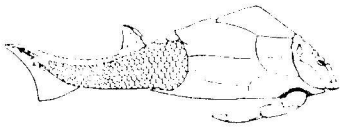

WEISBORD N.E. 1967. The Devonian system in western Venezuela. *Intemational Symposium on the Devonian System.* Alberta, Canada. 2: 215-226.

The Devonian System in Western Venezuela

NORMAN E. WEISBORD

ABSTRACT

The type section of the Devonian in western Venezuela is named the Rio Cachirí Group, and the type locality is near the headwaters of the Rio Cachirí, on the east flank of the Perijá Mountains, some 89 kilometers west of the city of Maracoibo The base of the Group is unconformable and possibly in fault contact with Precambrian schists and quartzites of the Perijá Series, and the top of the Group is unconformably overlain by the Palmar[illegible] Formation of Permo-Carboniferous age. The thickness of the Rio Cachirí Group is estimated at 2,438 meters, but because of structural complications and incomplete sequences, the present thickness measurement will undoubtedly be revised after a more detailed study has been made. The Rio Cachirí Group is made up of three formations, with transitional boundaries between them: the Caño Grande Formation below, the Caño del O[illegible] Formation in the middle, and the Campo Chico Formation above. The Caño Grande Formation is approximately 762 meters thick and consists of sandy shales, argillaceous sandstones, and calcareous shales, the latter locally fossiliferous, especially [illegible] near the top of the Formation. The Caño del Oeste Formation is about 1,067 meters thick, and is composed of blackish quartzitic sandstones, dark gray shales, and blue-black argillaceous limestones, occasionally containing corals and crinoid columnals. The uppermost formation -- the Campo Chica -- is an estimated 609 meters thick, and composed of quartzitic sandstones, sandy shales, and sandy limestones, all of which are generally unfossiliferous.

The fossils in the Caño Grande and Caño del Oeste Formations, and the rec[illegible] of similar strata in both the Caño del Oeste and Campo Chico, suggest that the Rio Cachirí Group was deposited in late Early Devonian to early Late Devonian time. In western Venezuela the Rio Cachirí Group occurs in a faulted and disturbed zone some 7 kilometers in length between Caño Grande and Caño del Norte, but the extent to the northeast and southwest beyond these limits is still not known with certainty. In Colombia the Group would seem to be correlative, at least in part, with the Middle Devonian reported by Schuchert in the Guajira Peninsula, but the Guajira location has not been confirmed. Elsewhere in Colombia, however, Middle Devonian fossils have been identified east of Manaure and south of Santa Isabel on the west flank of the Perijá Mountains, and at Floresta in the Cordillera Oriental. Farther south, the Erere Formation of Brazil and the Sicasica Formation of Bolivia are said to be contemporaneous with the Mesodevonian deposits of Venezuela and Colombia.

The lithofacies and biofacies of the South American Mesodevonian deposits are reminiscent -- often strikingly so -- of the Mesodevonian deposits of northeastern North America. This similarity has led to two alternative premises: that ecologic conditions must have been fairly uniform in a vast sea connecting North America and South America, or, that the Mesodevonian rocks and fossils are similar because the two continents were very much closer then than they are now. The latter hypothesis, based on palaeomagnetic and structural data, would have it that eastern North America was separated from northern South America by only a narrow, east-west Devonian seaway, located perhaps in the present Caribbean Sea; that from late Palaeozoic time on to the Recent North America has been drifting away from South America with a counterclockwise movement; and that the present Gulf of Mexico is the relict of this ever-widening rift.

