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PALEONTOLOGY OF THE OLIGOCENE OF THE CHEHALIS VALLEY, WASHINGTON

by
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No. 2. Paleontology of the Oligocene of the Chehalis Valley, Washington, by Katherine E. H. Van Winkle.

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CONTENTS

INTRODUCTION

The purpose of this paper is to record the results of an investigation made by the writer during the years 1916 and 1917 on the faunas and stratigraphy of the Oligocene formations exposed in Chehalis Valley between Chehalis and Porter, Washington. The occurrence of Oligocene fossils near Porter has been noted several times in the literature dealing with the Tertiary of the Pacific Coast. As a rule these fossils are in an excellent state of preservation and occur at different horizons from the basal to the uppermost beds of the formation. The region is of considerable importance in establishing the marine Oligocene stratigraphic column in western Washington.

Stratigraphic field studies were carried on by means of a compass and tape traverse on Porter, Gibson, Mox Chehalis, Williams and Independence creeks. All

observations made on the lithology of the rocks as well as the observations on strike and dip were tied in to these traverse lines. Fossils were collected wherever possible and their stratigraphic position determined. The faunal determinations were made by the writer in the Paleontological laboratory of the University of Washington. Twenty-five molluscan species are new and are described in the report. The writer wishes to express her acknowledgments to Professor C. E. Weaver, who has aided in and made possible the preparation of this report.

HISTORICAL REVIEW

One of the first references to the occurrence of Oligocene formations in the Porter area is in a report by Dr. Ralph Arnold[1] in 1906. In this paper a small geologic map of the border of the Olympic Peninsula is inserted, and upon this the occurence of Oligocene-Miocene strata is indicated along the north side of Chehalis River. In a paper published during the same year Dr. Arnold[2] refers to certain gray shales occurring in the vicinity of Porter, Chehalis County, Washington. Mention is made also of the occurrence of Oligocene fossils at Bean Point opposite Seattle, and in northern Clallam County along the south shores of the Strait of Juan de Fuca. In 1908 further reference is made to the occurrence of Oligocene strata by Dr. Arnold.[3] Three new species are described from Porter which are found in common with the Oligocene beds at San Lorenzo, California. These species are *Malletia chehalisensis, Cardium lorenzanum* and *Strepsidura californica.* In the following year Dr. Arnold[4] in a paper on the Tertiary of the Pacific Coast presents a correlation chart in which the Porter beds are placed in the Oligocene.

The occurrence of the Oligocene beds at Porter is considered in more detail in a paper by Dr. C. E. Weaver[5] published in 1912. The beds at Porter are described as being a part of the lower portion of the Blakeley formation and as slightly younger than the Oligocene exposed in the region around Lincoln Creek. The areal distribution of the Oligocene around Porter is indicated on a geological map accompanying the report. Several new species of fossil mollusks are described from this region.

In 1913, a paper appeared entitled "The Marine Tertiary Stratigraphy of the North Pacific Coast of America," by Dr. Ralph Arnold and Harold Hannibal.[6] In this report the Oligocene of Washington is divided into three formations: the San Lorenzo, or lowest; the Seattle, or middle; and the Twin River, or uppermost. These three formations are grouped as the Astoria series. The marine Oligocene exposed at Porter Creek is considered as belonging to the San Lorenzo or oldest division of

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[1] Arnold, Ralph. Reconnaissance of the Olympic Peninsula, Geol. Soc. Am. Bull., vol. 17, pp. 453-454, 1906.

[2] Arnold, Ralph. The Tertiary and Quaternary Pectens of California, U. S. Geological Survey, P.P. No. 47, p. 15, 1906.

[3] Arnold, Ralph. Descriptions of New Cretaceous and Tertiary Fossils from the Santa Cruz Mountains, California, Proc. U. S. Nat. Museum, No. 1617, vol. 34, pp. 365-367, 1908.

