THE CRETACEOUS STRATIGRAPHY AND PALEONTOLOGY OF SUCIA ISLAND SAN JUAN GROUP WASHINGTON

by

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CONTENTS

THE CRETACEOUS STRATIGRAPHY AND PALEONTOLOGY OF SUCIA ISLAND SAN JUAN GROUP WASHINGTON

INTRODUCTION

The purpose of this paper is to present the results of a stratigraphic and paleontologic study of the Cretaceous formation exposed on the Sucia Islands, situated in San Juan County, Washington. During the year 1926-27, the writer made a study of all the literature dealing with the paleontology and stratigraphy of northwestern Washington and Vancouver Island as well as the marine Cretaceous of the Pacific Coast. All of the fossil faunas of this region which were in the collections of the Geology Department of the University of Washington were studied biologically and were compared with the original descriptions of earlier writers, namely, Meek, Shumard, Gabb and Whiteaves.

During the spring of 1927, two weeks were spent by the writer in making a stratigraphic study of the Cretaceous formation exposed in the Sucia Islands. Two representative stratigraphic sections were made, and fossils were collected and tied into the stratigraphy in order to show the variation in the fossil content from the base to the top of each section.

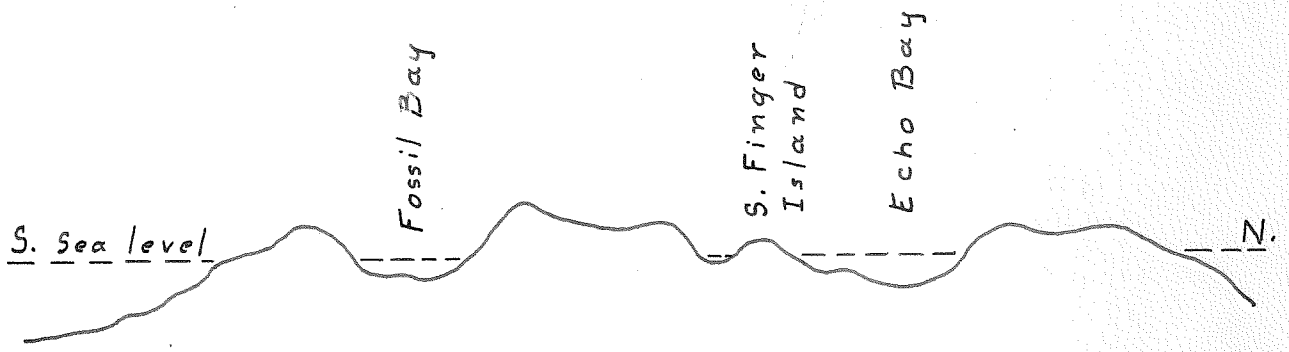
GEOGRAPHY

The term, Sucia Islands, is applied to a group of six

small islands, consisting of Sucia, Little Sucia or Fossil, Herndon, South Finger, North Finger and Ewing Islands. These are located at the southern extremity of the Straits of Georgia, two and one-half miles north of Orcas Island at 122°55' west longitude and 48°45' north latitude.

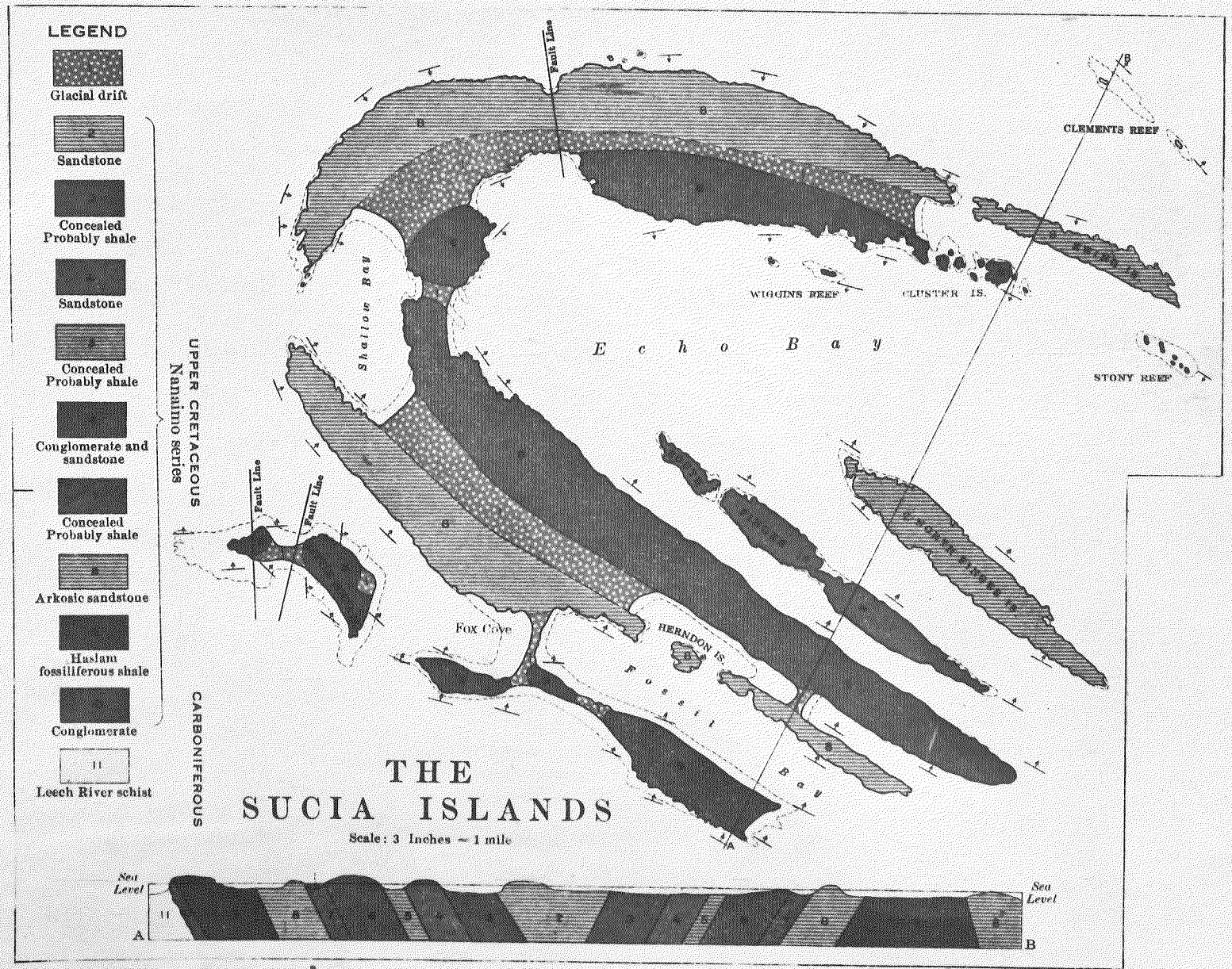
There is no regular means of access to the islands. To reach them small boats may be chartered at Bellingham, Anacortes, East Sound or Orcas.

The islands are horseshoe shaped and are flanked on all sides by steep sea cliffs. The topography of the islands is obviously due to their geologic structure.



North-south Profile Through the Sucia Islands

The water surrounding the islands and within a short distance of the shore is moderately deep, varying from 39 to 90 fathoms on the southern side, and from 11 to 30 fathoms on the northern side. The inlets are shallow, the average depth being about ten fathoms. The islands rise rather abruptly from the floor of the channels on all sides and exhibit the characteristics of a drowned topography.


LEGEND
Glacial drift
Sandstone
Concealed
Probably shale
Sandstone
Concealed
Probably shale
Conglomerate and
sandstone
Concealed
Probably shale
Arkosic sandstone
Haslam
fossiliferous shale
Conglomerate
Leech River schist
UPPER CRETACEOUS
Nanaimo series
CARBONIFEROUS
Fault Line
Fault Line
Fault Line
Shallow Bay
Echo Bay
WIGGINS REEF
CLUSTER IS.
CLEMENTS REEF
STONY REEF
Fox Cove
HERNDON IS.
Fossil Bay
THE
SUCIA ISLANDS
Scale: 3 Inches = 1 mile
Sea Level
A
B
Sea Level

REVIEW OF THE LITERATURE

The following list of references concerning the stratigraphy and paleontology of British Columbia, northwestern Washington, and the Pacific Coast are those that contribute in some way directly to the problem involved. The more important of these papers are here summarized:

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(1) 1857. Meek, F.B. Description of new organic remains from the Cretaceous rocks of Vancouver's Island. Trans.Albany Inst., Vol.4, pp.37-49.

This paper presents descriptions of the first known Cretaceous fossils from the Pacific coast and are from the now known Nanaimo formation.

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(2) 1858. Shumard, B.F. Descriptions of new fossils from the Tertiary formations of Oregon and Washington Territories and the Cretaceous of Vancouver's Island. Trans. Acad. Sci. St. Louis, Vol. 1, pp. 120-125.

Three new species of Cretaceous fossils from Nanaimo are listed.

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(3) 1861. Meek, F.B. Descriptions of new Cretaceous fossils collected by the northwest boundary commission on Vancouver and Sucia Islands. Proc. Acad. Nat. Sci. Philad., Vol. 13, pp. 314-318.

In this paper fossils from the Sucia Islands are for the first time described. New species from Vancouver Island are also listed.

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(4) 1864. Gabb, W.M. Geol. Sur. Calif., Pal., Vol.I.

This paper deals primarily with the Cretaceous fossils of California but in it are two new specimens from Vancouver Island, collected during the previous year by Gabb while on a trip through the northern territories.

(5) 1869. Gabb, W.M. Geol. Sur. Calif., Pal., Vol. 2.

Three fossil pelecypods from Nanaimo are described in this volume. The following correlation table is submitted:

		California	Vancouver Island	Europe
Upper Cretaceous	Div. B	Tejon		Maestrichtian
		Martinez		
	Div. A	Chico	Coal bearing formations	Upper or Lower Chalk
Lower Cretaceous		Shasta		Gault
				Neocomian

(6) 1876. Meek, F. B. Descriptions and illustrations of fossils from Vancouver and Sucia Islands and other northwestern localities. Bull. U.S.Geol.and Geog.Sur.Terr., Vol.2, pp. 351-374.

This paper deals entirely with the fossils of Vancouver and Sucia Islands. In it Meek revises and illustrates his preceding descriptions. The following correlation table is inserted:

Europe	California	Vancouver Island	N.E. Vancouver & San Juan I.	Upper Missouri Country	Atlantic Coast
Upper Chalk	Div. A		Sucia Islands and Comox	Ft. Pierre or: Div. No.4	New Jersey Greensand
		Nanaimo			

Meek states that the Nanaimo beds cannot be correlated with any beds east of the Cascade mountains although the beds at Comox and on the Sucia Islands can be.