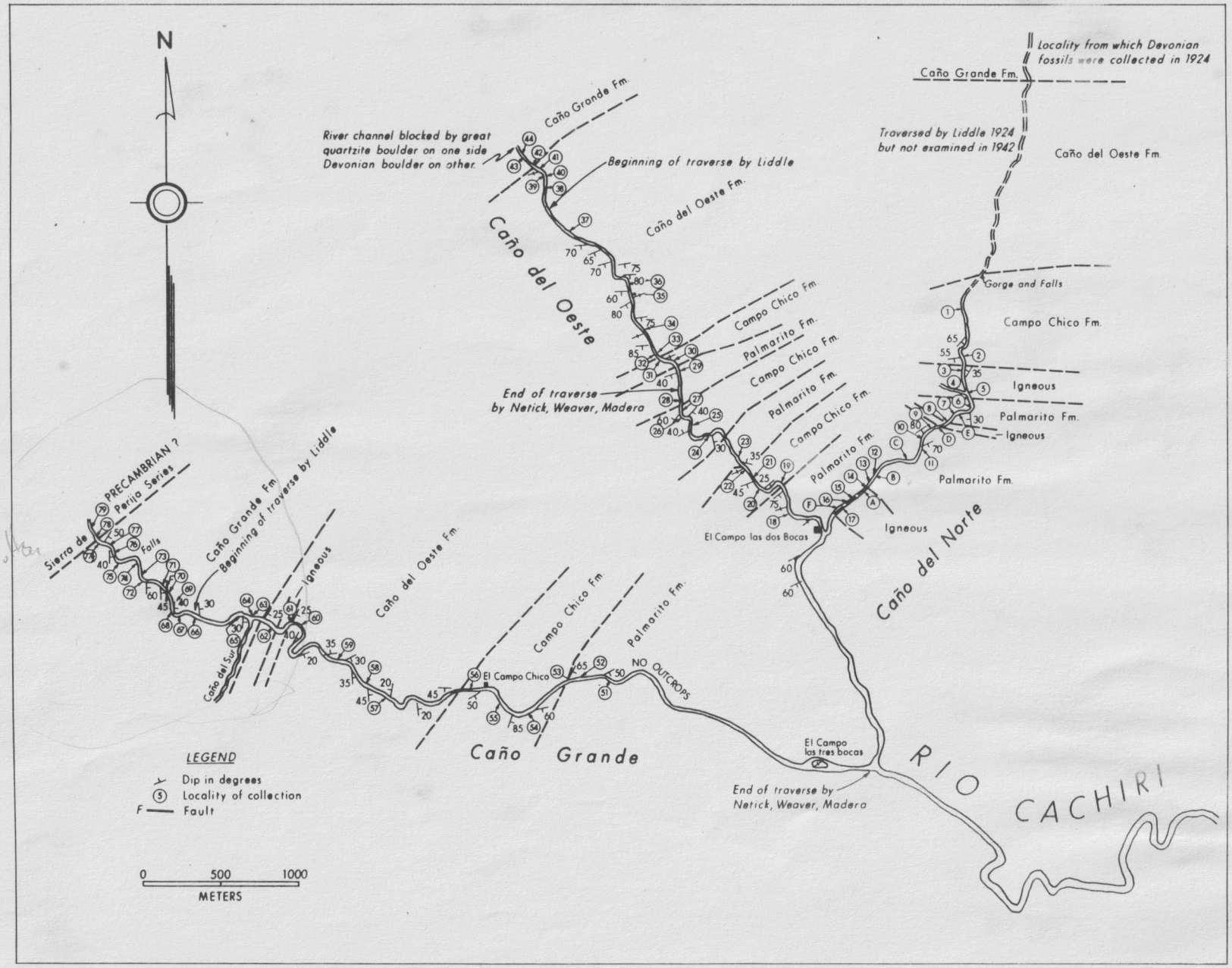

Fig. 1. Geological map of the upper reaches of the Rio Cachiri, Venezuela (adapted from Liddle, 1943).

HISTORICAL REVIEW

The type section of the Devonian System in western Venezuela is known as the Rio Cachirí Group, and is exposed in the upper reaches of the Rio Cachirí on the east flank of the Perijá Mountains in the District of Maracaibo, State of Zulia. The presence of Devonian rocks in this area may have been known earlier, but it was in 1924 that geologists R. A. Liddle, P. W. McFarland, and C. W. Yeakel traversed the Rio Cachirí upstream from its mouth and discovered Devonian fossils at a waterfall in the Caño del Norte, some 4.5 kilometers north of its junction with the Rio Cachirí. Yeakel, who had been trained in the classic Devonian region of New York state, noted that these fossils closely resembled fossils he had studied from the Middle Devonian, and he recorded this observation in a report titled "Rough notes on the Tigre area, State of Zulia, District of Mara", submitted in 1924 to J. E. Brantly, then chief geologist of the Venezuelan Atlantic Refining Company, as follows:

> DEVONIAN SYSTEM
>
> On the north fork of the Cachirí or Tule Rivers are hard gray calcareous sandstones and sandy shales here referred to the middle Devonian. Their total thickness is unknown but about 2,500 feet was observed. They have been highly folded and faulted, the average dip observed being about 60 degrees. Devonian float was also observed in the Guasare River, and rocks of similar lithologic character are reported to occur in Perijá. Thus it seems logical to believe that there is a continuous belt of these rocks throughout the spur of the Andes.
>
> The fossils collected have been examined only superficially but among them we have: *Phacops* resembling *P. rana* or *P. bufo, Spirifer* 4 sp., *Stropheodonta* 2 sp., *Leptaena rhomboidalis* Wilckins. Bryozoa several species. Corals of the staghorn type. Colonial corals.
>
> The general appearance of the forms as a whole leads the writer to believe that future determinations and study will ascribe an age of middle Devonian to these beds.

Yeakel's tentative Middle Devonian assignment was later confirmed by Weisbord (1926) who concluded that the fossils (now known to have come from near the top of the Caño Grande Formation) belonged in the upper part of the Lower Devonian or lower part of the Middle Devonian.

Two subsequent expeditions were made to the upper Cachirí, one in 1926 by Joe Netick, George A. Weaver, and Malcolm Madera, the other in 1942 by Ralph A. Liddle, his second after a lapse of 18 years.

In 1928 Liddle published his important book, "The Geology of Venezuela and Trinidad", and listed therein some of the Devonian fossils collected in 1924. The results of Liddle's second expedition were published by Liddle, Harris, and Wells (1943), and in that work the previous collections were described, illustrated, and tied in with the stratigraphic section established by Liddle. So far as the author is aware no further work in the type area of the Devonian has been published, though a number of papers have referred to the area. In one of these papers (Weisbord, 1956), the proposal was made to change Liddle's name of Rio Cachirí Series to Rio Cachirí Group in order to signify a geographically named rock sequence consisting of two or more formations.