[4] Arnold, Ralph. Tertiary Faunas of the Pacific Coast, Jour. Geol., vol. 17, pp. 509-533, 1909.

[5] Weaver, C. E. A Preliminary Report on the Tertiary Paleontology of Western Washington, Wash. Geol. Survey, Bull. 15, pp. 15-16, 1912.

[6] Arnold, Ralph, and Hannibal, Harold. The Marine Tertiary Stratigraphy of the North Pacific Coast of America, Proc. Am. Phil. Soc., vol. 52, pp. 559-604, 1913.

the Oligocene. Mr. Hannibal states, "The shales overlying the basal Astoria basalts north and east of Oakville, Porter and Elma; and the lowest Oligocene exposed at Lincoln Creek belong to the San Lorenzo formation." Several faunal localities in the vicinity of Porter Creek are listed as well as the fauna occurring at these places. He considers the San Lorenzo formation in the Grays Harbor area to have a thickness of 3,000 feet.

In a report published in 1916 by Dr. C. E. Weaver[7] on the "Tertiary Faunal Horizons of Western Washington" the Oligocene strata occurring in the Porter Creek area are referred to as the Porter Horizon, which is considered to be of middle Oligocene age. A list is given of the fauna occurring in this horizon and also those species which are most characteristic of it. This fauna is referred to as the Turritella porterensis Zone. The fauna is regarded as being distinct from the lower beds exposed at Lincoln Creek and also from the upper beds at Restoration Point. Evidence for subdividing the Oligocene into three distinct formations did not seem warranted; however, three faunal zones were recognized, and the middle one of these was referred to as the Porter Horizon. Several new species were described from this area.

Later in the same year a detailed paper appeared by Dr. Weaver[8] dealing with the stratigraphy of the Tertiary of western Washington. This report is accompanied by areal geologic maps and cross sections. Upon these maps the distribution of the Oligocene sediments in the vicinity of Porter Creek is shown as well as the structural details. A list of the faunal species occurring here is also given. The strata are referred to as the Porter Horizon and the fauna contained within these strata are grouped as the Turritella porterensis Zone.

During the summer of 1917 a paper appeared by Dr. Roy E. Dickerson,[9] in which he describes a marine invertebrate fauna of 48 species which was collected by Mr. F. M. Anderson and Mr. Bruce Martin. Thirty-six of these species are new. This fauna occurs in a sandstone formation associated with conglomerate which outcrops at the Greece ranch on the east bank of Cowlitz River, about four miles east of Vader, Washington. Dr. Dickerson believes this fauna to be of Oligocene age and to represent a lower phase of the Molopophorous lincolnensis Zone as exposed on Lincoln Creek.

STRATIGRAPHY

The Oligocene formations in southwestern Washington occupy three areas which appear to have been laid down originally in a long narrow marine embayment extending from Grays Harbor along the Chehalis Valley southeasterly to a point four miles east of Vader on the Cowlitz River. The westernmost of these areas lies between Oakville and Porter. The middle area lies between Helsing Junction

[7] Weaver, C. E. The Tertiary Faunal Horizons of Western Washington, Univ. Wash. Publ. in Geol., vol. 1, No. 1, pp. 1-66, 1916.

[8] Weaver, C. E. The Tertiary Formations of Western Washington, Wash. Geol. Survey Bull. No. 13, pp. 180, 206 and 207, 1916.

[9] Dickerson, Roy E. Climate and Its Influence on the Oligocene Faunas of the Pacific Coast, with Descriptions of some new Species from the Molopophorous lincolnensis Zone, Proc. Cal. Acad. Sci., Fourth Series, vol. 7, pp. 157-192, 1917.

and Centralia. The third area is situated to the southeast between Winlock and the Cowlitz River. For purposes of reference this arm of the sea may be spoken of as the Oligocene Chehalis Valley embayment.

