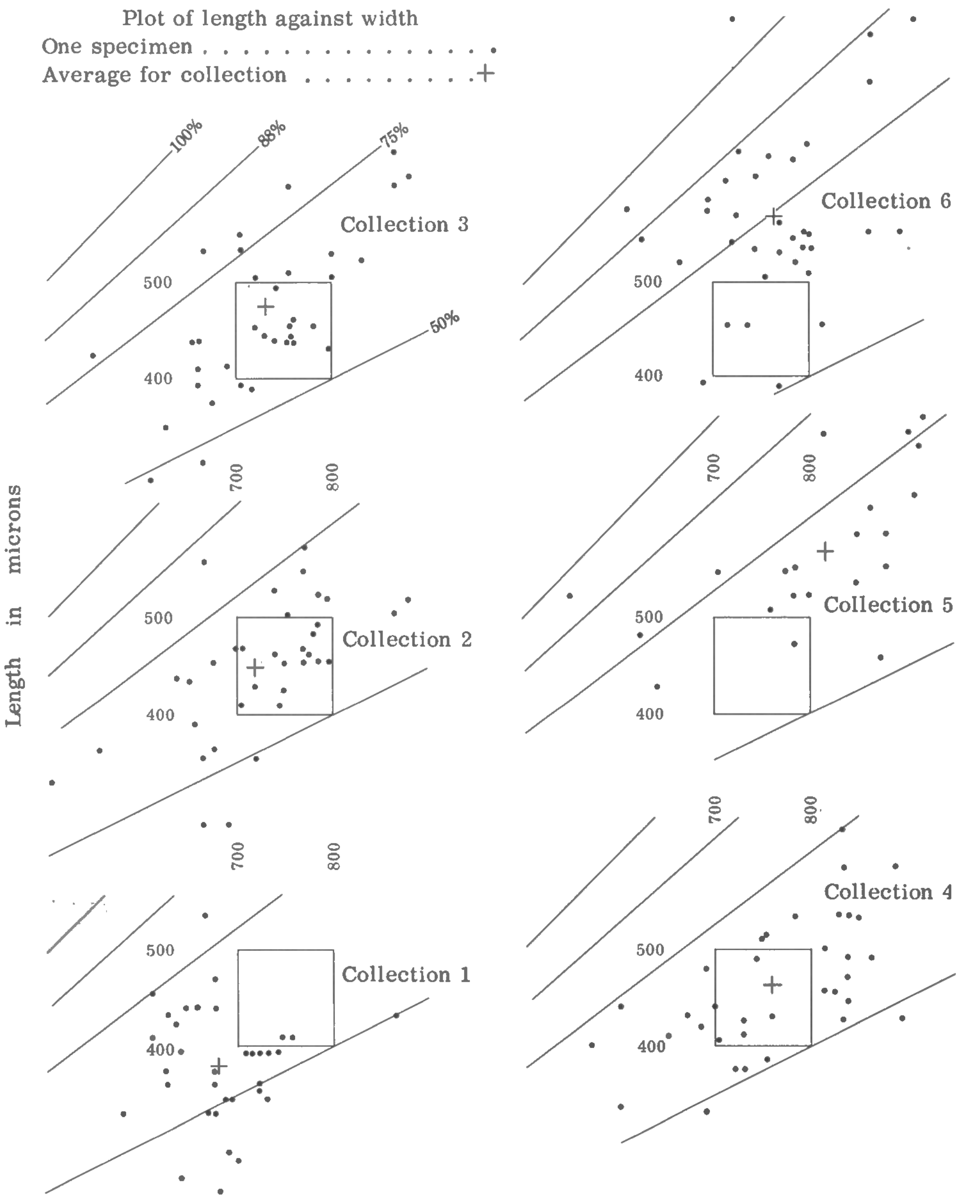

Figure 5. Chovanella burgessi.

On the other hand their biostratigraphic usefulness is severely limited by the extreme rarity with which they are found. This is understandable when we realize that charophytes are continental plants and will occur in marine sediments only if washed in from the land, which is unlikely to be a common occurrence. Their presence however should not be overlooked as they may furnish valuable and otherwise unavailable information on the age and provenance of the host strata.

SYSTEMATIC PALEONTOLOGY

Order CHARALES

Family PALAEOCHARACEAE

Genus *Eochara* Choquette, 1956

Eochara wickendeni Choquette

Plate I, figures 1-8; Figures 2, 3, 6

Eochara wickendeni Choquette, 1956, p. 1373.

Description. Non-coronulate, oblate, suboblate, and oblate spheroidal gyrogonites (*see* Fig. 6), ranging from 250μ to 510μ in length and 390μ to 635μ in width (from 275μ to 412μ and 522μ to 632μ, Peck and Morales, 1966, p. 309). They have from eight to thirteen (most from ten to twelve) sinistrally coiled spiral ridges which make about half a turn round the gyrogonite from base to apex. In many specimens the basal opening is occupied by a small circular protruding boss.

Remarks. Peck and Morales (1966, p. 310) point out that "*Eochara wickendeni* constitutes the only sinistrally spiraled charophyte found in Devonian sediments and represents the oldest member of the Order Charales." All specimens in the collections studied agree very closely with the published descriptions and there can be no question as to their identity. There is however a somewhat greater range in size and a considerable variation in shape. Although some of the individuals measured were a bit distorted, substantial error is unlikely. Between the apical pore and the end of the spiral ridges in many specimens is a confused area with irregular knobs and depressions (Pl. I, figs. 1-3, 7), and it is possible that this is the site of a coronula that was too lightly calcified to be preserved in recognizable form. While Figure 2 shows that specimens from each collection form a relatively compact group, Figure 6 shows that there are considerable differences in the average size for each collection. *E. wickendeni* is commonly found in association with *Chovanella burgessi* Peck and Eyer.

Occurrence. Pine Point, Watt Mountain, Slave Point, and Cedared Formations. Collection 1 to 5 of this study.

Age. Late Eifelian (Eyer, in press) and Givetian (late Middle Devonian).