STRATIGRAPHY

RIO CACHIRI GROUP

The Rio Cachirí Group was originally named the Rio Cachirí Series by Liddle in 1928 to designate an assemblage of black, gray, and red shales, gray micaceous sandstones, gray and black quartzitic sandstones, and red, blue-gray, and blackish limestones cropping out in the upper reaches of the Rio Cachirí, about 17 kilometers southwest of Dibujado and approximately 89 kilometers west of Maracaibo, in the District of Maracaibo, State of Zulia.

The Rio Cachirí Group as now defined consists of three formations. the Caño Grande forming the lowest subdivision of the Group, the Caño del Oeste comprising the middle, and the Camp Chico constituting the upper. The type section for the Group is in Caño Grande, the western branch of the Rio Cachirí (Fig. 1). The lowest exposed bed of the Group is in Caño Grande, 1,130 meters upstream from the mouth of Caño del Sur, where it is discordant and possibly in fault contact with schists of pre-Devonian

TABLE I.

LIST OF FOSSIL INVERTEBRATES FROM THE RIO CACHIRI GROUP

[Arranged in ascending stratigraphic sequence from Liddle's samples 73 to 31]

Y = Yeakel collection near top of Caño Grande Formation in Caño del Norte. F-1 = Float (sample OJ-113). Position in section not known. F-2 = Float (sample OJ-97). Position in section not known. Samples 38, 34 and 31 are float occurring in the outcrop area of the Caño del Oeste Formation in Caño del Oeste.

	Formations															
	Caño Grande										Caño del Oeste					?	
Samples	73	72	71	69	65	64	63	43	42	Y	38	37	36	34	31	F-1	F-2
COELENTERATA																	
Heliophyllum halli Milne Edwards & Haime	X	X	X		X		X					X	X				
Synaptophyllum vermetum (Weisbord)	X	X					X			X			X				
Zonophyllum sp. Wells	X																
Heterophrentis venezuelensis (Weisbord)	X	X	X				X			X		X	X				
Thamnopora venezuelensis (Weisbord)										X							
BRYOZOA																	
Fenestrellina venezuelensis (Weisbord)				X	X		X	X	X	X	X			X	X		
Polypora cachirita Weisbord				X	X			X	X					X			
BRACHIOPODA																	
Rhipidonella liddlei Harris		X			X	X								X			
Dalmanella sp. Harris					X												
Dalmanella ? venezuelensis Weisbord										X							
Leptaena rhomboidalis (Wilckens) s. l. (=L. boyaca Caster)					X		X										
Leptostrophia cf. *L. concinna* (Morris and Sharpe)					X												
Leptostrophia (Rhytistrophia) caribbeana Weisbord				X	X					X							
Dictyostrophia cooperi Caster					X												
Stropheodonta zuliana Weisbord										X							
Stropheodonta (Cymastrophia?) casteri Harris						X											
?*Strophonella* cf. *S. meridionalis* Caster														X			
Schellwienella goldringae Caster					X					X				X		X	
Tropidoleptus carinatus (Conrad)					X												
Chonetes (Eodevonaria) venezuelensis Weisbord					X					X							
Chonetes (Eodevonaria) subhemispherica Weisbord				X	X					X							
Chonetes stübeli Ulrich				X													
Chonetes ? zuliensis Weisbord										X							
? Eodevonaria imperialis Caster				X													
Camarotoechia sp. Harris					X												
Dictyloclostus liddlei Harris																X	
Dictyloclostus ? sp. Harris					X												
Conchidium ? sp. indet. Weisbord										X							
Productella ? sp. cf. *P. spinulicosta* Hall					X												
Amphigenia elongata weisbordi Harris				X						X							
Atrypa reticularis harrisi Caster					X					X	X						
Spirifer weisbordi Harris					X		X										
Spirifer kingi Caster					X					X							X
Spirifer olssoni Caster							X	X	X								
Spirifer meridioamericana Weisbord										X							
Spirifer venezuelensis Weisbord										X							
Spirifer audaculus zulianus Weisbord										X							
Elytha ? plana Harris											X						
Elytha colombiana Caster				X			X										
Meristella wheeleri Caster								X									
Meristella sp. Harris				X													
Vitulina ? venezuelensis Weisbord										X							
Athyris spiriferoides (Eaton)					X					X							
Pentagonia? gemmisulcata Caster					X												

TABLE I (continued)

	Formations																
	Caño Grande										Caño Grande					?	
Samples	73	72	71	69	65	64	63	43	42	Y	38	37	36	34	31	F-1	F-2
PELECYPODA																	
Leptodomus? ulrichi Clarke																X	
Tellinopsis ? venezuelanus Harris																X	
Tellinomya ? sp. Harris					X												
Edmondia sylvana Hartt & Rathbun					X											X	
Nucula ? sp. Harris																X	
Actinopteria subulrichi Harris					X												
Limoptera tenuis Harris				X	X												
Aviculopecten yeakeli Weisbord									X	X							
Aviculopecten sp. indet. Weisbord										X							
Cypricardinia subindenta Weisbord										X							
GASTROPODA																	
Pleurotomaria venezuelensis Weisbord										X							
Platyceras sinistrum Harris		X															
Platyceras ? gibraltar Harris									X								
Platyostoma ventricosum Conrad							X		X								
Platyostoma ventricosum permundum Harris							X		X								
Platyostoma neveritanum (Weisbord)										X							
ARTHROPODA																	
Phacops argentinus ? Thomas										X							
ECHINODERMA																	
Crinoid fragments		X	X			X	X		X			X			X		

age. The top of the Group is just under a basal conglomerate of the overlying Palmarito Formation (Permo-Carboniferous?) in the Caño Grande at a point 2,065 meters downstream from the mouth of Caño del Sur. The upper contact with the Palmarito Formation is presumed to be one of unconformity, though the strata on either side of the contact are more or less concordant.