The Oligocene formations exposed on Porter Creek are entirely composed of marine sediments, which attain a thickness of at least 1,200 feet. They rest unconformably upon sandstones and basalts of Eocene Tejon age. The contact between the Tejon basalts and the basal Oligocene sediments occurs on Porter Creek three and one-half miles above its junction with Chehalis River. The basal Oligocene beds are composed of a medium-grained conglomerate in which the pebbles range in diameter from two inches down to a fine grit. These lower beds exhibit a rough stratification and are nearly always stained a reddish brown color, due largely to the circulating waters, which are charged with iron derived from the nearby basaltic masses. The pebbles in the basal conglomerates are clearly derived from the underlying Tejon basalts. Exposures of Oligocene sediments occur at intervals in the banks and bed of Porter Creek southward from the contact. These strata have a prevailing northwest and southeast strike with a dip ranging from 4° to 20° to the southwest.

About seventy-five feet above the base of the Oligocene on Porter Creek, the gritty phase of the sediments grades over into a grayish brown, medium grained, micaceous shaly sandstone, which in turn grades into a sandy shale. The middle and upper strata in this section are prevailingly massive and well developed bedding planes are usually absent. The rock is prevailingly a shaly sandstone possessing a light grayish brown color. The uppermost beds exposed in the railway and wagon road cuts at the town of Porter contain numerous rounded concretions averaging from two to four inches in diameter. In the interior of these are commonly the fossil remains of mollusks or crustaceans.

The contact as observed between the Eocene and Oligocene on Porter Creek, in the east half of Section 11, T. 17 N., R. 5 W., extends northerly and again appears on Mox Chehalis Creek about nine miles above its junction with Chehalis River, in Section 13, T. 18 N., R. 5 W. The Oligocene sediments at this locality rest unconformably upon the older Eocene basalts.

Basal Oligocene conglomerates are exposed at the northwest end of a quarry composed of Tejon basalt situated one mile west of Oakville on the Northern Pacific Railway tracks. These conglomerates rest unconformably upon the basalt and have a thickness of about twenty feet. Above the conglomerates are massive gritty sandstones which are dipping at a low angle to the southwest.

The Eocene-Oligocene contact is exposed on Cedar and Gibson creeks about one and one-half miles east of their junction with Chehalis River. The bed rock exposures east of this contact consist entirely of Eocene basalt. On the western side of the contact the basal beds are mainly gritty or conglomeratic, while the upper beds are for the most part composed of gray sandy shales.

On the western side of Chehalis River, midway between Porter and Oakville, are exposures of massive sandy shales which may be seen in places along Williams Creek. The lack of good exposures renders it almost impossible to construct a

stratigraphic section. The rocks are composed of massive gray sandy shales dipping at a low angle to the northeast. They seem to constitute the southwest limb of the Chehalis synclinal trough. The basal contact with the Eocene was not observed, although rocks of probable Eocene age exist not far to the south.

On the south side of Chehalis River, between Oakville and Helsing Junction, the structural relations between the Eocene and Oligocene formations can be more clearly determined. The Oligocene strata rest with marked unconformity upon the upturned and eroded edges of the Eocene shales and basalts. Exposures of grayish brown sandstone containing characteristic marine Tejon fossils outcrop in the cuts along the C. M. & S. P. Railway from Balch Station, in Section 36, T. 16 N., R. 5 W., for a distance of three miles, to the southeast, where they rest upon the interbedded basalts. These strata strike northwest and southeast and dip from 10° to 30° to the southwest. In sections 8 and 9, T. 15 N., R. 4 W., a fine-grained badly altered basalt forms the rock along the south bank of Chehalis River. About one and one-half miles up Independence Creek are dark-colored massive shales which strike northwest and southeast and dip to the southwest. Lithologically they differ from the characteristic Oligocene sandy shales which rest unconformably upon the Eocene sediments. Westerly along the south side of Chehalis River from the mouth of Independence Creek are exposed light grayish brown shales having good bedding planes. These strata contain typical lower Oligocene marine fossils. They strike approximately N. 40° W. and dip to the northeast at angles ranging from 55° to 65°. They rest unconformably upon the Eocene rocks below. The Oligocene strata exposed at the mouth of Independence Creek constitute a part of the south limb of the Chehalis Valley syncline and presumably extend northwesterly to Williams Creek beneath the marsh and alluvium of the valley. The unconformable relations between the Eocene and Oligocene formations on Independence Creek suggest that during the latter part of Eocene time this part of Washington was undergoing uplift, folding and erosion.