(7) 1876-1903. Whiteaves, J.F. Geol.Sur.Can.,Mes.Foss.,Vol.1.
Part 1, 1876. On some invertebrates from the coal-bearing rocks of the Queen Charlotte Islands.
Part 2, 1879. On the fossils of the Cretaceous rocks of Vancouver and adjacent islands in the Strait of Georgia.
Part 3, 1884. On the fossils of the coal-bearing deposits of the Queen Charlotte Islands collected by Dr. G. M. Dawson in 1878.
Part 4, 1900. On some additional or imperfectly understood fossils from the Cretaceous rocks of the Queen Charlotte Islands, with a revised list of the species from these rocks.
Part 5, 1903. On some additional fossils from the Vancouver Cretaceous, with a revised list of the species therefrom.

In this report Whiteaves maintains a connection of the Pacific Coast and Interior Seas by passages in Central California and southern British Columbia. A broad summary of his report is given in the following correlation table:

Europe	Q.C.I.	Nanaimo	Comox	Sucia Ids.	Upper Miss.	California	Other parts of N. Amer.	Asia
Upper Cretaceous (Senonian)	Div. A	Fossbeds	Fossbeds	Fossbeds	Port Pierre & Fox Hill Group	Chico	New Jersey, Ala., Texas, Valdez Inlet Mississippi	Id. of Saghalien & South India
Lower Cretaceous	Div. B Div. C Div. D Div. E					Shasta Group		

Upper Cretaceous & Upper Jura.

First classification, 1876.
Div. A, or the upper shales and sandstones
Div. B, or the coarse conglomerates
Div. C, or the lower shales
Div. D, or the agglomerates
Div. E, or the lower sandstones

(8) 1879-1880. Dawson, G.M. Report on an exploration from Port Simpson on the Pacific Coast, to Edmonton on the Saskatchewan, embracing a portion of the northern part of British Columbia and the Peace River country. Geol. and Nat. Hist. Sur. Can., Rept. of Progress for 1879-80, 1881, pp. 1b-142b.

The following "comparative table of Cretaceous rocks" is given in this report:

England	Nebraska & Missouri R.	Rocky Mt. Region: 40th parallel	British Columbia Coast: Nanaimo	British Columbia Coast: Comox	California
	Ft. Union & Judith R. beds	Laramie			
					Tejon

(Table Cont.)

Maes- trict & Faroe beds	No.5 Fox Hill	Fox Hill	Sand- stones &	Sand- stones, conglom- erates &	
White Chalk	No.4 Pierre	Pierre	Shales	Shales	Chico

(9) 1889. White, C.A. On invertebrate fossils from the Pacific Coast. U.S.G.S.Bull. 51, pp. 463-465.

Dr. White's conclusions concerning the Vancouver Cretaceous are:

A. Sucia, Waldron and Skip Jack Island all belong to the same formation as represented at Nanaimo and Comox.

B. The Vancouver Cretaceous and the Chico of California are closely related faunally.

C. Species which characterize the upper part of the Chico-Tejon series of California are not represented in the Vancouver region.

(10) 1891. White, C.A. Correlation Papers - Cretaceous. Bull. 82, U.S.G.S., pp. 192-196.

Dr. White in this peper states that the Nanaimo series is identical with the Chico series of California. He also states that no Tejon species are recognizable among the faunas of the Nanaimo series.

(11) 1893. Stanton, T.W. The faunas of the Shasta and Chico formations. Bull. Geol. Soc. Amer., Vol.4, pp. 245-256.

Dr. Stanton's paper may be summarized as follows:

A. Inoceramus problematicus Schloth. is characteristic of "Div. A" of the Queen Charlotte section and the Colorado formation, and is found no higher than the Turonian in Europe.

B. The Nanaimo beds, those of the Queen Charlotte Islands and the Shasta-Chico series are closely related.

C. The Pacific border faunas have nothing in common with those of the Interior province.

D. The Queen Charlotte formation and the Shasta-Chico series have a relationship with the Blackdown Beds in England which belong to the Gault.

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(12) 1902. Anderson, F.M. Cretaceous deposits of the Pacific Coast. Proc. Cal. Acad. Sci., Third Series, Geol., Vol. 2, No.1.

In this report the Upper Cretaceous rocks of Vancouver and the neighboring islands are designated as the homotaxial equivalents of the Chico of California. A connection of the Pacific border seas and the Interior sea is shown by the presence of Inoceramus labiatus in both regions. The Pacific border faunas are noted as being closely related to the Indo-Asiatic faunas. The Chico should be correlated with the Turonian although Cenomanian and Gault types are present.

The following table summarizes Anderson's correlations:

Sacramento Valley	Oregon Basin	B.C.	South.	S. Amer. and Mexico	Interior Basin	South. India	Europe
							Danian
Upper Chico-					Mont- and Fort Benton:	Arrio-loor Trichinopoly: Ootatoor	Senonian
Lower	Phoenix and Henley: Beds	Nanaimo and Div.A.: Q.C.I.	Silverado and San Diego	Quiriquina Island			Turonian

(13) 1909. Stanton, T.W. Later Mesozoic invertebrate faunas. Jour.Geol., Vol.17, No.5, pp. 413-419.

In this article Stanton states: "On the Pacific Coast the Horsetown fauna is succeeded by the littoral Chico fauna which is distributed from the Yukon River to Lower California, occurring on the lower Yukon, the Alaska Peninsula, Queen Charlotte and Vancouver Islands, in middle and southern Oregon, in the Sacramento Valley and the coast ranges of California to San Diego, and on the peninsula of Lower California as far south as latitude 31°30'. There are considerable local variations in this fauna as would be expected in view of its great range in latitude. The assemblage of forms found on the Yukon is quite different from that occurring in the Sacramento Valley, and still another facies is found in southern California, but these are all connected by

common species so there is no hesitation about referring both the northern and southern facies to the Chico fauna. The fauna as a whole, like the later Horsetown fauna, is Indo-Pacific in its affinities, and is strikingly different from the faunas of the Atlantic border and interior regions of North America. Whiteaves and F. M. Anderson have argued for a connection during Chico time between the Pacific and Interior seas, but the evidence brought forward in support of this view is based on types that have a world-wide distribution and on those that are only similar, not specifically identical. In my opinion direct connection has not been proved. In time range the Chico fauna apparently began somewhat earlier and continued somewhat later than the Colorado fauna of the interior sea but it did not extend to the end of the Cretaceous, and latest Cretaceous time is probably not represented by marine deposition on the Pacific Coast."

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(14) 1909. Willis, Bailey. Paleogeographic maps of North America. Jour.Geol.,Vol.17, No.5, pp. 426-428.

The map accompanying this article is reprinted to show the extent and location of the Upper Cretaceous seas and land masses.

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(15) 1912. Daly, R. A. Geology of the North American Cordillera at the 49th parallel. Geol.Sur.Can.,Memoir 38, part 2, p. 558.

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(24) 1916. MacKenzie, J.D. Geology of Graham Island, British Columbia. Geol.Sur.Can., Memoir 88, pp. 56-66.

Top of Section

Skidgate formation	2,000 feet		ss. & sh.
Honna "	2,000 "		cg.,ss. & sh.
Haida "	(Upper) 2,300 "		
	(Lower) 3,000 "		ss.

Base of Section

CRETACEOUS OF THE BELLINGHAM REGION

There are no known marine Cretaceous deposits exposed near the city of Bellingham. Eastward from Bellingham, near the town of Glacier and on the northern base of Mt. Baker, rocks bearing Aucella crassicollis Keys occur, denoting the presence of the upper Knoxville.

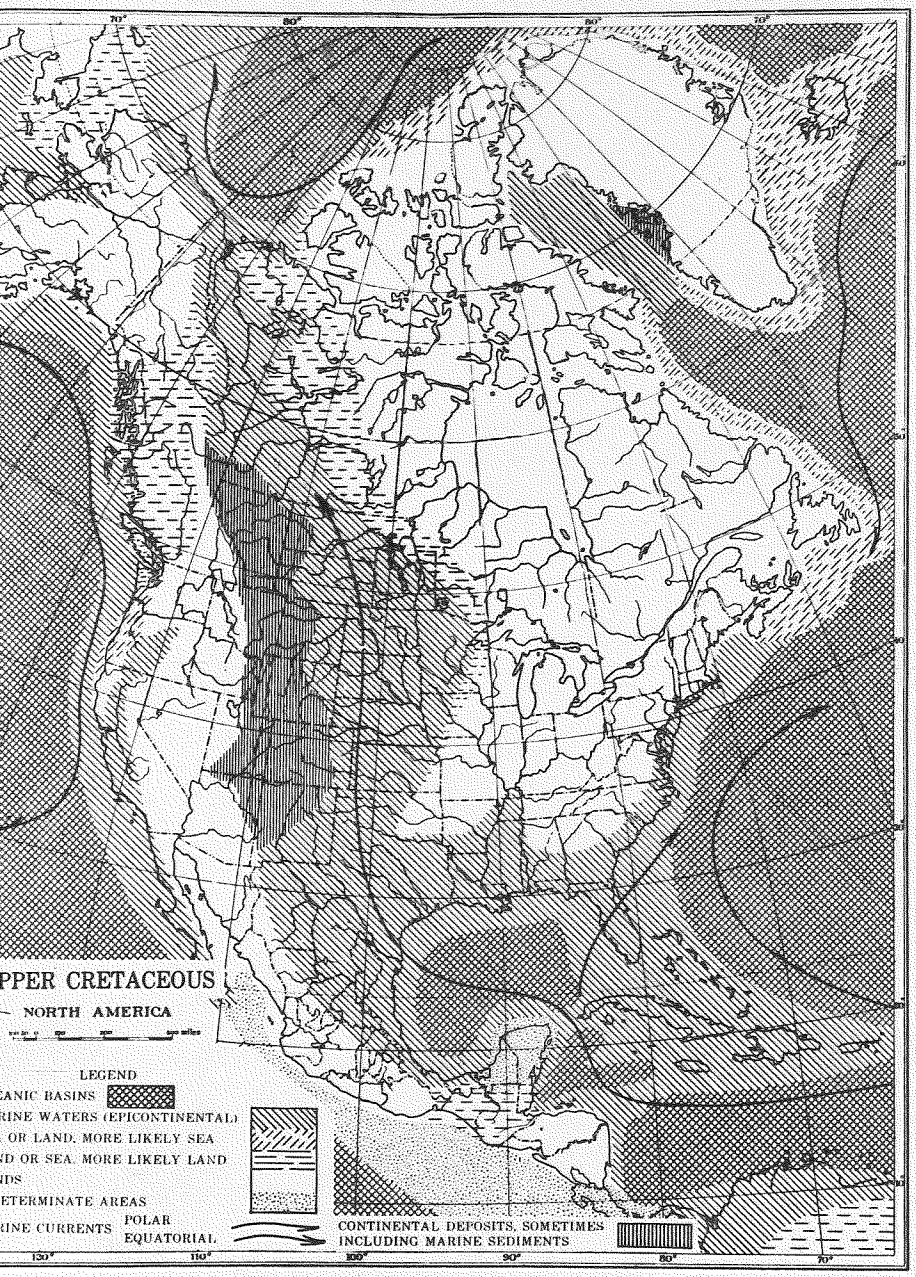
CRETACEOUS OF THE PASAYTEN REGION

The Cretaceous of north central Washington is represented by the Pasayten series. Daly (25) found this series to

(25) 1912. Daly, R.A. Geology of the North American Cordillera at the 49th parallel. Geol.Sur.Can., Memoir 38, pt. 1, pp.479-489.

have a thickness of 30,000-40,000 feet, striking approximately N.30° W, and dipping 48° S.W. This series is largely unfossiliferous, although at four localities unidentifiable

Sacramento Valley	Oregon Basin	British Columbia	Southern California	S. America and Mexico	Interior Basin	Southern India	Europe
							Danian
Chico — Upper	Phoenix and Henley beds	Nanaimo and "Div. A," Q.C.I.	Silverado and San Diego	Quiriquina Island	Montana	Arrialoor	Senonian
Chico — Lower					Ft. Benton	Trichinopoly	Turonian
Conglomerates		Conglomerates			Dakota	Ootatoor	Cenomanian
Horsetown — Upper		"Div. C" (in part)		"No. 3"?	Comanche — Washita		Gault
Horsetown — Lower	Riddles				Fredericksburg		
Knoxville	Riddles	"Div. C" (in part)	San Luis Obispo etc.	"No. 2" (in part)	Trinity		Neocomian
Sub-Knoxville	Folded Slates			"No. 2" (in part)	Caborce, Mexico		Portlandian
Franciscan				"No. 1"?			