The thickness of the Rio Cachirí Group is calculated from Liddle's section to be about 2,438 meters (8,000 feet) thick. However, structural complications in all of the sections measured by Liddle, including the occurrence of faults, unconformities, tight folds, and overturned strata, undoubtedly will necessitate revision of the present thickness estimate.

Caño Grande Formation

The type section of the Caño Grande Formation (named by Liddle, 1943, pp. 14-17) is in Caño Grande, an east-flowing tributary of the Rio Cachirí, located in the District of Maracaibo, State of Zulia, approximately 90 kilometers west of the city of Maracaibo.

At the type locality, the Caño Grande Formation constitutes the lower division of the Cachirí Group, extending from a point 1,130 meters upstream to a point 65 meters downstream from the mouth of Caño del Sur. The base of the Caño Grande Formation is discordant with, and possibly faulted against, a pre-Devonian complex of schists and quartzites intruded by granite, whereas the upper part of the Caño Grande Formation grades into, and is conformable with, the overlying Caño del Oeste Formation. The pre-Devonian complex is named the Sierra de Perijá Series and is inferred to be Precambrian (Weingeist, 1956, pp. 446-447). The thickness of the Caño Grande Formation in the type section is calculated at 762 meters (2,500 feet), but in view of the possible fault at the base, the indication is that the lowermost strata are not exposed and that the total thickness may be greater than that calculated on the basis of the measured section.

As originally described by Liddle, the Caño Grande Formation in the type section for the most part consists of gray, nodular shales which are locally fossiliferous and contain mudstone pellets and particles of lignitic matter. The shales commonly are limonitic and calcareous, and break with a shattery fracture. In the lowest portion of the Formation there are some even-bedded argillaceous sandstones which contain imprints of *Spirifer* and of corals. In the Caño del Oeste, 3.4 kilometers northeast of the type section, and in the Caño del Norte, 3.3 kilometers east-northeast of that, the uppermost beds of the Caño Grande Formation, as in Caño Grande itself, are composed of gray, highly fossiliferous, calcareous shales and black limestones.

Some 61 species of invertebrate fossils have been described from the Caño Grande Formation by Weisbord (1926) and by Harris and Wells (1943), including corals, bryozoans, brachiopods, pelecypods, gastropods, crinoid stems, and rare trilobites. Many of the fossils in the Caño Grande Formation resemble, and a few are identical with, species found in the Oriskany, Hamilton, and Onandoga Formations (especially the Onandoga of New York State), and on the basis of this similarity the Caño Grande Formation is predicated to have been deposited in the interval between late Early Devonian and early Middle Devonian time.

The fossils described from the Caño Grande Formation and from the overlying Caño del Oeste Formation are listed in Table I.

Most of the fossils occur in the upper two-thirds of the Caño Grande Formation and are particularly abundant near the top, as, for example, at Liddle's sample stations 63, 64, and 65 in Caño Grande, and at stations 42 and 43 in Caño del Oeste. Yeakel's fossils were also obtained in the upper part of the Caño Grande Formation in Caño del Norte. The largest number of species (37) in the Caño Grande Formation are in phylum Brachiopoda, the next largest in Mollusca (Pelecypoda 10, Gastropoda 6), followed by Coelenterata (5), Bryozoa (2), and lastly phylum Arthropoda in which one species of trilobite is recorded. There are also several species of Echinodermata (crinoids) but these have not been identified because of the fragmental nature of their preservation.

The Caño Grande Formation extends northeast of the type section through Caño del Oeste and Caño del Norte for a distance of about 6.7 kilometers. Farther north, fossiliferous float probably from this formation has been reported from the Rio Socuy and Rio Guasare, and this suggests that the Caño Grande Formation continues northeastward from Cano Grande for perhaps a distance of 25 kilometers or more along the east flank of the Perijá Mountains. The Formation is exposed southwest of Caño Grande but its extent in that direction is not known with certainty. According to Edwards (1956, p. 577), the rocks underlying the Tinacoa Formation (Carboniferous) in Rio Tinacoa were described by Gealey under "Devonian Undifferentiated" in practically the same terms as Liddle used to describe his Caño Grande Formation, and possibly Gealey's "Devonian Undifferentiated" is correlative with Liddle's Caño Grande Formation. No fossils have been reported from the "Devonian Undifferentiated" and the correlation is therefore suspect, but if correct would indicate the presence of Lower-Middle Devonian rocks about 50 kilometers southwest of Caño Grande. On the west flank of the Perijá Mountains in Colombia, deposits that seem to be correlative with the Caño Grande Formation of the Rio Cachirí Group of Venezuela are known east of Manaure, near Curumaní, and southeast of Santa Isabel (Fig. 2). According to Trumpy (1943, p. 1291-1293), the Devonian at Manaure is composed mainly of whitish brown sandstone and quartzites with intercalations of silky, gray shales. About 1.5 kilometers east of Manaure the following fossils, identified by James Steele Williams, were collected in a fine-grained ferruginous sandstone:

Fenestrellinoid bryozoans, probably largely belonging to *Polypora*, *Leptaena?* cf. *L. Loyaca* Caster, *Strophcodonta? koslowskii* Caster, *Stropheodonta?* cf. *S. concava* Hall, *Stropheodonta (Cymostrophia)* cf. *dickeyi* Caster, *Chonetes?* sp. undet., *Delthyris?* cf. *"Spirifer" duodenarius* Hall, *Spirifer (Australospirifer)* cf. *S. antarcticus* (Morris and Sharp), *Spirifer (Australospirifer) iheringi* Kayser, *"Spirifer" kingi* Caster, other indeterminate fragmentary brachiopods. Gastropods, indeterminate fragments. Trilobite pygidium. Crinoid columnals.

Several of the Manaure forms in the above list are present in the Caño Grande Formation of Venezuela, approximately 85 kilometers N 62° E of Manaure. The two other localities in Colombia where Middle Devonian rocks are exposed on the west flank of the Perijá Mountains (in the Rio Simiti near Curumani and approximately 8 kilometers southeast of Santa Isabel) are about 140 and 125 kilometers, respectively, southwest of Manaure. The fourth Mesodevonian locality in Colombia is Floresta, some 383 kilometers south of Manaure, in the Cordillera Oriental where a number of species are the same as at Manaure and in the Caño Grande Formation of Venezuela. The fifth locality in Colombia with reported Middle Devonian rocks (Schuchert 1935), is in the Goajira Peninsula, but in the latest work on the Goajira Peninsula by Rollins (1965) no Devonian rocks have been recognized.

Caño del Oeste Formation

The Caño del Oeste Formation is named from the Caño del Oeste branch of the Rio Cachirí, and is located in the District of Maracaibo, about 87 kilometers west of the city of Maracaibo. In Caño del Oeste, the type section, which was named and described by Liddle in 1943 (p. 17-19), extends from 3,000 meters upstream to 1,550 meters upstream above the junction of Caño del Norte. The Caño del Oeste Formation, the middle division of the Rio Cachirí Group, is conformable with both the underlying Caño Grande and overlying Campo Chico Formations, and its thickness is given as approximately 1,067 meters (3,500 feet). In the type section, the base of the Caño del Oeste Formation is represented by a black unctuous shale which conformably overlies gray, calcareous shale at the top of the Caño Grande Formation. The greater part of the Caño del Oeste Formation, however, is composed of bluish black, fine-grained, micaceous and ferruginous quartzite; dark gray, micaceous, nodular, unfossiliferous shale which has a shattery fracture and contains particles of lignite; black, micaceous, slaty and splintery shale; and argillaceous limestone containing many corals and some crinoid columnals. In Caño Grande, some 3 kilometers southwest of the type section, there is a dike of basalt about 9 meters (30 feet) thick near the base of the Caño del Oeste Formation, and on both sides of the steeply dipping dike the shales are indurated and slaty.

Although Liddle (1943, p. 18) stated that no fossils were found in the Caño del Oeste Formation, he reported (*ibid,* p. 45, 46) that sample 37, presumably found in place, and taken from "'calcareous shale and shaly limestone" in the lower third of the Formation, contained many corals and some crinoid stems. The corals are *Heliophyllum halli* Milne Edwards and Haime and *Heterophrentis venezuelensis* (Weisbord), and both these species occur in the upper two-thirds of the underlying Caño Grande Formation, which is considered to be late Lower Devonian to early Middle Devonian in age. In view of the presence of several identical fossil species in both formations and the transition of the Caño Grande to the Caño del Oeste Formation, the age of the Caño del Oeste Formation is thought by the present writer to be Middle Devonian.

The Caño del Oeste Formation has been correlated by Edwards (1956, p. 577-578) with the Tinacoa Formation, the type section of which is in the Rio Tinacoa, approximately 52 kilometers southwest of Caño del Oeste. The Tinacoa Formation was probably first described by geologists of the Caribbean Petroleum Company, but it was also named a "Devonian" unit by Donald MacArthur in 1928 in a report to the Venezuelan Atlantic Refining Company. In 1945 (see Edwards, 1956), Gealey described the type section as follows:

> "The Tinacoa Formation consists of uniformly thin-bedded, hard, gray-black, nodular calcareous shales, medium-gray, carbonaceous siltstone, and light gray, hard, fine-grained, calcareous sandstones. Thickness of invidual beds is commonly between two and five centimeters but may reach a decimeter or more. The formation is stained with limonite, and limonitic nodules are locally abundant in the shales and siltstones. The shales break with a blocky or splintery fracture".

The type section of the Tinacoa Formation begins in the Rio Tinacoa 1.5 kilometers northwest of "hacienda" Medellin, and extends northwest and upstream from that point for an aerial distance of 1.6 kilometers. The Tinacoa Formation occupies the center of a syncline, both limbs of which are bounded by faults. At least 850 meters (2,779 feet) are exposed on the disturbed west flank of the syncline. The Tinacoa Formation overlies "Devonian un-

differentiated" in the Rio Tinacoa, and in the Rio Cuiba near by to the south, it is overlain apparently conformably by the Macoita Formation.