Order SYCIDIALES

Family SYCIDIACEAE

Genus *Chovanella* Reitlinger and Yartseva, 1958

Chovanella burgessi Peck and Eyer

Plate I, figures 9-12; Figures 4-7

Chovanella burgessi Peck and Eyer, 1963, p. 98. Pl. 1, figs. 1-15.

Description. Coronulate, oblate-spheroidal to peroblate gyrogonites (only a few oblate-spheroidal specimens were seen and Peck and Eyer's definition omits this catagory). Size; length 240μ to 670μ, width 505μ to 970μ

(Peck and Eyer 1963, p. 310 give LPA 425μ to 625μ and LED 500μ to 800μ). While most measurements from these collections fall well within Peck and Eyer's limits some are larger or smaller and certainly not all discrepancies are due to distortion. Moreover the pattern of the dimensions as plotted (*see* Fig. 5) gives no hint that more than a single species is present. It can therefore be safely accepted that the full size range of the species is somewhat greater than that given by Peck and Eyer. In all other characteristics the agreement is excellent.

Eight to eleven meridional ridges is given as diagnostic of the species, and, although specimens well enough preserved for the ridges to be accurately counted are few, the same numbers were found in this study also; ten is the number commonest in every collection. In most specimens the ridges originate close to a small protruding boss at the base, bifurcate almost immediately, the two forks, presumably following the margins of the original cell, joining again in a loop near the apex. In many specimens these loops appear as a ridge or shoulder round the summit of the gyrogonite. Within this shoulder is generally a rather confused coronula surrounding the apical opening.

The gyrogonites vary considerably in general form and three types with distinctive lateral aspects can be recognized, although intermediate forms are common. There is no doubt that the three types form an integrated series and would scarcely deserve mention were it not that in some collections certain types predominate producing a characteristic aspect to that collection. Perhaps these are growth stages or perhaps responses to environmental conditions.

Type I (Fig. 7a) seems to conform to the holotype and is very common in most of the collections. In it the ridge formed by the apical loops of the meridional ridges is not prominent so that there is little difference in curvature between the basal and apical halves. The gyrogonite resembles a ridged doughnut the hole being stuffed with a slightly protruding, irregular filling. This is clearly transitional to Type II and intermediate forms are very common.

Type II (Fig. 7b) is also very common and is characterized by a pronounced shoulder round the summit formed by the loops of the meridional ridges. As a result the base of the gyrogonite appears bowl shaped, with or without a protruding boss, and the summit irregularly truncated, the irregularities resulting from the loops of the ridges and a jumble of imperfectly preserved coronula cells. A common variation of this type results from a flattening of the base which produces a form like a short, stout barrel.

Type III (Fig. 7c) is scarcer but very distinctive and forms the bulk of Collection 1. In essence it is a very much compressed form of Type I. The meridional ridges are most strongly developed near the equator and proceed from there almost straight towards the base and apex instead of over a curved surface. The resulting effect is of a short, spindle-shaped disc or wheel and in rare specimens the ridges are reduced to little more than equatorial knobs. The above description is of the extremes of the type, most specimens being longer with less distinctly planar lateral surfaces and individuals transitional to Type I are common.

One other observation deserves comment. It will be noted on Figure 5 that the shape of some of the groups resulting from the plot of the length of individuals against their width is crudely elliptical and that the axis of this ellipse tends to cross the lines denoting a constant ratio of length to width. In general the small gyrogonites tend to be short and broad, the larger ones more nearly round. This relationship is even more apparent when we consider the group formed by plotting the average size of each collection in a similar manner (*see* Fig. 6). This group is almost linear and crosses the percentage lines at a high angle. The significance of this observation is obscure to the writer.

Occurrences. Slave Point, Pine Point, Watt Mountain, and base of the Prairie Formations and (Eyer, in press) from the Cedared and Mount Forster Formations, all in western Canada; Cooper Limestone facies of the Calloway

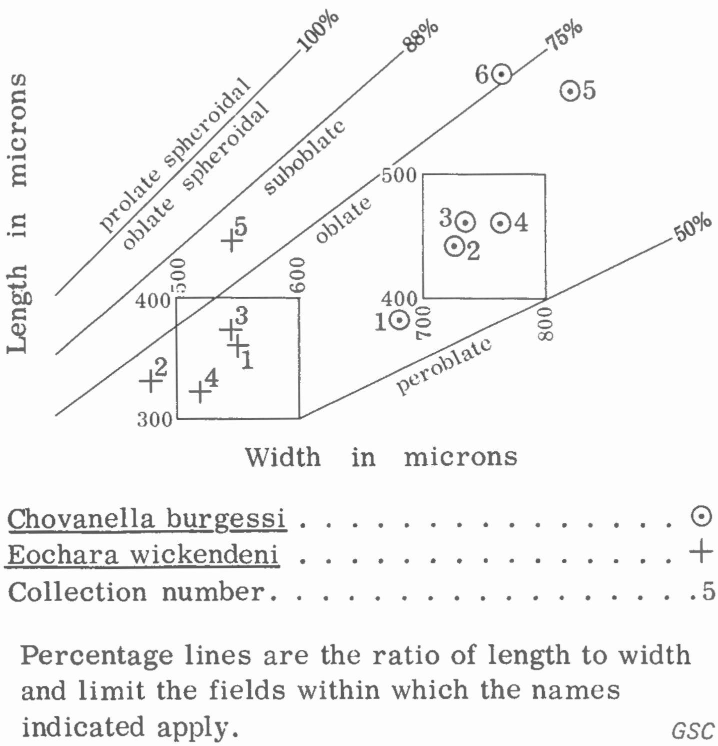

Figure 6. Average size of gyrogonites in each collection.