The type exposures of the Lincoln Horizon of the Oligocene occur in cuts along Chehalis River west of the mouth of Lincoln Creek. The basal beds of this section are not exposed. The strata are composed of massive gray sandy shales containing well preserved marine fossils. They dip to the southwest at a very low angle and have a thickness of at least 500 feet.

The area between Oakville and Gate, along the present valley of Chehalis River, is deeply filled with gravel and alluvium, and the underlying bed rock is nowhere exposed. The structural conditions between Porter and Oakville and between Lincoln Creek and Helsing Junction suggest a direct connection of the Lincoln Horizon with some portion of the lower Porter Creek section. The strata at both localities seem to form a part of the northeast limb of the Chehalis Valley syncline.

Bedrock exposures are for the most part absent south of Chehalis for some distance. In the rock bluffs along Olequah Creek, southwest of the town of Winlock, there are exposures of massive gray sandy shales containing an Oligocene fauna similar to that at Lincoln Creek. These beds are resting almost horizontal

with a very low dip to the northeast. They are apparently unconformable upon the marine Tejon sediments which occur only 1,500 feet to the south. These beds were probably deposited contemporaneously with those at Lincoln Creek.

About five miles to the southeast of Winlock, along the south bank of Cowlitz River, there are exposures of Oligocene strata. At this locality there is a cliff exposed for about fifteen feet above the water's edge. The lower five feet of this section is composed of a coarse-grained gritty to pebbly, massive, brown-colored, iron-stained sandstone, which lies nearly horizontal with a very low dip to the northeast. These rocks contain a rich marine molluscan fauna. The upper portion of this section grades into a conglomerate in which the pebbles range in size up to four inches in diameter. They have been derived largely from basalt. The upper beds are also fossiliferous. Exposures of marine Oligocene strata have not as yet been recognized southeast of Cowlitz River. The region is heavily covered with deposits of glacial drift or river wash. The Oligocene deposits at the Greece ranch on Cowlitz River were probably deposited during early Oligocene time near the south end of the Chehalis Valley embayment and in proximity to the mouth of some Oligocene river.