It was formerly conjectured that the Tinacoa Formation, which is unfossiliferous except for plant remains, might be correlative with Liddle's Campo del Oeste Formation of Middle Devonian age, but on the basis of palaeobotany and other data (Miller 1962, p. 1571-1572), the Tinacoa Formation is now considered to be Carboniferous in age.

Campo Chico Formation

The Campo Chico Formation is the uppermost unit of the Rio Cachiri Group. Its type section is in Caño Grande, a tributary of the Rio Cachirí, in western Maracaibo District, about 88 kilometers west of the city of Maracaibo. In Caño Grande, the Campo Chico Formation extends from 1,400 meters to 2,065 meters downstream from the junction of Caño del Sur. The Formation is said by Liddle to be conformable and transitional with the underlying Caño del Oeste Formation, and unconformable, though virtually accordant with the overlying Palmarito Formation of Permo-Carboniferous age. It is not possible to determine with certainty, but the unconformity between the Campo Chico and Palmarito Formations is believed to be one of considerable magnitude.

According to Liddle, the Campo Chico Formation is at least 609 meters (2,000 feet) thick in the type section, where it consists of dark gray, even-bedded, ferruginous, quartzitic sandstones interbedded with hard, dark gray, micaceous and sandy shales. There are also a few thin, black limestones. In Caño del Oeste, about 2 kilometers northeast of Caño Grande, quartzites with rounded to angular grains of quartz are present in the Formation, and in Caño del Norte, about 3.8 kilometers northeast of Caño Grande, sandy limestones and calcareous sandstones are components of the Formation. No fossils are reported from the Campo Chico Formation, but its conformability with the underlying Caño del Oeste Formation of Middle Devonian age, and the resemblance of some of the strata in each of the two formations, are reasons for suggesting that deposition continued into the early Upper Devonian.

The Campo Chico Formation was mapped by Liddle for a distance of 4 kilometers between Caño Grande and Caño del Norte. The Formation undoubtedly extends northward from Caño del Norte and southward from Caño Grande, but the distances are not known. Liddle (1944, p. 20) and Edwards (1956, p. 348) suggested that the equivalent of the Campo Chico Formation to the southwest was the Macoíta Formation, exposed in Rio Macoíta, approximately 65 kilometers southwest of Caño Grande. However, in a more recent discussion, Miller (1962, p. 1574) presents the following interpretation:

> "The Macoíta Formation, which rests on the Tinacoa, may very likely be Permian. This Formation is made up of quartzitic sandstones, calcareous shales, some dense basaltic flows, and abundant conglomerates and gritty sandstones. In their constituent clastic materials the Tinacoa and Macoíta Formations, and the basal 'Palmarito' of the Rio Cachirí, show evidence of a period of structural disturbance and consequent erosion of older units, including in part the reworking of basalts and other materials from within the Macoíta."

With the Macoíta and Tinacoa Formations now assigned to the Permo-Carboniferous, the only Devonian rocks reported south of the Rio Cachirí are those described by Gealey (see Edwards 1956, p. 577) as "Devonian undifferentiated" in the Rio Tinacoa, underlying the Tinacoa Formation (Carboniferous). The "Devonian undifferentiated" in Rio Tinacoa is not fossiliferous like the Caño Grande Formation in the Rio Cachirí, but lithologically some of the rocks described by Gealey seem to be identical with those described by Liddle in the Caño Grande Formation. If they are correlative, then the Middle Devonian would be known from a region 75 kilometers southwest of the type locality, on the east flank of the Perijá Mountains. The geology of the back country this far south is relatively unknown, though there is reason to suspect that the Devonian is indeed present, if only locally.

AGE AND CORRELATION OF THE RIO CACHIRI GROUP

The 61 fossils identified and described by Weisbord (1926) and by Harris and Wells (1943) from the Rio Cachiri Group, indicate that the Caño Grande and Caño

del Oeste Formations were deposited between Oriskany and Hamilton time as represented in North American chronology, and that the age of these strata is late Lower Devonian to early Middle Devonian. The upper part of the Rio Cachirí Group is said to be unfossiliferous in the type locality, but the transitional nature of the formations and the recurrence of similar sediments throughout the Group are thought to indicate that deposition continued into later Devonian time, and that the uppermost formation of the Rio Cachirí Group, the Campo Chico Formation, is Middle to Upper Devonian in age.

The areal extent of the Mesodevonian in western Venezuela has not been established. From the occurrence of fossiliferous float in the Socuy and Guasare Rivers north of the Rio Cachirí, it is conjectured that the Rio Cachirí Group may be exposed for a distance of 25 kilometers north of Caño del Norte. The Group certainly continues southwestward from Caño Grande, but again the extent can only be surmised. To judge from the tectonic map of the Sierra de Perijá by Miller (1962, p. 1580-1581), the Devonian could be present here and there along a southwest-trending complex for some 75 kilometers.