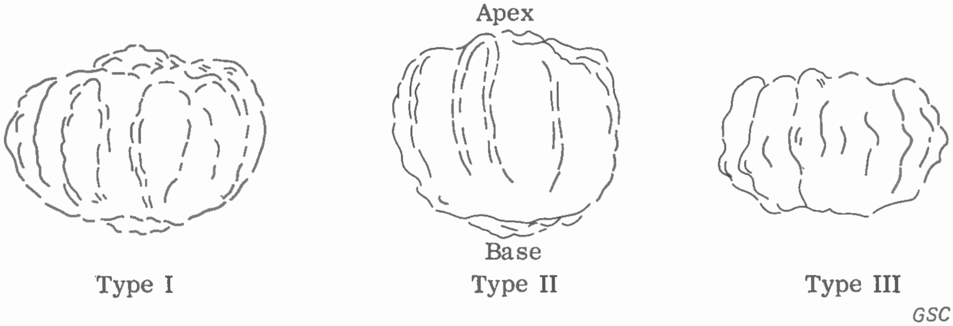

Figure 7 a,b,c. Chovanella burgessi. Three main types.

Formation, Missouri and elsewhere (Peck and Eyer, 1963, p. 100), commonly in association with *E. wickendeni*. Collections 1 to 6 of this study.

Age. Late Eifelian to late Givetian (late Middle Devonian).

Family TROCHILISCACEAE

Genus *Moellerina* Ulrich, 1886

Moellerina greenei Ulrich

Figures 8-10

?*Calcisphaera robusta* Williamson, 1880 p. 523, Pl. 20, fig. 81.
?*Saccammina eriana* Dawson, 1883, pp. 5-8, text figs. 3a-e.
Moellerina greenei Ulrich, 1886, p. 35, Pl. 3, figs. 8, 82-e.
Calcisphaera lemoni Knowlton, 1889, pp. 202-209, text figs. 1-3.
?*Calcisphaera robusta* Williamson, Miller, 1889, p. 155, text fig. 95.
Chara devonica Wieland, 1914, p. 245.
Trochiliscus bellatulus Peck, 1934, p. 115, Pl. 10, figs. 21, 23-24.
Trochiliscus devonicus (Wieland), Peck, 1934, p. 108, Pl. 13, figs. 14-21.
Trochiliscus rugulatus Peck, 1934, p. 115, Pl. 12, figs. 1-4.
Trochiliscus sp., Peck, 1934, p. 116, Pl. 13, figs. 8-11.
Trochiliscus greenei (Ulrich), Brown, 1946, p. 344.

Description. Non-coronulate, oblate spheroidal gyrogonites with seven to nine dextrally coiled spiral units. Peck and Morales (1966, p. 315) give a size of from 522µ to 1100µ, but Kesling and Boneham (1966) in their extensive study of *Trochiliscus bellatulus* give a range of not more than 810µ to 1200µ for the length and 900µ to 1200µ for the width.

Remarks. Kesling and Boneham's figures are plotted on Figure 10 and, although only three specimens were seen in this study, one from Collection 13 and two from Collection 14, their dimensions are well within the ranges given. The three specimens reported on here agree so well with the Peck and Morales description of *Moellerina greenei* and even better with that of Kesling and Boneham in every respect that there seems no doubt of their identity.

Stratigraphy. Collected from the base of the Beaverhill Lake Formation and the Escarpment Member of the Hay River Formation.

Age. The Canadian collections are both Frasnian (early Upper Devonian) in age. However the range of the species given by Peck and Morales (1966, p. 32) is Middle and Upper Devonian. Collections 13 and 14 of this study.

?*Moellerina greenei* Ulrich

Plate I, figures 13-15; Figures 8-10

Description. Non-coronulate, oblate to oblate spheroidal gyrogonites ranging in length from 505µ to 785µ and in width from 585µ to 895µ. From seven to ten dextrally coiled spiral ridges make from a quarter to half a turn from base to apex. In one collection most gyrogonites had nine ridges but in all others ten is the commonest number, although many always have nine.

Remarks. There is little doubt that Collections 7 to 12 are of *Moellerina greenei* but certain features are puzzling. It should be pointed out that the principal difference recorded between the genera *Karpinskya* and *Moellerina* is the presence of a coronula in the former and its absence in the latter. Many of the GSC specimens have a confused, slightly raised area round the apical pore, many have well marked pits at the apical end of the spiral