PPER CRETACEOUS
NORTH AMERICA
LEGEND
EANIC BASINS
RINE WATERS (EPICONTINENTAL)
OR LAND, MORE LIKELY SEA
ND OR SEA, MORE LIKELY LAND
NDS
ETERMINATE AREAS
RINE CURRENTS
POLAR
EQUATORIAL
CONTINENTAL DEPOSITS, SOMETIMES INCLUDING MARINE SEDIMENTS

In this report Daly's views are presented by the following correlation table:

	South Alaska	Western B.C. and Yukon	West. Geosynel. Belt. 49th par.	Oregon & Nor. Cal.	Middle Calif.
Upper Cretaceous	Sandstones, Shales & coal (Kuiu Id.) Unconformity	Nanaimo group; Conglomerates, shales & sandst. Some coal	Pasayten Series upper part; shale and sandstones.	Chico formation Sandstone, shale & conglomerate.	Chico formation. Unconformity.

(16) 1912. Clapp, C.H. Southern Vancouver Island. Geol.Sur. Can., Memoir 13, pp. 124-136.

The lithology and structure of the southernmost exposures of the Nanaimo series on Vancouver Island are discussed in this report. A few fossil localities are mentioned.

(17) 1913. Clapp, C. H. Geology of the Victoria and Saanich map areas, Vancouver Island, B.C. Geol.Sur.Can., Memoir 36, pp. 94-102.

In this report a short discussion of the lithology and structure of the Nanaimo series is given. A few fossils are listed from scattered localities.

(18) 1914. Clapp, C.H. Geology of the Nanaimo map area. Geol.Sur.Can., Memoir 51, pp. 44-80.

In this article the stratigraphy of the Nanaimo series, based upon the lithology, is described. Each lithologic

unit is named. The structural relations and the paleontology are briefly mentioned.

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(19) 1916. Weaver, C.E. The Tertiary formations of western Washington. Wash.Geol.Sur.,Bull. 13, pp. 77-79.

The geographic distribution, structure and lithology of the Cretaceous of the San Juan Islands are briefly mentioned in this report.

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(20) 1917. Clapp, C.H. Sooke and Duncan map-areas, Vancouver Island. Geol.Sur.Can.,Memoir 96, pp. 218-255.

The structure, stratigraphy and lithology of this area is discussed in the same manner as that of the Nanaimo map-area.

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(21) 1924. Goranson, R.W. A correlation of the Mesozoic formations of the Pacific Coast of North America. Amer.Jour. Sci., Ser.5, Vol.8, 208. July-Dec., pp. 61-78, 159-182.

This paper presents a summary of the older literature on which the correlations are based. A bibliography is included. The Upper Cretaceous of the Pacific Coast is summarized in the following correlation table:

	Alaska	British Columbia			California (after J.P.S.)	
Upper Creta-ceous	Chignik: Bay-ss., sg., sh. ?North of Douglas Village ?Kuiu Id. (con: tains coal	Nanaimo series of Vancouver Island. Pt. of Pasay-ten series: of 49th par.	Queen Char-lotte Series	Skid-gate forma-tion Honna forma-tion	Chico forma-tion	Upper Chico sandstone with Schloen-bachia chi-coensis and Pachydiscus newberryanus Lower Chico beds with Schloenbachia, Placenticeras and Phylloceras ramosum

STRATIGRAPHY

PRE-CRETACEOUS OF VANCOUVER ISLAND AND NORTHWESTERN WASHINGTON

The pre-Cretaceous deposits of Vancouver Island and northwestern Washington consist of deformed igneous, sedimentary and metamorphic rocks. Fossil bearing rocks of pre-Cretaceous age are scattered and the fossils poorly preserved. On the Sucia Islands there are no known deposits older than the late Cretaceous.

The following table shows the relations of the pre-Cretaceous rocks of southeastern Vancouver Island and the San Juan Islands.

San Juan Islands		Vancouver Island			
		South. Vancouver Id. 1912	Victoria & Saanich Map-area 1913	Nanaimo Map-area 1914	Sooke & Duncan Map-Area 1917
Lower Cretaceous	Spieden formation	Upper Jura. or Lower Cretaceous			Minor intrusiveness
Late Jurassic	Turtleback complex	Upper Jura.& possibly Lower Cretaceous	Batholithic & dike intrusives Sooke Gabbro. Dike & Minor intrusives. Saanich granodiorite. Beale diorite..	Batholith & minor intrusive Sicker Porphyrite. Diorite. Granodiorite. Colquitz gneiss. Wark gneiss	Granitic intrusives Sicker Porphyrite. Saanich granodiorite. Gabbro diorite	Batholithic & minor intrusives. Granodiorite. Porphyrite. Saanich granodiorite. Sicker Gabbro. Tyee Porphyrite. Colquitz gneiss. Wark gneiss
Jurassic?	Eagle Cliff porphyrite					
Upper Trias	Haro formation		Wark gneiss	Wark gneiss		
Triassic	Fidalgo formation					
Penn-Perm.	Leech River group. San Juan ser. Lime-stone lenses	Jurassic & Triassic	Vancouver group. Sicker ser. Metchosin volcanics Sutton formation. Vancouver volcanics	Vancouver group. Sicker schist Sicker volcanics Sutton formation Vancouver volcanics	Vancouver group Sicker series Vancouver series	Vancouver group Sicker series Sutton formation Vancouver volcanics
Dev-Miss.	Crcas group					

San Juan Islands	Vancouver Island		
	Carboniferous	Leech River formation	Malahat volcanics / Leech River formation

CRETACEOUS OF VANCOUVER ISLAND AND NORTHWESTERN WASHINGTON

The definitely Upper Cretaceous deposits of Vancouver Island consist of a series of sedimentary rocks with varying amounts of deformation. There is no evidence of schistosity, although many of the rocks are indurated and badly crushed. In some formations coal seams are numerous. Invertebrate fossils are abundant in the marine facies, while a rich fossil flora may be obtained in the fresh and brackish water phases. The Cretaceous series are best exposed in the Nanaimo and Cowichan basins, and on the small islands on the southeastern side of Vancouver Island.

In northwestern Washington rocks of Cretaceous age have been found only in the northern part of the San Juan Islands and as scattered remnants near Mt. Baker, in the northern part of Whatcom County.

The Upper Cretaceous deposits of Vancouver and the San Juan Islands have been correlated with the Chico formation of California and also with formations within the Atlantic and

Interior provinces. The deposits in Whatcom County are of Lower Cretaceous age.

The following correlation table by Schuchert (22) shows

(22) 1924. Schuchert, Charles. A Textbook of Geology. Part 2, Historical Geology, 2nd Revised Edition, pp.554-561.

the relative position of the Chico and other Upper Cretaceous formations of the United States as compared with the European time scale.

Europe	Atlantic Coast	Gulf Coast	Texas	North Great Plains	Black Hills	Central Great Plains	Colo. Plat.	Pacific Coast
"Paleocene"				Great-est Mt. making Break Ft. Union	Great-est Mt. making Break Ft. Union	Great-est Mt. making Break	Great-est Mt. making Break Torrejon	
Cernaysian								
Thanetian								
Montanian	Shark River				Ludlow	Denver	Puerco	
Break	Break		Break		Low. Lance	Arapahoe Mt. Making Lara-mie	Ojoamo-Animas Mt. Making Kirtland Fruit	
Danian: Maestrichtian	Manasquan Rancocas Break		Navarro Escondido	Bear-paw	Fox Hills	Fox Hills		Break

Europe	Atlantic Coast	Gulf Coast	Texas	North Great Plains	Black Hills	Central Great Plains	Colo. Plat.	Pacific Coast
Senonian								
Campanian	Monmouth	Brook					Pictured Cliff	Upper Chico
Santonian	Matawan	Ripley	Taylor	Blue River	Pierre	Pierre	Lewis	
Coniacian		Selma		Judith River			Mesaverde	
Emscherian	Magothy	Eutaw		Claggett Eagle				
Turonian	Brook		Austin Eagle Ford	Colo. shale	Niobrara Carlile Greenhorn	Niobrara Carlile Greenhorn	Manco	
		Tuscaloosa						Lower Chico
Cenomanian	Raritan	Brook	Woodbine	Brook	Craneros Dakota	Craneros Dakota	Dakota	

CRETACEOUS SECTION OF VANCOUVER ISLAND

The Upper Cretaceous section of Vancouver Island has been designated as the Nanaimo series. The members of the Nanaimo series have been distinguished by Clapp on the basis of lithology. The fauna is said to be the same

throughout the series. The Nanaimo series averages 6,760 feet in thickness. The members constituting the Nanaimo series are:

Top of Section

Gabriola formation	1,400 feet	. . .	ss. & sh.
Northumberland formation . .	1,150 "	. .	ss.,sh. & cg.
DeCourcy " . .	900 "	. . . . .	ss.
Cedar District " . .	750 "	. . . . .	ss.
Protection " . .	650 "	. . . . .	ss.
Newcastle " . .	175 "	. .	ss.,sh. & coal
Cranberry " . .	400 "	. .	ss.,sh.& cg.
Extension " . .	600 "	. .	ss.,cg. & coal
East Wellington " . .	35 "	. . . . .	ss.
Haslam " . .	600 "	. . . . .	ss.
Benson " . .	100 "	. . .	Basal congl.