In the neighboring republic of Colombia, Middle Devonian rocks are reported in the Guajira Peninsula by Schuchert (1935, p. 672); near Manaure, near Curumaní in the Rio Simití, and southeast of Santa Isabel by Trumpy (1943, p. 1291); and at Floresta by Caster (1937; 1942). Manaure, Curumaní, and Santa Isabel are on the west side of the Perijá Mountains (the Sierra de Perijá forms the divide between Colombia and Venezuela), and Floresta is in a knot of the Cordillera Oriental (Fig. 2). One arm of the knot diverges to form the Sierra de Perijá west of Lake Maracaibo, and the other arm diverges to form the mountain system of Táchira, Mérida, and Trujillo southeast of Lake Maracaibo in Venezuela.

Little is known about the Guajira occurrence except Schuchert's statement that fossils collected by Scholl and Remington were identified by Galloway as Middle Devonian. There is no question in my own mind that the fossils identified by Galloway were indeed Middle Devonian, though their locality must be verified. In the latest work on the Guajira Peninsula by Rollins (1965) which covers in detail nearly the whole of the Peninsula in Venezuela and Colombia, the presence of Devonian rocks is not recorded. The rich fauna from Manaure has been dated as Devonian by James Steele Williams, as have the fossils from Santa Isabel, by Emeis. Considerably more is known about the Floresta fauna from the works of Caster (1939; 1942) who concluded that the Floresta beds were laid down about

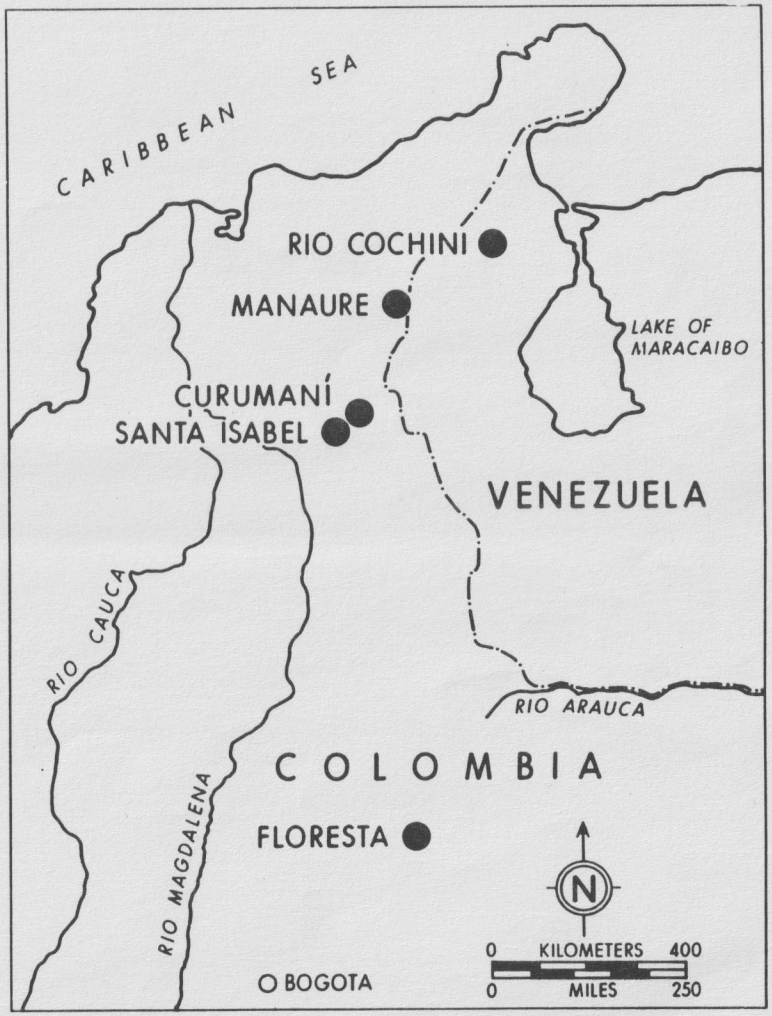

Fig. 2. Map showing Mesodevonian localities in northwestern Venezuela and northern Colombia. (Adapted from Trumpy 1943, p. 1285).

the same time as those of the Caño Grande and Caño del Oeste Formations (Middle Devonian). Trumpy (1943, p. 1291) was of the opinion that the Santa Isabel and Manaure faunas are more closely allied to that of Floresta than to that of the Rio Cachirí Group, though geographically they are nearer, and palaeontologically just as close, to the complex at Rio Cachirí in Venezuela than to Floresta in the Cordillera Oriental. However, it may well be that the "Mesodevonian" deposits at Manaure, Curumaní, Santa Isabel, and Floresta were laid down coeval with the Rio Cachirí Group, or a part thereof, despite certain differences in lithology and faunal content which may perhaps be ascribed to local ecological conditions. Caster (1942, p. 58) visualized a Mesodevonian seaway extending from North America across the Caribbean Sea into what is now Venezuela, Colombia, Peru, Brazil, and Bolivia, and it would seem from the data available that the Venezuelan and Colombian sediments were deposited in this seaway. Caster (1942, p. 51) further suggested that the Rio Cachirí Group of Venezuela, the Floresta beds of Colombia, the Erere Formation of Brazil, and the Sicasica Formation of Bolivia are essentially time equivalents.