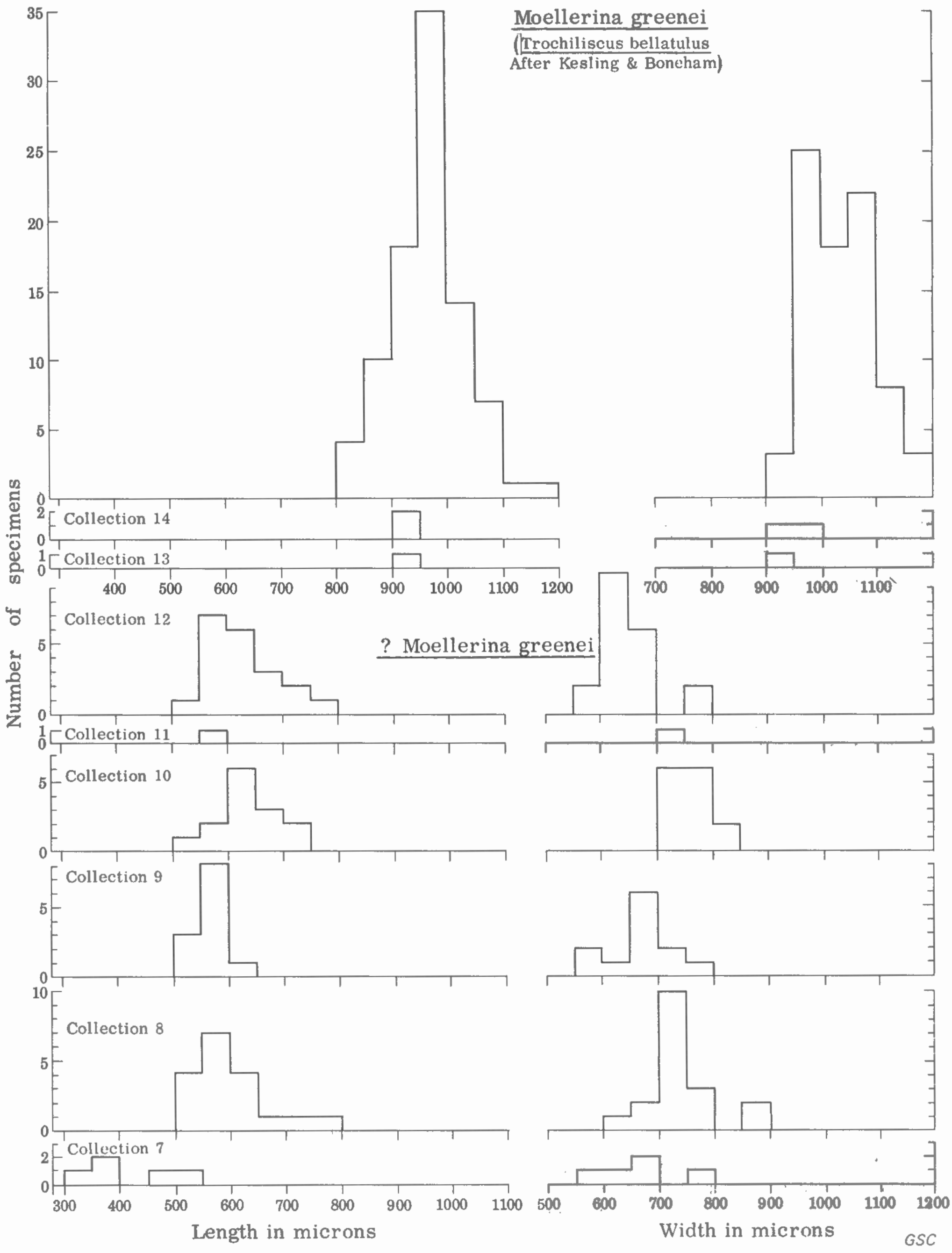

Figure 8. Moellerina greenei and ? Moellerina greenei. Size distribution.

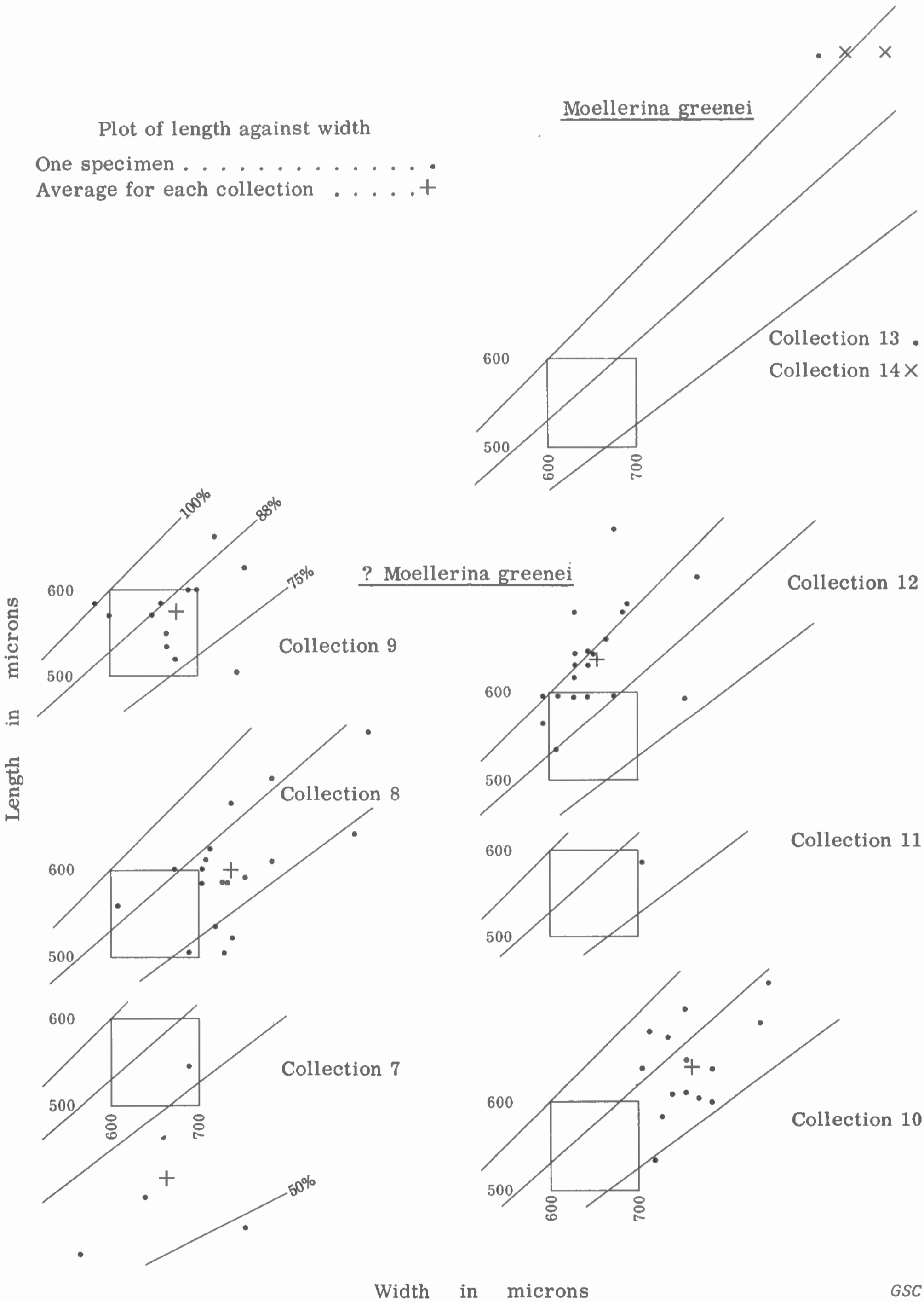

Figure 9. Moellerina greenei and ? Moellerina greenei.

ridges, and in some the ridges split near the top to reunite and enclose a tear-drop-shaped depression. Some indeed are very like those of *Karpinskya bilineata* Peck, illustrated by Peck and Morales (1966, Pl. 2, figs. 2-5), particularly in size and shape. They are also, however, extremely like specimens of *Trochiliscus bellatulus* Peck, a synonym for *M. greenei* (Peck and Morales, 1966, p. 315), illustrated by Kesling and Boneham (1966, Pls. I, II). Of their specimens Kesling and Boneham said (pp. 188-189): "The variation in shape of the apical pore and the deep pits in the apical region suggests that coronula cells were attached there but not preserved". Although no specimen was seen by the writer that definitely showed the coronula so clearly illustrated by Peck (1934, Pl. 10, figs. 26, 28) for *K. bilineata*, it is hard to ignore the statement of Peck and Morales regarding the same species that: "If the coronula units are not present, small depressions at the terminations of the spiral units mark the position previously occupied by them.".