Base of Section

CRETACEOUS SECTION OF THE QUEEN CHARLOTTE ISLANDS

The rocks of Cretaceous age on the Queen Charlotte Islands are known as the Queen Charlotte series. This series is composed of detrital sediments which have been divided by Clapp (23) with respect to the lithology. The Queen Char-

(23) 1912. Clapp, C.H. Geol.Sur.Can.,Sum.Rept.,p. 18.

lotte series rests unconformably upon the Vancouver group and is intruded by and underlies Tertiary igneous rocks. The section as given by MacKenzie for Graham Island is:

plant or animal remains are found. This series is correlated with the Lower Cretaceous, Horsetown group of California. Near the top of the series questionable animal remains of Chico age are present. Plant remains found near the top are designated as Chico.

TYPE SECTION FOR WESTERN WASHINGTON AND WESTERN BRITISH COLUMBIA

To summarize the Cretaceous stratigraphy of western British Columbia and northwestern Washington the following correlation table is given:

California	Queen Charlotte Islands	Vancouver Island	Northwestern Washington
Eocene		Gabriola form. ?	Puget Group
Chico: Upper:	Skidgate formation	Gabriola Northumberland DeCourcy Cedar Dist. Protection Newcastle Cranberry Extension East Wellington Haslam Benson	Pasayten series in part. Waldron, Skip Jack and Patos Islands Sucia Ids. (Marine, foss. member) (Basal Conglom.
Lower:	Honna formation		Pasayten series in part.
Horsetown	Haida formation		Pasayten series in part
Knoxville			Glacier and Mount Baker region (Aucella crassicollis zone) Pasayten series in part.

STRATIGRAPHY OF SUCIA ISLAND

The Sucia Islands are composed of a series of conformable sedimentary rocks, resting upon a coarse basal conglomerate. The only fossiliferous member of this series is the one resting upon the basal conglomerate. This series is folded so as

to produce an easterly plunging syncline.

Two sections were measured in the fossiliferous member of the series.

Section X, measured by the writer, on the southeastern portion of the island is the most complete. This section rests conformably upon a basal conglomerate composed of angular blocks of micaceous schist and milky quartz. The conglomerate is unfossiliferous and cross-bedded. No fragments of the conglomerate can be found in the overlying strata. The fossiliferous member is composed of a grayish green, sandy shale, with intercalated bands of gray, calcareous shale lenses or concretions. Near the top of the section the grayish green shale gives way to a black calcareous shale with fissile-like structure.

This section represents the lowest member of a northwest-southeast syncline. The average dip of the section is 47°N.E. and the strike N.65°W. There is no recurrence of the schist quartz conglomerate or the fossiliferous formation on the northern side of the Sucia Islands.

The strata overlying this section are chiefly grits and sandstones, buff colored and fairly hard. They are often cross-bedded.

The details of the measured section are as follows:

Top of Section X

	Feet	Inches
Alluvium and beach material		
Black shale with fissile-like structure	23	

	Feet	Inches
Sandstone lens		4.5
Black shale with fissile-like structure	13	
Sandstone lens		4.5
Gray to black sandy shale	79.5	
Sandstone lenses	6	
Slide material and alluvium	159	
Blue calcareous shale lens		4.5
Grayish sandstone	23	
Shale lens, wavy laminae	3	
Grayish sandstone	33	
Sandstone lens		10.
Grayish sandstone	5	
Sandstone lens	2	
Gray sandstone	16.5	
Sandstone lens	1	
Gray shaly sandstone	10	
Greenish-gray shaly sandstone with six small sandstone lenses	18	
Greenish-gray shaly sandstone	43	
Sandstone lens, coarse, with large pebbles and shell fragments	1	5
Greenish-gray sandy shale with increasing amounts of sand	43	
Sandstone lens	1	8
Greenish-gray sandy shale	10	
Blue gray, hard, calcareous shale lens	1	8

	Feet	Inches
Greenish-gray sandy shale	103	
Finely laminated blue micaceous sandy shale	3	4
Greenish-gray sandy shale	13	
Conglomerate lens, with many shell fragments	10	
Greenish-gray sandy shale with included greenstone pebbles	12	
Total	627 feet	

Section Z was measured along the western tip of the southernmost portion of the Sucia Islands. It is bounded on the north by Fox Cove. The basal quartz-micaceous schist conglomerate is not exposed and the top portion of the section is obscured by slide material. The average dip of the section is 47°N.E. and the strike N.65°W.

The strata exposed in this section consists of a great number of small, hard, calcareous, gray, usually fine banded, sandstone lenses intercalated with massive shale members. These lenses are sometimes in the form of rounded or elongated concretions. In the description of the section these lenses are referred to as "sandstone lens." The shale members are usually massive and are rather sandy, often they are coarsely laminated. The only megascopic difference noticeable is the coloring.

The measurements of this section are as follows:

Top of Section 2

	Feet	Inches
Slide material		
Sandstone lens	2	9
Grayish black sandy shale	24	
Sandstone lens	2	
Grayish black sandy shale	47.5	
Sandstone concretions forming a nodose strata	2 to 8	
Grayish black sandy shale	56	
Sandstone lens	3	2
Grayish black sandy shale	62.5	
Sandstone lens	3	2
Grayish black sandy shale	33	
Sandstone lens	3 to 17	
Grayish light green sandy shale	5	
Sandstone lens	2	
Grayish light green sandy shale	4	
Sandstone lens	2	
Grayish green shaly sandstone	10	
Sandstone lens	3 to 8	
Grayish green shaly sandstone	25	
Sandstone lens	1	
Grayish green shaly sandstone	5	
Sandstone lens	3	2
Grayish green sandstone	10	

	Feet		Inches
Sandstone lens	1		5
Grayish green sandstone	10		
Sandstone lens	8	to	8
Grayish green sandstone	5		
Sandstone lens	2		
Total	330 to 371 feet		

SEDIMENTARY PETROGRAPHY

A brief petrographic study of the sediments of the fossiliferous strata of the Sucia Islands shows that there are two noticeable mineral zones; the Lower zone, which would roughly coincide with the Trigonia tryoniana zone, and the Upper zone, which takes in the two faunal zones and Fossil Island. The lower zone is characterized by the presence of glaucophane while in the Upper zone this mineral is totally absent.

Five representative samples give the following minerals:

Fossil Localities 1 to 5	Fossil Locality 15
Glaucophane	Epidote
Zircon	Zircon
Hornblende	Hornblende
Epidote	Colorless pyroxene
Iron oxide	Iron oxide
Quartz	Quartz
Turbid feldspar	Feldspar
Muscovite	

Fossil Locality 5	Fossil Island
Hornblende	Hornblende
Zircon	Spinel
Spinel	Zircon
Quartz	Augite
Turbid feldspar	Andesine feldspar
Muscovite	Quartz
	Muscovite

FAUNAL RELATIONS

FOSSIL LOCALITIES

The fossil localities are located in strata comprising Little Sucia or Fossil Island and the most southern extension of Sucia Island. Localities 1 to 17 inclusive are included in stratigraphic section X. Localities 101 to 108 inclusive are included in stratigraphic section Z. Locality No.1 is a few feet above the top of the conglomerate exposed at the very southeastern corner of the southern extension of Sucia Island. Localities 2 to 8 are along the beach northward from No.1. Localities 9 to 16 are along the southern border of Fossil Bay. Localities 101 to 108 are in the section bounded by Fox Cove and Puget Sound.

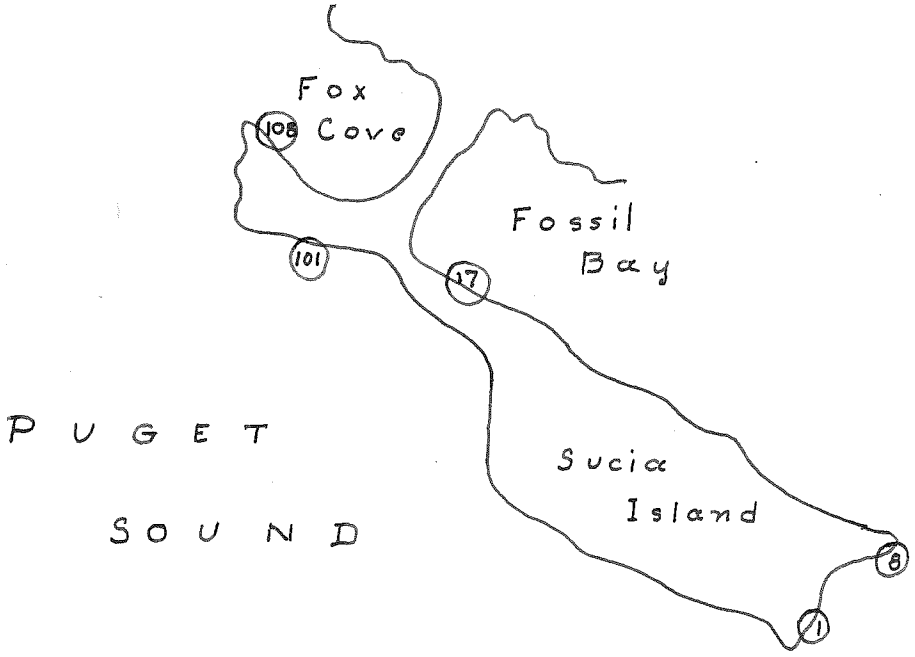


Diagram of the most southern extension of Sucia Island showing fossil localities.

FAUNA IN STRATIGRAPHIC SECTION X

PELECYPODA

Acila truncata Gabb var.

Cliscocolus dubia var. cordatus Whiteaves

Crassatellites cf. conradiana Gabb.

Cucullaea tumida Whiteaves nov. var.

Cucullaea truncata Gabb nov. var.

Cucullaea vancouverensis Meek

Glycimeris sueiensis McLellan

Glycimeris nov. sp.

Homomya sp.

Inoceramus subundatus Meek

Inoceramus vancouverensis Shumard

Inoceramus sp.

Lima suciensis Whiteaves

Pholadomya subelongata Meek

Spisula ashburnerii Gabb

Tellina (Linearia) multicostata Gabb

Trigonia evansana Meek

Trigonia scabra Lamarck

Trigonia tryoniana Gabb

GASTROPODA

Crepidula suciensis Whiteaves

Lysis nov. sp.

Margarites (Atira) ornatissimus Gabb

Oligoptycha (Cimulia) obliqua Gabb

Volutoderma cf. averillii Gabb

BRACHIOPODA

Rhynchonella suciensis Whiteaves

CEPHALOPODA

Baculites chicoensis var. suciensis nov. var.

Desmoceras selwynianum Whiteaves

Canadoceras newberryanus Meek

Lytoceras (Pseudophyllites) cf. indra Forbes

Metaplacenticeras vancouverensis Meek

Pachydiscus (Parapachydiscus) sp.

Nautilus campbelli Meek

PISCES

Shark teeth

FAUNA IN STRATIGRAPHIC SECTION Z

PELECYPODA

Cucullaea tumida Whiteaves

Inoceramus subundatus Meek

Inoceramus vancouverensis Shumard

Pinna calamitoides Shumard

Tellina sp.