In addition to their occurrence on both flanks of the Perijá Mountains, rocks of the Devonian system have been reported for many years in the Mérida Andes of Venezuela. The Mérida Andes is the mountain chain which branches off from the Cordillera Oriental of Colombia (in which the Floresta Devonian is found), and extends northeasterly through the Venezuelan states of Táchira, Mérida, and Trujillo. The sedimentary units that have been said to include Devonian strata are the Mucupatí Series, the Momboy Series, or the Mucuchachí Group. The propriety of including the Devonian in any of these units was questioned by Alberding, Mohler, and Weisbord in their contributions to the Stratigraphical Lexicon of Venezuela in 1956. In 1961, the Mucuchachí Group was subdivided by Pierce, Jefferson, and Smith, in ascending sequence, into the Rio Momboy, the Libertad, and Remolino Formations, with all these formations being placed in the Devonian system. A re-study of the "Mucuchachí" interval has since been made by geologists and palaeontologists of Compañia Shell de Venezuela and Creole Petroleum Corporation, and in their paper titled "Paleozoic rocks of Mérida Andes, Venezuela" (1964, p. 70), the following statements, supported by field evidence and expert palæontological analysis, are made:

> "Re-study of supposedly Devonian faunas from the Mérida Andes has shown that their true ages are Ordovician, Silurian and Permo-Carboniferous . . . Not a single fauna of definite Devonian age was recognized in this revision. Paleozoic stratigraphy is reviewed in the light of this new information . . . The name Mucuchachí Formation (not group) is applied to the metamorphosed slates and allied rocks which contain Permo-Carboniferous faunas in their upper part. The names 'Remolino Formation', 'Libertad Formation', and 'Rio Momboy Formation' are suppressed as unnecessary synonyms of the Caparo, and (or) Mucuchachí Formations."

Thus today, the only region in Venezuela in which the Devonian is known beyond doubt is in Liddle's type section in the upper Rio Cachirí, on the east flank of the Perijá Mountains, 89 kilometers west of the city of Maracaibo. However, there is little question that the Devonian can be extended northeast and southwest of the Rio Cachirí, and with so much of the Palaeozoic represented in the Mérida Andes, evidence that the Devonian was also deposited there may yet be discovered.

SPATIAL RELATIONSHIP OF THE SOUTH AMERICAN AND NORTH AMERICAN MESODEVONIAN

Yeakel, Weisbord (1926), Caster (1939; 1942), McNair (1940), and Harris and Wells (1943) all have noted the similarity of the Rio Cachirí and Floresta faunas and those of equivalent age in northeastern United States, especially in the classic and relatively flat-lying Middle Devonian strata of central New York state. As shown in Table II, there are 61 species in 53 genera and 5 major hierarchies (phylum or class) thus far reported from the Rio Cachirí Group of Venezuela. Of these, 6 species (10 per cent) and at least 35 genera (66 per cent) occur in the Mesodevonian of the "Central New York Province." Additionally, 24 of the Venezuelan species (or 43 per cent) so closely resemble their "New York" counterparts that without knowledge of their locality a number of the Venezuelan species might be considered the same as the northern ones.

TABLE II

Comparison of the Venezuelan and "Central New York" Mesodevonian taxa.

PHYLUM or CLASS	Rio Cachirí Group, Venezuela		"Central New York"		
	No. of Species	No. of Genera	Identical Species	Closely Allied Species	Same Genera
Coelenterata	5	5	1	3	4
Bryozoa	2	2	0	0	1
Brachiopoda	37	23	4	16	20
Pelecypoda	10	9	0	2	7
Gastropoda	6	3	1	2	2
Trilobita	1	1	0	1	1
TOTAL	61	53	6	24	35

Though the taxonomy of the Venezuelan fauna may be in need of revision, it is clear that many of the fossils in the Caño Grande and Caño del Oeste Formations are similar to, and some identical with, those of the Oriskany, Onandoga, and Hamilton Formations of the Central New York Province. Even in appearance some of the rocks of the Onandoga and Hamilton Formations in New York are difficult to distinguish from those of the Caño Grande Formation. Of course a shale is a shale wherever it is, but if a shale in a northern latitude has the same gross lithology, the same texture, the same colour, and contains identical or nearly identical fossils as a shale in a tropical latitude 3,540 kilometers (2,200 miles) away, such facts may either reinforce an observer's acceptance of the concept that ecologic conditions were essentially the same in an extensive connecting sea during a past period of geologic time, or it may cause him to speculate that the rocks and fauna are alike because the two now widely separated regions were relatively close to each other during that period. The Mesodevonian of New York and Venezuela, now separated by some 32 degrees of latitude, suggest deposition at about the same time and in a similar environment, and the question that poses itself is whether ecological and biological conditions were indeed similar over the great distances implied, or whether the similarities indicate a nearness of North and South America in Devonian time. I have discussed this problem with my colleague William F. Tanner, and he has stated to me, that based on palaeomagnetic data and certain unpublished structural evidence, eastern North America and northern South America could have been close together during Middle Devonian time, that the two continents may then have been separated by only a narrow east-west seaway located possibly in the present Caribbean Sea, that since Palaeozoic time North America probably has rotated counterclockwise way from South America more or less continually to Recent time, and that the resulting separation of the continents has produced the present Gulf of Mexico.

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