In the absence therefore of a clearly recognizable coronula it seems probable that the species being discussed must be regarded as *M. greenei* but there is a possibility that a coronula may have been present but not preserved in any of the specimens seen. For this reason and because of the difference in size, to be discussed below, the writer prefers to question the assignment.

Inspection of Figures 8 to 10 shows the discordance in size between the gyrogonites of Collections 7 to 12 and those of Collections 13 and 14. Unfortunately the last two collections consist of only three specimens, so that the range in size is quite unknown, but it is striking that no single specimen of ?*M. greenei* is as large as any of the three, nor of any reported on by Kesling and Boneham for *T. bellatulus*. It is hard to escape a feeling that, as the two groups are of about the same age and from the same geographic region, we are dealing with two distinct species, and that the smaller species may be *Karpinskya bilineata*. This is an added reason for questioning the assignment.

Fortunately for purposes of stratigraphic correlation *M. greenei* and *K. bilineata* have the same chronological range.

Stratigraphy. Hare Indian, Hay River, Hume and Pine Point Formations, all from northwestern Canada.

Age. ?*M. greenei* ranges in age from early Givetian to early Frasnian (Middle and early Upper Devonian). The Hume Formation is believed to straddle the Eifelian-Givetian boundary (*see* Table I) and, although a Givetian age is regarded as more likely for collection 12, there is a possibility that it may be as old as Eifelian. ?*M. greenei* seems to be in part of the same age as *C. burgessi* and *E. wickendeni* and it is interesting that it has not been found in collections containing them.

The age of the Canadian collections agrees with that given by Peck and Morales (1966, p. 313) for both *M. greenei* and *K. bilineata*.

DESCRIPTIONS OF COLLECTIONS

Collection 1. Falconbridge No. 2 well.

Location. This well was drilled under the Quartz Mining Act and no official record of its location is available. It is believed to be about 3.5 miles south of the mouth of Buffalo River, District of Mackenzie.

Collector. Unknown.

Stratigraphy. Reported to be from Slave Point Formation (*see* Table I).

Age. Late Givetian (late Middle Devonian).

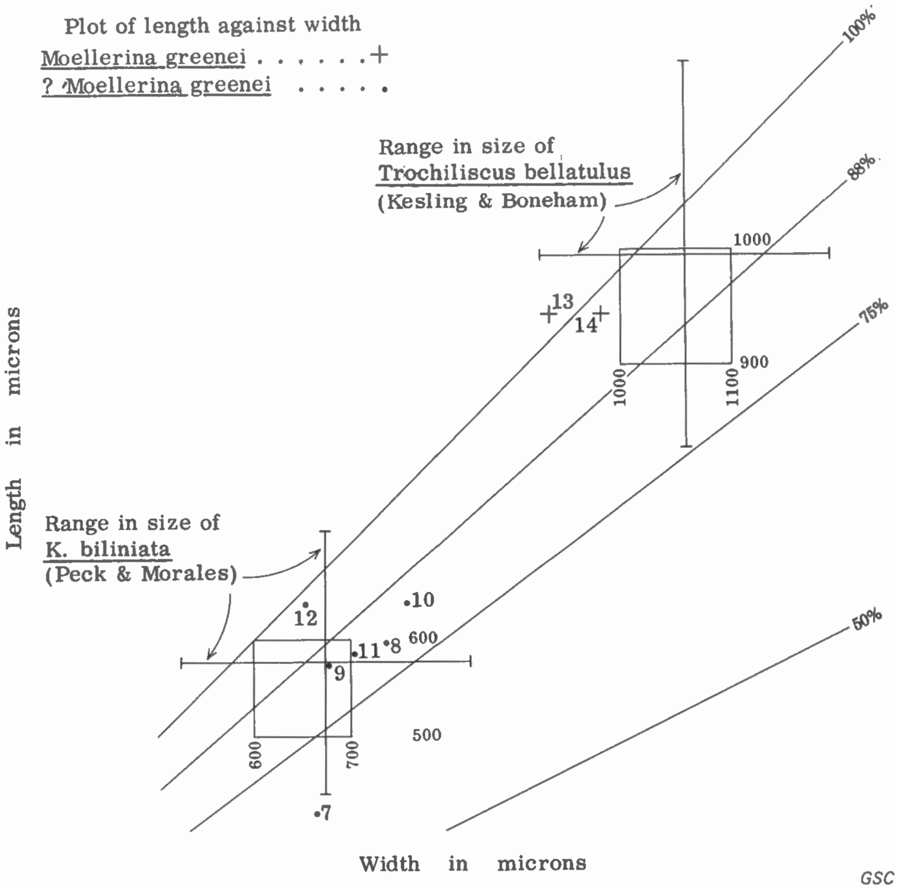

Figure 10. Average size of gyrogonites in each collection.

Charophyta. *Chovanella burgessi* (35 gyrogonites measured). Abundant and mostly well preserved. The average size of specimens from this collection is considerably smaller than that of specimens from the other collections. Most noticeable is the preponderance of Type III (Fig. 7) which accounts for 65 per cent of 26 well preserved gyrogonites, far more than in the other collections. Figures 5 and 6 clearly show this difference, and Figure 5 also shows that variation in length seems far less directly related to variation in width than in the other collections. It would seem, however, that these differences were of environmental rather than biostratigraphical significance as they do not appear in Collections 2 and 3, also from the Slave Point Formation.

Eochara wickendeni (one gyrogonite measured). Only two specimens of this species were seen, one too badly distorted to permit measurement. The other (*see* Figs. 2 and 3) was also somewhat distorted but the measurements are probably reasonably reliable. There is no doubt as to the identity of the specimens and nothing particularly remarkable about the occurrence except their rarity. Perhaps the preponderance of *C. burgessi* Type III indicates a condition unfavourable for *E. wickendeni*.