Triconia evansana Meek

GASTROPODA

Perissitys (Perissolax) nov. sp.

Volutoderma cf. averillii Gabb

CEPHALOPODA

Baculites chicoensis var. suciensis nov. var.

Canadoceras newberryanus Meek

FAUNAL COMPARISONS

The following table is given to show the range and distribution of the fossils collected by the writer on Sucia Island as compared with the fossils collected at other known Upper Cretaceous localities on the Pacific Coast of North America.

FAUNAL ZONES OF VANCOUVER ISLAND

Although the stratigraphy and paleontology of Vancouver Island have been extensively dealt with by Richardson, Dawson and Whiteaves no attempt has been made to arrange the fossil faunas in zones. Clapp states that the same fauna ranges from the top to the bottom of the Nanaimo series.

FAUNAL ZONES OF THE SUCIA ISLANDS

The fossiliferous Cretaceous rocks of the Sucia Islands are divisible into three faunal zones, each of which, as observed by the writer, can be designated by the name of a representative species. The lowermost strata in the Sucia Islands is termed the Trigonia tryoniana zone and this species with its associated fauna ranges through localities 1 to 5. Above the Trigonia tryoniana zone is the Inoceramus vancouverensis zone, including faunal localities 6 to 15. The uppermost division is designated the Cucullaea vancouverensis zone, represented by localities 16 and 17. From the following stratigraphic column it will be seen that most of the species collected range from the top to the bottom of the column. The Ammonoidea range throughout the section. The Nautiloidea have only been found in the upper zone.

COMPARISON OF SUCIA ISLAND WITH VANCOUVER ISLAND SECTIONS

No zonal correlation can be made with any of the strata

upon Vancouver Island. Comparing the faunas of Vancouver and the Sucia Islands, however, it will be noticed that the fossiliferous member of the Sucia Islands may be correlated with the Haslam formation or lowest marine member of the Nanaimo series.

SECTION X

Top of Section

Nautilus campbelli
Cucullaea vancouverensis
Desmoceras selwynianum — Zone of

Lytoceras (Pseudophyllitos) indra
Oligoptycha obliqua
Crassatellites conradiana
Clisocolus dubia
Cucullaea vancouverensis — Cucullaea vancouverensis

Lima suciensis
Acila n. sp. — Lysis n. sp.

Predominantly Inoceramus vancouverensis together with Baculites chicoensis n. var., Oligoptycha obliqua, Crassatellites conradiana, Volutoderma averillii, Trigonia evansana, Glycimeris suciensis, and Inoceramus subundatus — Zone of Inoceramus vancouverensis

Trigonia evansana

Rhynchonella suciensis
Trigonia tryoniana

Metaplacenticeras vancouverensis
Inoceramus vancouverensis
Crassatellites conradiana — Zone of

Cucullaea tumida
Desmoceras selwynianum
Margarites ornatissimus
Baculites chicoensis n. var.

Tellina (Linearia) multicostata
Nonoya sp.?
(Trigonia evansana
(Trigonia tryoniana
(Baculites chicoensis n.var.
(Crepidula suciensis — Trigonia tryoniana

Spisula ashburneril
Glycimeris n. sp.

Glycimeris sueiensis
Glycimeris sueiensis
Glycimeris n. sp.
Pholadarya subelonga
ta
Trigonia tryoniana

Canadoceras newberryanus
Crassatellites tuscana
Inoceramus sp.?
Baculites chicoensis n. var.
Cucullaea truncata n. var.
Inoceramus vancouverensis

SECTION 2

Top of Section

Tellina sp.?
Inoceramus n. sp.

Section contains a scattered fauna consisting of:

Volutoderma averillii
Trigonia evansana
Perissitys brevirostris
Pinna calamitoides
Cucullaea tumida
Canadoceras newberryanus
Inoceramus vancouverensis
Inoceramus subundatus
Baculites chicoensis n. var.

CONCLUSIONS

The type section of the northwest Cretaceous as given on a preceding page is best expressed as a series of lithologic divisions. The fossil fauna, while abundant, is somewhat scattered. The Sucia Islands are very fossiliferous with a completely exposed section. For this reason the Sucia Islands are chosen for the type section of the marine, fossiliferous, Upper Cretaceous deposits of the Northwest, excluding Alaska.

LITHOLOGIC STRATIGRAPHY OF SUCIA ISLAND

The lithologic stratigraphy of the Sucia Islands has been worked out by R. D. McLellan (26). The stratigraphic

(26) 1927. McLellan, R.D. The geology of the San Juan Islands. Univ. of Wash. Pub. in Geol., Vol. 2, pp. 113-134.

section measured by McLellan is as follows:

Top of Section

Buff sandstone with some conglomerate	427 feet
Concealed (probably shale)	470 "
Buff sandstone with some conglomerate . . .	300 "
Concealed (probably shale)	250 "
Conglomerate with crossbedded sandstone . .	544 "
Concealed (probably shale)	290 "
Coarse to medium grained sandstone	655 "

Fossiliferous olive gray sandy shale . . . . 700 feet

Coarse conglomerate . . . . . 100 "

Total . . . . . .3736 feet

In correlating the lithologic units of Vancouver and the Sucia Islands only the two lower formations can be compared with any degree of accuracy. It is entirely possible that the unfossiliferous strata of the Sucia Islands may represent the upper nine formations of the Nanaimo series. The differences in thickness may be due to differences in the conditions of sedimentation.

FAUNAL ZONES OF SUCIA ISLAND

The following faunal zones established in the Sucia Islands are:

Top - - Cucullaea vancouverensis zone

Middle - Inoceramus vancouverensis zone

Base - - Trigonia tryoniana zone

COMPARISON OF THE SUCIA ISLAND FAUNAS WITH THOSE OF THE KNOXVILLE

There is no evidence of the occurrence of a Knoxville fauna in the Sucia Islands. The characteristic Knoxville genus, Aucella, was not found by the writer nor has it ever been reported from these islands by any other collector.

COMPARISON OF THE SUCIA ISLAND FAUNAS WITH THOSE OF THE HORSETOWN

The following species occur in the Sucia Islands, and have been reported as occurring in the upper portion of the Horsetown beds of California.

Acila truncata Cabb

Cucullaea vancouverensis Meek

Nautilus suciensis Whiteaves

Trigonia evansana Meek

COMPARISON OF THE SUCIA ISLAND FAUNAS WITH THOSE OF THE CHICO

The Cretaceous faunas of the Sucia Islands have their closest affinity with those of the Chico formation, every species occurring there being represented in the Chico deposits either identically or by closely related forms. The upper portion of the Chico is better represented than the lower Chico.

STRATIGRAPHIC POSITION OF THE UPPER CRETACEOUS OF THE NORTHWEST

The stratigraphic position of the Upper Cretaceous formation of the Sucia Islands in reference to that of the Pacific Coast is summarized in the following table:

Europe	California		Alaska	Vancouver Id.		Sucia Id.
	Schuchert	Anderson	Martin	Anderson	Corenson	
Danian						
Maestrichtian			Chignik formation			
Campanian	Upper Chico				Nanaimo Series	Nanaimo Series
Santonian		Upper Chico		Nanaimo Series		
Coniacian						
Turonian	Lower Chico	Lower Chico		Nanaimo Series		
Cenomanian						

In this table the Nanaimo Series is taken to include the upper and middle portions of the Senonian and extending into Maestrichtian time. The writer believes that Coniacian sedimentation in the Northwest was partly if not totally missing. This conclusion is based upon the faunas collected, which show many species that have decided Tertiary relationships, and by the negative fact that the Ammonoid family, Priomotropidae, is entirely missing. The members of this family are found in nearly every upper Chico locality of California and Oregon. This family is designated by J. P. Smith (27) as belonging to

(27) 1913. Von Zittel, K.A. Textbook of Paleontology. Second Ed., revised by C.R.Eastman, pp.674-675.

the middle Cretaceous and the lower portion of the Upper Cretaceous. Of the other Ammonoidea the family Lytoceratidae is best represented by the genus Baculites. This genus, which is characteristic of the Upper Cretaceous, and which is found at the Sucia Islands in great numbers, is taken by the writer as evidence that these beds extend well into Maestrichtian time and possibly to the end of that period.

DESCRIPTION OF SPECIES

MOLLUSCA

Class CEPHALOPODA

Sub-class TETRABRANCHIATA

Order NAUTILOIDEA Zittel

Family NAUTILIDAE Owen

NAUTILUS SUCIENSIS Whiteaves

Nautilus suciensis Whiteaves (1879), Can. Geol. Sur., Meso. Foss., Vol. 1, Pt. 2, p. 97, pl. 11, Figs. 1-1a.
Not Nautilus suciensis Whiteaves (1884), ibid. Pt. 3, p. 197, pl. 21; Nautilus suciensis Whiteaves (1903), ibid. Pt. 5, p. 327.

Only a small fragment of one whorl was obtained by the writer. This form is marked by a broadly rounded ventro

which is crossed by prominent costae.

This form is in some respects similar to the Neocomian forms, N. elegans, N. pseudo-elegans, and N. kayeanus. However, it differs in the position of the siphuncle and in the angle made by the costae with a mid-ventral line. The siphuncle is medial, while the Indian forms have the siphuncle dorsal. It is very close to N. pseudo-elegans and varies in the number of septa to the whorl.

EUTREPHOCERAS CAMPBELLI Meek

Eutrephoceras campbelli Meek

Nautilus bouchardianus Blanford (1861), Mem. Geol. Sur. India, Paleon. Indica, Foss. Ceph., p. 13, pl. 3, 4, 5.

Nautilus campbelli Meek (1861), Proc. Acad. Nat. Sci., Philad., Vol. 13, p. 318.

Nautilus campbelli Meek (1876), Bull. Geol. & Geog. Sur. Terr., Vol. 2, No.4, p. 373, pl. 6, Figs. 2, 2a.

Nautilus campbelli Whiteaves (1879), Can. Geol., Sur., Meso. Foss., Vol. 1, Pt. 2, p. 99, pl. 11, Figs. 2, 2a, 2b.

Nautilus campbelli Whiteaves (1903), ibid., Pt. 5, p. 327.

The specimen collected by the writer is exactly the same as pictured by Meek, except for a difference in the inflection of the suture line.

This form is very close to N. bouchardianus D'Orbigny, but as the group N. bouchardianus is very large and has a wide variance it is best to retain the specific name campbelli until a greater differentiation is made in the Indian forms.

Order AMMONOIDEA Zittel

Family DESMOCERATIDAE Zittel

DESMOCERAS SELWYNIANUM Whiteaves

Plate I

Desmoceras selwynianum Whiteaves

Ammonites selwynianus Whiteaves (1879). Can. Geol. Sur., Meso. Foss., Vol. 1, Pt. 2, p. 104, pl. 13, Figs. 1-1a.