Collection 2. Silver Summit, hole No. 1.

Location. This well was also drilled under the Quartz Mining Act and there is no official record of its location. Probably in the Buffalo River area, District of Mackenzie. Depth 110 feet.

Collector. Unknown.

Stratigraphy. Reported to be from Slave Point Formation.

Age. Late Givetian (late Middle Devonian).

Charophyta. *Chovanella burgessi* (35 gyrogonites measured). Abundant and about average in size and shape (*see* Figs. 4-6). Type III present but forms only 20 per cent of 30 well preserved specimens.

Eochara wickendeni (31 gyrogonites measured). More plentiful than *C. burgessi* and entirely typical of the species. On the average the gyrogonites are the smallest in any of the collections. Not many specimens are well preserved, many being distorted, but only the better specimens were measured and the figures plotted are believed to be nearly correct.

Collection 3. Falconbridge No. 28.

Location. As for previous wells, there is no official record; assumed to be about 9.5 miles south-southeast of the mouth of Buffalo River, District of Mackenzie. Depth 54 feet.

Collector. Unknown.

Stratigraphy. Reported to be from Slave Point Formation.

Age. Late Givetian (late Middle Devonian).

Charophyta. *Chovanella burgessi* (35 gyrogonites measured). Abundant, mostly Types I and II (*see* Fig. 7) but a few of Type III also present. Well preserved and quite typical.

Eochara wickendeni (30 gyrogonites measured). Also abundant and quite typical.

Collection 4. Cominco Test Hole 471.

Location. Pine Point Highway, District of Mackenzie. Depth 233-235 feet.

Collector. Helen R. Belyea.

Stratigraphy. No core was recovered from the 25-foot interval overlying the collection and the formation from which it was collected is therefore uncertain. It is either Watt Mountain or a green dolomite or calcareous shale within the Sulphur Point Formation.

Charophyta. Chovanella burgessi (35 gyrogonites measured). Abundant and very similar to those of Collection 3. Types I and II predominate but typical examples of Type III are present.

Eochara wickendeni (eight gyrogonites measured). Only eight specimens of this species are present, but these are typical and, although some are rather distorted, they match well in size and shape with those from Collections 1 to 3.

Collection 5. Midland Pine Point No. 1.

Location. About 60° 47½' N, 114° 15' W, District of Mackenzie. Depth 84 feet, sample 3.

Collector. J. Vasquez.

Stratigraphy. Pine Point Formation.

Age. Givetian (late Middle Devonian).

Charophyta. Chovanella burgessi (22 gyrogonites measured). Much less plentiful than *E. wickendeni*; mostly Types I and II, none clearly recognizable as Type III. They average larger that those from Collections 1 to 4, more nearly like those in Collection 6, but are otherwise typical.

Eochara wickendeni (30 gyrogonites measured). Predominates in the collection and is typical of the species but on the average much rounder than those in Collections 1 to 4 (*see* Figs. 3 and 6). Whereas in the earlier collecions ten spiral ridges is the commonest number, of the fifteen specimens in Collection 5 in which they could be accurately counted, 8 had twelve ridges, 5 had eleven and 2 thirteen ridges.

This collection differs from the other collections in the proportions of the two species present, in the larger size of *C. burgessi* (more like those from Collection 6), and in the rounder shape and greater number of spiral ridges of *E. wickendeni*.

Collection 6. Imperial Wolverine 7-24-76-18 Well.

Location. G.S.C. loc. 37518. Well 7-24-76-18 W4, Alberta. Depth 3770-3775 feet.

Collector. Helen R. Belyea; April, 1959.

Stratigraphy. From the basal five feet of shale in a sequence of interbedded green shale, dolomite, and anhydrite with inclusions of salt that lies at the base of the Prairie Formation. This important collection demonstrates the range of *Chovanella burgessi*, in this area, to be at least from the base of the Prairie Formation to the Watt Mountain Formation, approximately 670 feet in this hole.

Age. Givetian, probably early or middle (Middle Devonian).

Charophyta. Chovanella burgessi (35 gyrogonites measured). Abundant and the only collection in which *E. wickendeni* is absent. Gyrogonites are typical of the species, mostly Types I and II but a few are of Type III. They are however larger than any except those from Collection 5 but are, on the average, rounder than all of them (Fig. 6).

Collection 7. Clearwater River.

Location. G.S.C. loc. 45293. Section measured at 55° 51' N, 123° 15' W, Clearwater River, Pine Pass map-area, British Columbia.

Collector. B.S. Norford, 1961.

Stratigraphy. Probably Pine Point Formation, collected from 175 to 200 feet above the base of the Middle Devonian just above Horizon C of Norford, Gabrielse, and Taylor (1967, p. 511).

Age. Probably Givetian (late Middle Devonian).

Charophyta. *?Moellerina greenei.* This collection consists of only five specimens (Figs. 8-10), and three of these are so distorted that the accuracy of the measurements is in doubt, some specimens particularly seem to have been squashed vertically so that the length may appear to be less than it really was. Three specimens are well enough preserved for the spiral ridges to be counted, and all have nine ridges. Pits and sculpturing, suggesting the position of a coronula, now absent, are well marked.

Collection 8. Ramparts Gorge (No. 1).

Location. G.S.C. loc. 45309. Lower end of gorge, right bank, Macken ie River, District of Mackenzie.

Collector. D.J. McLaren, 1961.

Stratigraphy. Hare Indian Formation, 90 to 110 feet below top.

Age. Givetian (late Middle Devonian). The Hare Indian Formation overlies the Hume Formation (*see* Collection 12) which straddles the Eifelian-Givetian boundary.

Charophyta. *?Moellerina greenei* (18 gyrogonites present). Typical of the species. Apical sculpturing and well developed pits common. Of ten well preserved specimens, 8 had eight spiral ridges and 2 had nine. In this respect it differs from those of Collection 7 where all had nine.

Collection 9. Ramparts Gorge (No. 2).

Location. G.S.C. loc. 45317. Lower end of the gorge, right bank, Mackenzie River, District of Mackenzie.

Collector. D.J. McLaren, 1961.

Stratigraphy. Uppermost part of Hare Indian Formation.

Age. Givetian (late Middle Devonian). See remarks for Collection 8.

Charophyta. *?Moellerina greenei* (12 gyrogonites present). Not different from those of Collection 8 except that on the average they are considerably smaller (Fig. 10). In this collection also most have eight spiral ridges. Of ten good specimens, 6 have eight ridges and 4 have nine.

Collection 10. Ramparts Gorge (No. 3).

Location. G.S.C. loc. 45318. Lower end of gorge, right bank, Mackenzie River, District of Mackenzie.

Collector. D.J. McLaren, 1961.

Stratigraphy. Hare Indian Formation, 90 feet below top.

Age. Givetian (late Middle Devonian). See remarks on Collection 8.

Charophyta. *?Moellerina greenei* (14 gyrogonites present). Not different from those described above except that the average size is slightly larger than for those of Collection 8 and much larger than for those of

Collection 9. However all three collections are so small and the range in size of individuals so great that there is no reason to attach much significance to this observation. Of ten specimens in which the number of ridges could be counted, 4 had eight ridges, 4 had nine ridges, 1 had ten ridges, and 1 probably seven.

Collection 11. Hay River

Location. G.S.C. loc. 31283. On Hay River 0.75 miles upstream from the gravel pit at Mile 23, District of Mackenzie.

Collector. Peter Harker, 1957.

Stratigraphy. Hay River Formation.

Age. Frasnian (early Upper Devonian).

Charophyta. Collection consists of a single specimen of ? *Moellerina greenei* but this is typical of the species and in the middle of its size range. It is indistinguishable from specimens from the Givetian Hare Indian Formation of the Ramparts Gorge section (Collections 8-10).

Collection 12. Little Bear River.

Location. G.S.C. loc. C-3896. North fork of Little Bear River, District of Mackenzie. South side of canyon; 64° 28 1/3' N, 126° 28 1/2' W (NTS 96D).

Collector. A.E.H. Pedder, 1969.

Stratigraphy. Hume Formation, 214 feet above base, 350 feet below top.

Age. Givetian, possibly Eifelian (early Middle Devonian). The Hume Formation is believed to straddle the Eifelian-Givetian boundary and this collection was made from near the mid-point of the exposed section. This is the only collection of *?M. greenei* from beds that might be as old as Eifelian; the age assignment is made with reservations but a Givetian age is regarded as the more probable.

Charophyta. The gyrogonites of this interesting collection are all typical of *?Moellerina greenei* in every respect except that the average specimen is much rounder than normal (Figs. 8-10). In the bulk of them the length and width are almost identical and many specimens are longer than wide, which is not true of any specimens from the other collections. In this respect they are more like *Moellerina greenei* except that all are much smaller.

Collection 13. Hudson Bay Union Assineau 10-32-72-8 Well.

Location. G.S.C. loc. 37989. 10-32-72-8W5, Alberta. Depth 6349 feet.

Collector. Helen R. Belyear, 1960.

Stratigraphy. Probably basal Beaverhill Lake Formation.

Age. Probably early Frasnian (earliest Upper Devonian).

Charophyta. Only a single gyrogonite is present but it is typical of *Moellerina greenei* in size and appearance, and is much larger than any specimen of *?M. greenei.*

PLATE I

Figure 1. *Eochara wickendeni*. Hypotype, GSC No. 27624, x 50. Collection 2, Silver Summit. Apical view.

Figure 2. *E. wickendeni*. Hypotype, GSC No. 27625, x 50. Collection 2, Silver Summit. Apical view.

Figure 3. *E. wickendeni*. Hypotype, GSC No. 27625, x 50. Collection 2, Silver Summit. Apical view. Figures 1, 2, 3 and 7 show the general confused area round the apical pore which hints that a coronula may have been present but not preserved.

Figure 4. *E. wickendeni*. Hypotype, GSC No. 27627, x 25. Collection 2, Silver Summit. Lateral view, apex up. Note the prominent basal plug.

Figure 5. *E. wickendeni*. Hypotype, GSC No. 27628, x 50. Collection 5, Midland Pine Point. Basal view.

Figure 6. *E. wickendeni*. Hypotype, GSC No. 27629, x 50. Collection 5, Midland Pine Point. Lateral view, apex up. Note protruding boss at base.

Figure 7. *E. wickendeni*. Hypotype, GSC No. 27630, x 50. Collection 5, Midland Pine Point. Apical view.

Figure 8. *E. wickendeni*. Hypotype, GSC No. 27631, x 50. Collection 5, Midland Pine Point. Lateral view, apex up. Note the difference in shape from the specimen illustrated by Figure 6.

Figure 9. *Chovanella burgessi*. Hypotype, GSC No. 27632, x 50. Collection 5, Midland Pine Point. Basal view.

Figure 10. *C. burgessi*. Hypotype, GSC No. 27633, x 50. Collection 5, Midland Pine Point. Apical view.

Figure 11. *C. burgessi*. Hypotype, GSC No. 27634, x 50. Collection 5, Midland Pine Point. Lateral view, apex up. This is a good example of Type I, which is the most common. Note that the loops of the ridges do not form a pronounced collar as they do in Type II.

Figure 12. *C. burgessi*. Hypotype, GSC No. 27635, x 50. Collection 1, Falconbridge No. 2. Lateral view, apex up. Note that the bifurcation of the ridges is not evident but the specimen illustrates the high shoulder and flat top of Type II.

Figure 13. *?Moellerina greenei*. Hypotype, GSC No. 27636, x 50. Collection 10, Ramparts Gorge No. 3. Apical view. Note the prominent pits round the apical pore suggesting the site of a coronula, now lost. This figure and figures 14 and 15 are quite typical of *M. greenei* except that they seem to be significantly smaller.

Figure 14. *?M. greenei*. Hypotype, GSC No. 27637, x 50. Collection 10, Ramparts Gorge No. 3. Basal view.