Desmocera selwynianum Whiteaves (1903), ibid., Pt. 5, p. 351.

Desmoceras selwynianum Kossmat (1897), Beitr. zur Palaeont. Oesterreich-Ungarns und des Orients, Vol. II, p. 198.

This form has been repeatedly described but no tracing of the suture line has been placed upon record.

CANADOCERAS NEWBERRYANUS Meek

Plates II and III

Canadoceras newberryanus Meek

Ammonites newberryanus Meek (1857), Trans. Albany Inst., Vol. IV, p. 47. (Not A. newberryanus Gabb (1864), Pal. Cal., Vol. 1, p. 61, pl.27).

Ammonites newberryanus Meek (1876), Bull. Geol. & Geog. Sur. Terr., Vol. II, p. 367, pl. 41, Figs. 3, 3a, 3b.

Ammonites newberryanus Whiteaves (1879), Can. Geol. Sur., Meso. Foss., Vol. 1, Pt. 2, p. 109, pl. 14, Figs. 1 and 1a.

Pachydiscus newberryanus Whiteaves (1903), ibid., Pt. 5, p. 348.

Desmoceras newberryanum Whiteaves (1893), Trans. Roy. Soc. Can. for 1892, Vol. X, Sect. IV, p. 114.

Pachydiscus newberryanus Stanton (1896), U. S. G. S. Bull. No. 133, p. 16.

Pachydiscus newberryanus Anderson (1902), Proc. Cal. Acad. Sci., 3rd Ser., Vol. II, No.1, p. 102.

Canadoceras newberryanum Spath. (1921?), Trans. Royal Soc. South Africa, Vol. X, Pt.3, p. 125, pl. 7, 8. (On the Senonian Ammonite Fauna of Pondoland).

A rather large form, although small specimens are more commonly found. Ventral margin rounded; surface marked by numerous prominent costae which are often bifurcated near

the umbilical shoulder. Umbilicus wide and deep, shoulder rounded and on the inner whorl marked by prominent, widely spaced nodes. On small specimens deep constrictions are present but they apparently die out on the larger forms. On internal casts a deep groove marks the center of the venter. The suture is usually well shown.

Spath places this form in the Campanian and Maestrichtian.

PACHYDISCUS (PARAPACHYDISCUS) NEEVESII Whiteaves

Plate IV

Pachydiscus (Parapachydiscus) neevesii Whiteaves

Pachydiscus neevesii Whiteaves (1903), Can. Geol. Sur., Meso. Foss., Vol. 1, Pt. 5, p. 342, pl. 47, Fig. 1.

The specimen collected by the writer is nearly the same as pictured by Whiteaves.

The suture line is very complex and consists of six lateral lobes. The siphonal lobe is very large and is approached in size by the superior lateral lobe. The other lobes are rather small. The saddles are hardly noticeable.

Family LYTOCERATIDAE Neumayr

LYTOCERAS (PSEUDOPHYLLITES) INDRA Forbes

Plate V

Lytoceras (Pseudophyllites) Indra Forbes

Ammonites Indra Forbes (1846), Tran. Geol. Lond., VII, p. 105, pl. 11, Fig. 7.

Ammonites Indra Giebel (1852), Fauna der Vorwelt, III, p. 437.

Ammonites Indra Stoliczka (1865), Mem. Geol. Sur. India, Pal. Ind., p. 112, pl. LVIII, Fig. 2.

Lytoceras (Pseudophyllites) Indra (Kossmat) Forbes (1895), Beitr. zur. Palaeontologie und Oesterreich-Ungarns, 9-10, p. 164, p. 157, pl. 16 (II), Fig. 6a, b; 7, 8a, b; 9 a, b, pl. XVIII (IV), Fig.5, pl. XVII (III),Fig. 6, 7, a, b.

Ammonites Garuda Stoliczka (1865), Cret. S. Ind. I, p. 149, pl. LXXIV, Fig. 5.

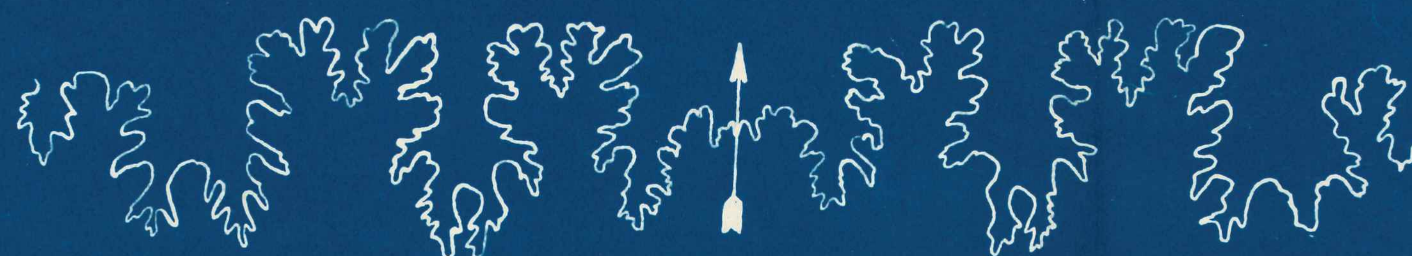
Ammonites Indra Whiteaves (1879), Mes. Foss., Can. Geol. Sur., Vol. I, Pt. 2, p. 105, pl. XIII, Fig. 2.

Pseudophyllites Indra Whiteaves (1903), Ibid. Pt. 5, p. 351.

A very large form, with numerous very fine costae. Ventral margin rounded with the costae passing over it. The umbilicus is wide and deep with the umbilical shoulder rounded. The suture line is very complex.

This form is in agreement with the illustrations by Forbes, Giebel, and Stoliczka, but it is doubtful if the Sucia Island specimens can be identical to the Indian forms because of the wide variance in geologic time. The Indian forms are only found in the Valudayur group of South Arcot, which is Lower Cretaceous. The specimens from Sucia Island belong in the Upper part of the Upper Cretaceous. The Indian and American forms undoubtedly came from the same stock, but the American form has reached a higher development. There are enough differences in the septation to warrant a new species or variety.

The illustration of the suture line as given by the writer shows the complexity but it is also distorted with regards to the superior lateral lobe.



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BACULITES OCCIDENTALIS Meek

Plate VI

Baculites occidentalis Meek (1876), Bull. U.S. Geol. & Geog. Sur. of the Terr., Vol. 2, p. 366, pl. 4, Fig. 1, 1a, 1b.

Baculites occidentalis Whiteaves (1879), Geol. Sur. Can., Meso. Foss., Vol. 1, Pt. 2, p. 115.

This shell is indistinguishable from that of B. chicoensis var. sucoensis, and the two can only be readily distinguished by the suture line. In the great number of specimens of Baculites collected only one or two specimens of B. occidentalis are noticeable. Whiteaves apparently decided that B. occidentalis was not a true species and called all the Baculites from this region B. chicoensis. However, when the suture lines are examined carefully it will be noted that there are two species of Baculites present in this region, and not one.

BACULITES sp.

Plate VII

A rather small shell resembling B. chicoensis var. suciensis. This form is form is represented by only poor specimens which cannot be accurately determined. It is possible that this form is a youthful stage of B. chicoensis var. suciensis.

BACULITES CHICOENSIS Trask var. SUCIENSIS Nov. Var.

Plates VIII, IX, X, XI

Baculites Chicoensis Trask (1856), Proc. San Francisco Acad. Nat. Sci., 85, pl. 2, Fig. 2.

Baculites chicoensis Gabb (1864), Geol. Sur. Calif., Paleontol., Vol. 1, 80, pl. 17, Fig. 27, 27a; pl. 14, Fig. 27b, 29, 29a.

Baculites chicoensis Meek (1876), Bull. U.S. Geol. & Geog. Sur. of the Territories, Vol. 2, 1876, 364, pl. 4, Fig. 2, 2a, 2b, 2c.

Baculites inornatus Meek (1861), Proc. Acad. Nat. Sci. Phila., XIII, 316.

Baculites chicoensis Whiteaves (1879), Geol. Sur. Canada, Meso. Foss., Vol. 1, Pt. 2, 114.

Baculites chicoensis Whiteaves (1903), Geol. Sur. Canada, Mes. Fossils, Vol.1, Pt. 5, 339.

Baculites occidentalis Meek (1876), Bull. U.S.Geol. & Geog. Surv. of the Territories, Vol. 2, 1876, 366, pl. 4, Fig. 1, 1a, 1b.

Baculites occidentalis Whiteaves (1879), Geol. Surv. Canada, Mes. Foss., Vol. 1, Pt. 2, 115.

Baculites chicoensis White (1889), U.S.G.S. Bull. 51, 1889, 47.

Baculites fairbanksi Anderson (1902), Proc. Cal. Acad. Sci., 3rd Ser., Geol., Vol. 2, No.1, 92, Pl. 8, Fig. 152-153; pl. 10, Fig. 194.

Has been compared with

Baculites ovatus Say,

Baculites grandis Meek and Hayden,

Baculites occidentalis Meek (1858-64), Trans. Albany Inst., Vol. 4, p. 48.

Shell attaining a fairly large size, the largest specimen found being 15 inches long. Body chamber occupying nearly one-half of the length. In cross section various specimens show a wide variation, ranging from trigonal to oval.

The suture line is usually well shown and does not show the variation that is present in the cross section. The suture line as drawn by the writer corresponds very closely with that pictured by Meek, but differs from the suture line of the Californian form, Baculites chicoensis as pictured by Gabb.

Baculites vagina Forbes var. simplex has the septation approaching that of Baculites chicoensis var. suciensis but externally it differs widely. B. teres Forbes is similar externally but differs in the septation.

The differentiation of B. occidentalis Meek from B. chicoensis var. suciensis on the cross section can not be held.

LYTOCERAS (TETRAGONITES) MACLUREI (WHITE)

Lytoceras (tetragonites)maclurei White.

Ammonites maclurei White (1889), Bull. U.S.G.S., No.51, p. 48, pl. 7, Figs. 2, 3.

Ammonites cala Stoliczka (1865), Cret. S. Ind., Vol. I, p. 153, pl. LXXV, Fig. 4.

Ammonites cala Forbes, Trans. Geol. Soc. Lond., Vol. 7, p. 204, pl. 8, Fig. 4, 1846.

Ammonites cala Giebel. Faun. d. Vorwelt, III, p. 421, 1852.

Lytoceras (tetragonites) cala Kossmat (1895), Beit. zur Pal. und Geol. Ost.-Ung. IX, 1895, p. 136, pl. XVII (III), Fig. 12a-d.

Only pieces of this species have been collected. No suture lines can be noted.

This form is in close agreement with Lytoceras (tetragonites)cala Stoliczka except that in the Sucia Island specimens the peripheral corners are not quite so square as shown on the Indian forms. The sutures agree as to the placement and number of lobes. The rather prominent constrictions are the same on both the Indian and Sucia Island specimens. It is possible that these two forms are identical but this cannot be shown until more specimens are collected.

Family COSMOCERATIDAE Zittel

METAPLACENTICERAS VANCOUVERENSIS (Meek)

Plates XII and XIII

Ammonites vancouverensis Meek (1861), Proc. Acad. Nat. Sci. Phila., XIII, 317.

Placenticeras vancouverensis Meek (1876), Bull. U. S. Geol. & Geog. Sur. Terr., Vol. 2, p. 370, pl. 6, Figs. 1-1c.

Ammonites vancouverensis Whiteaves (1879), Can. Geol. Sur., Meso. Foss., Vol. 1, Pt. 2, p. 103.

Hoplites vancouverensis Whiteaves (1903), ibid. Pt. 5, p. 339.

Hoplites vancouverensis Whiteaves (1893), Trans. Royal Soc. Can. for 1882, Vol. 10, Sect. 4, p. 118.

Specimens showing only a portion of a volution have been collected. Shell moderately large. All specimens show that the umbilicus is small and deep. The sides are slightly convex. The ventral margin is flat and rather narrow; the sides of the ventral margin are marked by a single row of sharp, elongated nodes, evenly and fairly wide-spaced. These nodes are elongated parallel to the ventral shoulder. They decrease in size and become more widely spaced on the inner whorls. The umbilical shoulder is rather pronounced and is surmounted by a row of small nodes.

The ornamentation consists of a few prominent costae

which become less prominent on the inner whorls. These costae originated at the nodes on the umbilical shoulder; they died out near the ventral shoulder and did not cross the ventro. Between costae are numerous finer ribs which are not shown on the casts. All the ribs are sharply bent forward at the umbilicus and make a sweeping curve at the mid-lateral portion and are directed backward near the ventral margin.

Every specimen shows a trigonal cross section.

The suture was represented on only one specimen and it differs from that pictured by Meek. However, this is most likely due to faulty drawing of Meek's specimen.

There are no forms in the Asiatic or North American Cretaceous which show a close relationship with the form from the Northwestern Chico.

FAUNAL COMPARISONS
SUCIA ISLANDS

Species	Elder Creek, California	North Fork of Cottonwood Creek, Calif.	Ashland, Oregon (Not Uppermost Chico)	Griffin Creek, Ore. (Slightly below Ashland Sect.)	'49 Mines, Oregon	Upper Chico: Tuscan Spring	Upper Chico: Chico Creek	Upper Chico: Pence's Ranch	Upper Chico: Texas Flat	Lower Chico: Phoenix	Lower Chico: Henley	Lower Chico: Silverado	Lower Chico: San Diego	Eagle Ranch, San Luis Obispo Co., Calif.	Sisquoc Canyon, Santa Barbara Co., Calif.	Pacheco Pass, California	Benicia, California	South of Mt. Diablo, California	Southwest of Martinez, California	Todos Santos Bay, Lower Calif.	Santa Ana Mts. Southern Cal.: Actaeonella oviformis zone	Santa Ana Mts. Southern Cal.: Turritella pescaderoensis zone	Santa Ana Mts. Southern Cal.: Tellina ooides zone	Santa Ana Mts. Southern Cal.: Zonal position uncertain	Chignik Form. Alaska: Lower	Chignik Form. Alaska: Middle	Chignik Form. Alaska: Upper	Sooke & Duncan Map-areas, V.I.	Southern Vancouver Island	Nanaimo Map-area, V. I.	Spanish Gulch, Oregon
Brachiopoda																															
Rhynchonella suciensis Whiteaves																												x			x
Pelecypoda																															
Acila truncata		x				x			x	x									x	x	x	x									
Anatina n. sp.																						*									
Cucullaea ponderosa Whiteaves n. var.																															
Cucullaea ponderosa Whiteaves																															
[illegible]ocolus dubia Gabb						x	x														x	x	x								
Crassatellites conradiana Gabb									x												x	x	x								
Crassatellites crassa Whiteaves																															
Cucullaea waterii n. sp.																								x							
Cucullaea truncata Gabb n. var.	x	x	x		x	x			x	x	x						x	x			x	x	x								
Cucullaea n. sp.																															
Cucullaea cf. tumida Whiteaves																															
Cucullaea vancouverensis Meek	x	x				x					x	x	x									x									
Cucullaea tumida Whiteaves n. var.																															
Dosinia inflata Gabb																															
Eriphyla n. sp.																															
Meretrix arata Gabb																															
Meretrix lens Gabb n. var.																															
Glycimeris suciensis McClellan																															
Glycimeris n. sp.	*				*	*		*	*	*		*	*	*	*		*		*	*	*	*	*		*			*	*		*
Homomya sp.?			*		*																										
Inoceramus subundatus Meek								*	*	*	*	*					*							*					*		
Lucina sp.																															
Inoceramus sp.?																															
Inoceramus vancouverensis Shumard													x															x			
Lima suciensis Whiteaves																															
Modiolus siskiyouensis Gabb																															
Mytilus sp.?																															
Paphia (Baroda) n. sp.																															
Pholadomya subelongata Meek																															
Pinna calamitoides					*					x	x							x			x	x									
Pleuromya sp.?																															
Protocardium sp.																															
Spisula ashburnerii Gabb						x	x	x	x	x	x	x	x				x			x		x			x					x	
Spisula gabbiana Anderson										x	x	x										x									
Tellina (Linearia) multicostata																														*	x
Tellina nanaimoensis Whiteaves																									x						
Tellina occidentalis Whiteaves																*															
Thracia subtruncata Meek																															
Thracia sp.																															
Trigonia evansana Meek	x	x			x	x	x	x	x					x			x				x	x	x						x	x	x
Trigonia tryoniana Gabb				x		x																x						x	x		
Trigonia scabra Lamarck																															
Gastropoda																															
Anchura callosa Whiteaves																															
Callistoma n. sp.																															
Crepidula suciensis Whiteaves																															
Epitonium matthewsonii Gabb																															
Fasciolaria n. sp.																															
Fusus kingii Whiteaves																									*						
Fusus sp.?																															
Gyrodes canadensis Whiteaves	x	x			*					*	*	*	*			*			*	*	*	*									
Lysis carinifera Whiteaves																														*	*
Lysis n. sp.																															
Lysis suciensis Whiteaves																															
Margarites (Atira) ornatissimus						x			x		x	x												x							
Mesostoma suciensis Whiteaves																															
Mesostoma newcombii Whiteaves																															
Oligoptycha obliqua (Gabb)		x	x		x			x	x	x	x	x	x		x				x	x		x									
Perissitys n. sp.						*		*			*	*				*			*				*		*						*
Turritella n. sp.										x		x					x			x											
Volutoderma cf. averillii Gabb					x		x	x																							
Volutoderma n. sp.																															
Volutoderma sp.																															
Cephalopoda																															
Baculites occidentalis																															
Baculites chicoensis var. suciensis					*	*	*																								
Baculites sp.												*	*	*	*	*		*		*		*									
Canadoceras newberryanus Meek	x							x			x																				
Desmoceras selwynianum Whiteaves																	x								x						
Metaplacenticeras vancouverensis Meek																															
Pachydiscus (Parapachydiscus) neevesii Whiteaves																															
Lytoceras (Pseudophyllites) indra Forbes																															
Lytoceras (tetragonites) maclurei White																															
Eutrephoceras campbelli Meek																															
Nautilus suciensis Whiteaves																															
Scaphopoda																															
Dentalium sp.?					*					*	*	*			*			*													
Pisces																															
Lamna sp.?																								?							*

x = species which have been reported as identical
* = species which are questionable.

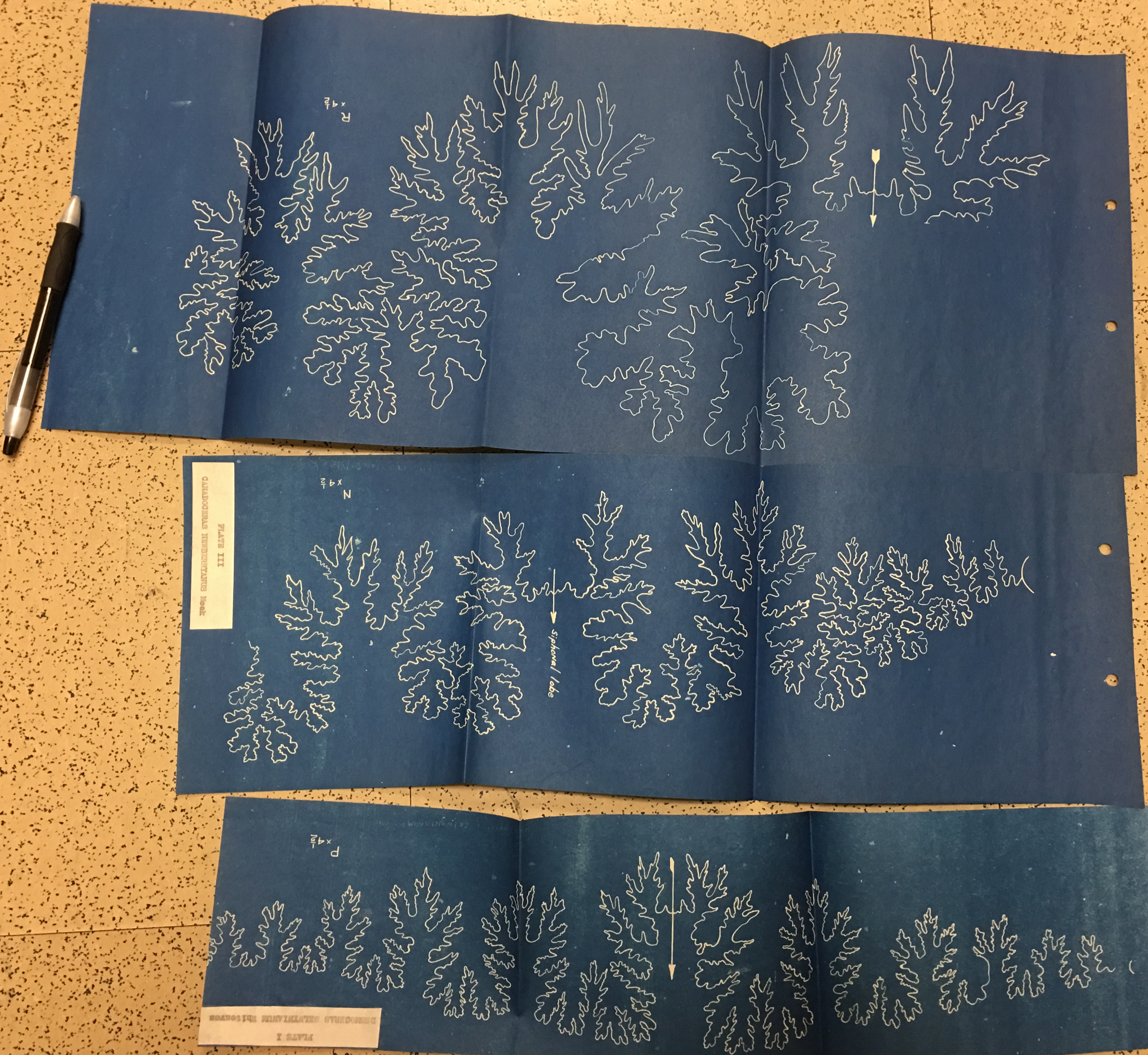
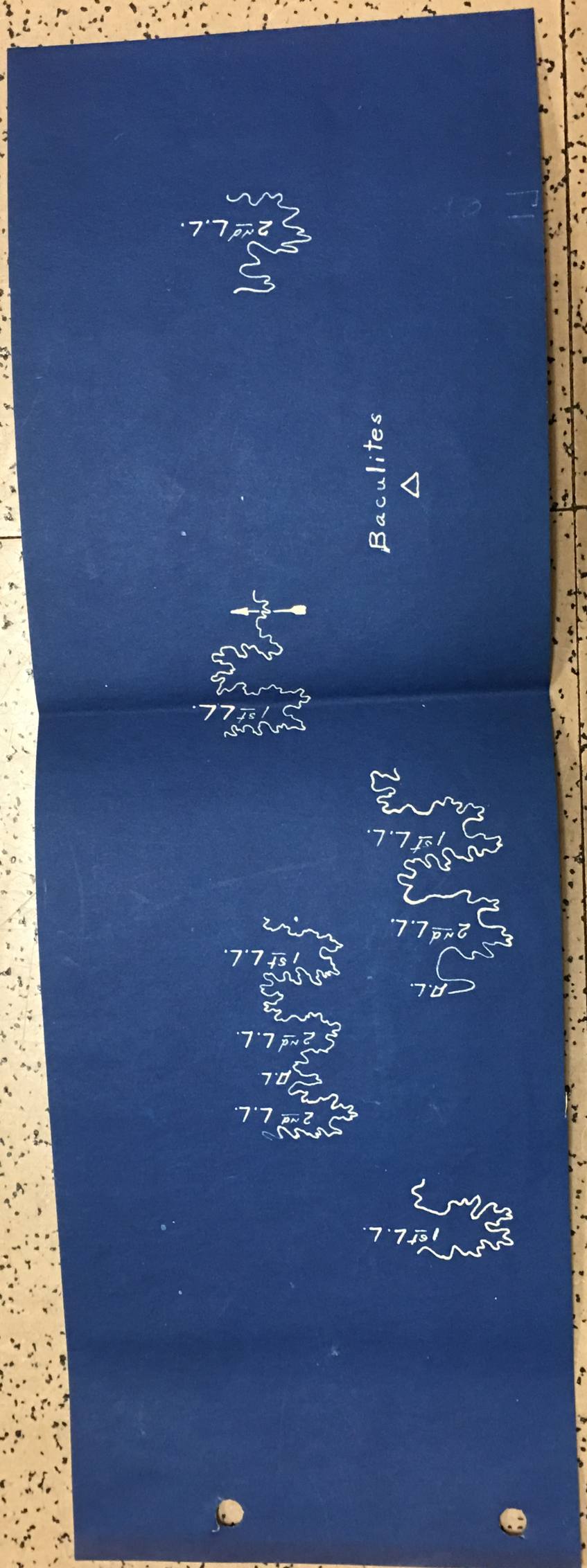