Figure 15. *?M. greenei*. Hypotype, GSC No. 27638, x 50. Collection 10, Ramparts Gorge No. 3. Lateral view, apex up. Note splitting of spiral ridges towards apex. These forks reunite just beyond the scope of the illustration.

Illustrations of Fossil Charophytes (Neg. 201313).

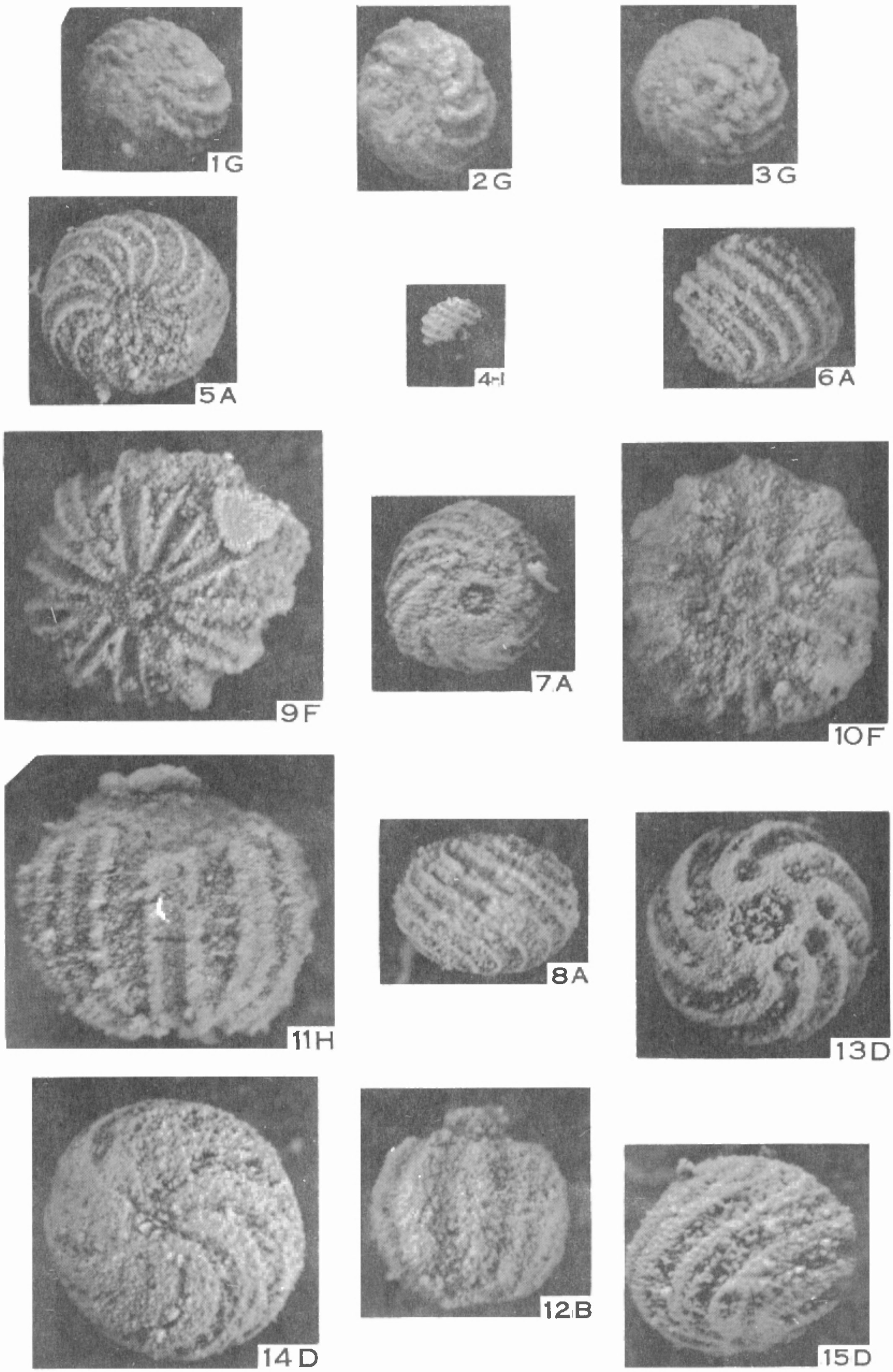

Plate I

Collection 14. Murphy Canada Alexandra Falls No. 2 well.

Location. G.S.C. loc. 41782. At 60° 15' 30.8" N, 116° 34' 41.96" W. District of Mackenzie. Cuttings recovered from the interval 580-590 feet.

Collector. Helen R. Belyea.

Stratigraphy. Escarpment Member, Hay River Formation.

Age. Early to Middle Frasnian (early Upper Devonian). It must be pointed out that these specimens were recovered from drill cuttings and there is a chance that they have actually come from beds higher in the well than those at the point of recovery. However the well started in the Tathlina Formation, also Frasnian, so that a Frasnian age is not in doubt.

Charophyta. Only two specimens are present but both are typical of *Moellerina greenei* in size and appearance and very like the one in Collection 13.

ADDENDUM

Since completing the above report two additional charophyte collections have been brought to the writer's attention. These are of compact dark grey limestone and charophytes are plainly visible on the weathered surface. Unfortunately in only a few is the outer layer with the spiral cells preserved so that identification of most individuals is not possible.

Location. G.S.C. loc. 70519. Fairmont Ridge, southeastern British Columbia. 50° 20.5' N, 115° 46.3' W.

Collector. G.B. Leech (1965).

Stratigraphy. Cedared Formation, 153 feet above the base of the Devonian.

Age. Late Eifelian (Middle Devonian).

Charophyta. Poorly preserved but both *Chovanella burgessi* Peck and Eyer and *Eochara wickendeni* Choquette identified.

Location. G.S.C. loc. 70522. Fairmont Ridge, southeastern British Columbia. 50° 20.8'N, 115° 46.3'W.

Collector. G.B. Leech (1965).

Stratigraphy. Cedared Formation, 470 feet above the base of the Devonian.

Age. Late Eifelian (Middle Devonian).

Charophyta. Poorly preserved but *Chovanella burgessi* Peck and Eyer identified.

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