PLATE III
CANADOCERAS NEWBERRYANUM Meek
siphonal lobe
PLATE I
DESMOCERAS SELWYNIANUM Whiteaves

PLATE IV

PACHYDISCUS (PARAPACHYDISCUS) [illegible] Whiteaves


2nd L.L.
1st L.L.
Baculites
1st L.L.
2nd L.L.
D.L.
1st L.L.
2nd L.L.
D.L.
2nd L.L.
1st L.L.
2nd L.L.
D.L.
1st L.L.

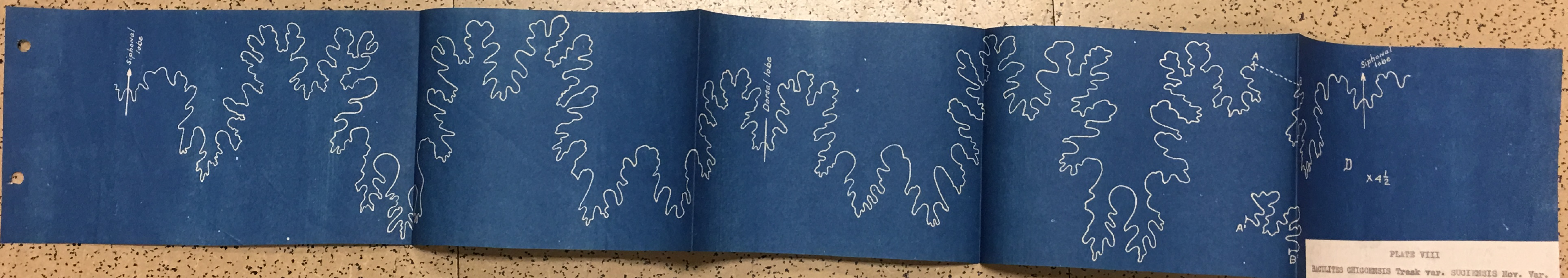


PLATE VIII

BACULITES CHICOENSIS Trask var. SUCIENSIS Nov. Var.

PLATE X

MONOTIS OBLIQUUS Trask var. SUBLINEOLA Hoy. var.

A x2½

Siphonal lobe

Siphonal lobe

Dorsal lobe

C x 2½

Siphonal lobe

Dorsal lobe

Siphonal lobe

Dorsal lobe

Siphonal lobe

B x2½

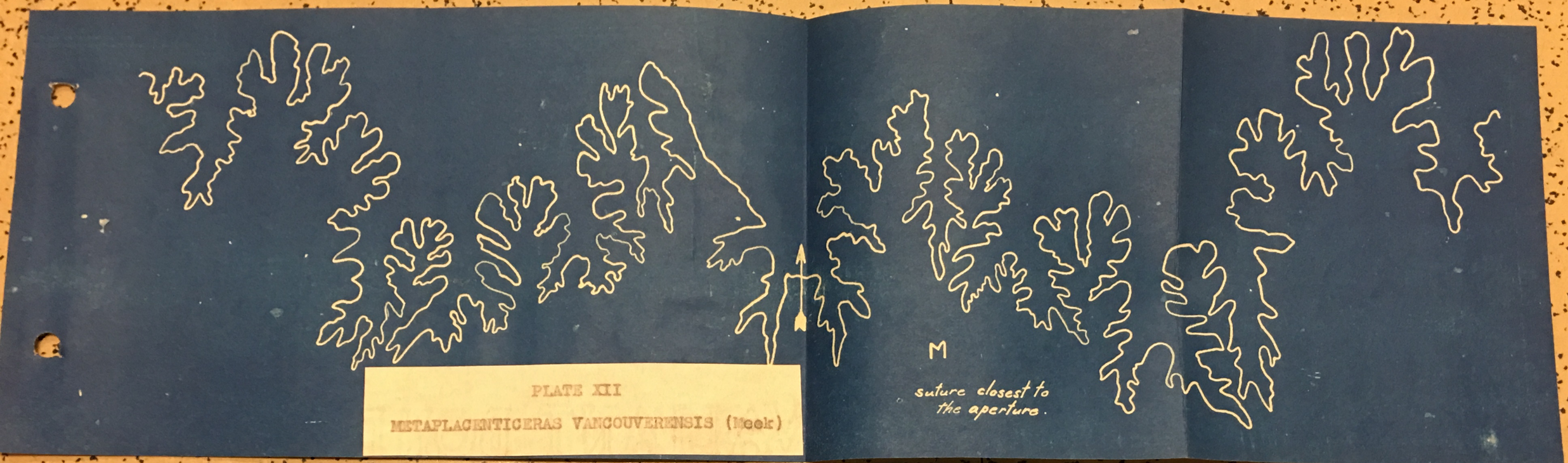


PLATE XII

METAPLACENTICERAS VANCOUVERENSIS (Meek)

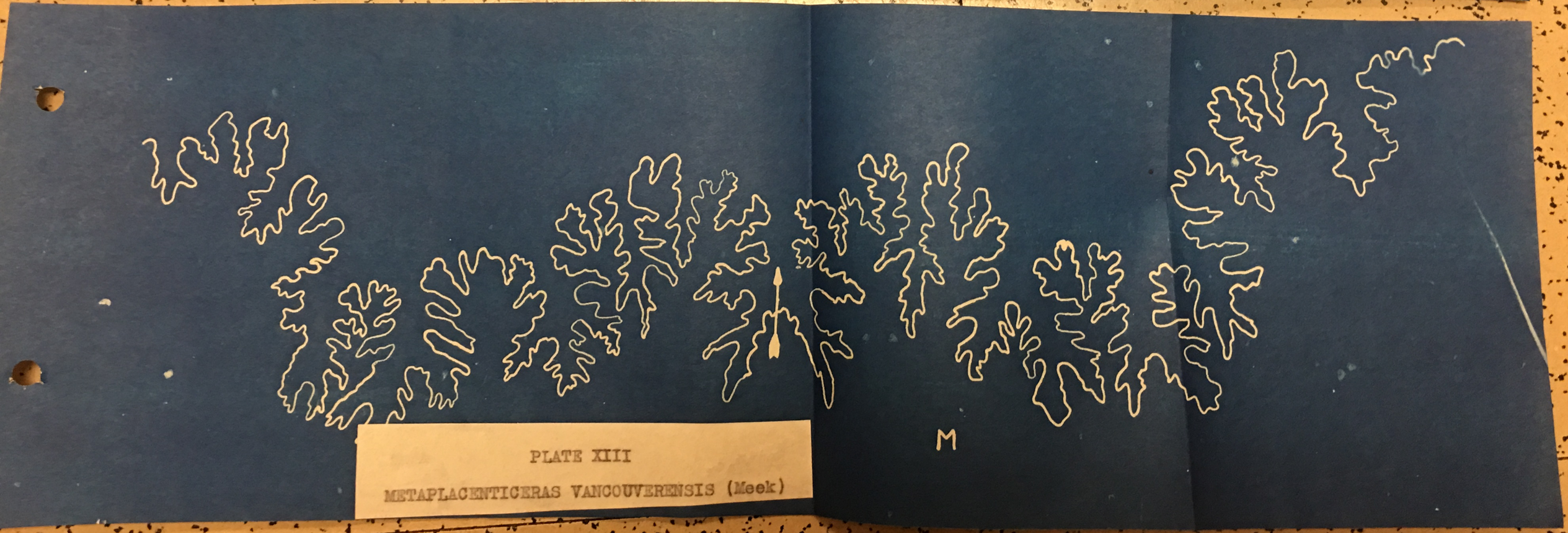


PLATE XIII

METAPLACENTICERAS VANCOUVERENSIS (Meek)