Oligocene Fauna

	Lower Porter	Upper Porter	Oakville	Lincoln Creek	Winlock	Greece Ranch	Blakeley	Tejon	Monterey	Montesano	Recent
Pelecypoda											
Acila gettysburgensis Reagan							*				
Acila shumardi Dall		*		*	*						
Astarte perrini Dickerson						*					
Anomia subcostata Conrad		*						*			
Arca washingtoniana Dickerson						*					
Barbatia merriami n. sp.	*										
Barbatia andersoni n. sp.	*										
Barbatia gabbi Dickerson						*					
Cardium lorenzanum (Arnold)		*			*	*	*				
Cardium lincolnensis Weaver		*		*		*					
Cardita weaveri Dickerson						*					
Chama pacifica Dickerson						*					
Corbula cowlitzensis Dickerson						*					
Chione cathcartensis Weaver				*			*				
Callocallista arnoldi Weaver		*		*			*				
Crenella porterensis Weaver		*		*	*		*				
Crenella washingtonensis Weaver				*							
Crassatellites washingtonensis Weaver				*							
Crassatellites lincolnensis Weaver				*							
Diplodonta dalli Dickerson						*					
Glycimeris chehalisensis Weaver				*	*						
Glycimeris andersoni Dickerson						*					
Leda washingtonensis Weaver				*	*		*				
Leda impressa Conrad				*				*			
Leda lincolnensis Weaver		*		*	*						
Leda merriami Dickerson						*					
Lima bella Dickerson						*					
Malletia chehalisensis Arnold		*		*	*		*				
Macrocallista pittsburgensis Dall		*		*	*						
Macrocallista vespertina Conrad							*				
Macrocallista newcombi (Merriam)			*								
Macoma astori Dall							*		*	*	
Modiolus directus Dall							*				
Modiolus restorationensis n. sp.							*				
Mytillus sammamishensis Weaver				*			*				
Mytillus buwaldana n. sp.			*								
Mytillus snohomishensis Weaver							*				
Ostrea lincolnensis Weaver		*		*		*					
Panope estrellana Conrad				*			*				
Pandora washingtonensis Weaver				*							
Psammobia martini Dickerson						*					
Pecten peckhami Gabb		*					*				
Pecten branneri Arnold						*					
Pecten porterensis Weaver		*		*							
Pitaria dalli Weaver		*		*			*				
Pitaria clarki Dickerson						*					
Phacoides acutilineatus (Conrad)		*					*		*		
Paphia landesi n. sp.						*					
Solemya ventricostata Conrad							*		*		
Solen curtus Conrad							*		*		
Solen lincolnensis Weaver				*	*	*					
Saxicava arnoldi Dickerson						*					
Semele reagani Dickerson						*					
Semele gayi Arnold						*					
Spisula packardi Dickerson						*					
Tellina obruta Conrad						*	*		*		
Tellina oregonensis Conrad						*	*		*		
Tellina congesta Conrad							*				
Tellina lincolnensis Weaver				*	*						
Tellina gibsonensis n. sp.		*		*							
Tracia trapezoidea Conrad		*					*		*		
Thyasira bisecta Conrad		*					*		*		*
Venericardia castor Dall							*		*		
Yoldia oregona Shumardi						*			*		
Yoldia impressa Conrad		*		*			*		*		
Yoldia sammamishensis Weaver							*				
Scaphopoda											
Dentalium substriatum Conrad		*		*			*		*		
Dentalium stramineum Gabb		*		*	*		*				

OLIGOCENE FAUNA—[*Continued*]

	Lower Porter	Upper Porter	Oakville	Lincoln Creek	Winlock	Greece Ranch	Blakeley	Tejon	Monterey	Montesano	Recent
Gastropoda											
Ampullina oregonensis Dall							*				
Acteocina chehalisensis Weaver				*							
Acmaea simplex Dickerson			*			*					
Acmaea oakvillensis n. sp.			*								
Acmaea dickersoni n. sp.			*								
Acmaea clarki n. sp.			*								
Actaeon parvum Dickerson						*					
Bittium lincolnensis Weaver				*							
Calyptraea excentrica Gabb				*			*	*			
Calytraea washingtonensis Weaver				*	*						
Calytraea filosa Gabb	*			*						*	
Cancellaria washingtonensis Weaver				*							
Cancellaria landesi n. sp.						*					
Conus ruckmani Dickerson						*					
Conus washingtonensis n. sp.						*					
Cerithiopsis fasteni n. sp.						*					
Chrysodomus lincolnensis Weaver				*							
Chrysodomus packardi Weaver				*							
Crepidula praerupta Conrad							*		*	*	
Chlorastoma arnoldi Weaver		*									
Cypraea oakvillensis n. sp.			*								
Drillia chehalisensis Weaver		*		*	*		*				
Epitonium washingtonensis Weaver					*		*				
Epitonium condoni Dall						*	*				
Epitonium rugiferum Dall		*									
Epitonium merriami Dickerson						*					
Exilia lincolnensis Weaver			*		*						
Exilia weaveri Dickerson						*					
Eudolium petrosum Conrad							*				
Eulima clarki Dickerson						*					
Eulima hiltoni n. sp.						*					
Eulima smithi n. sp.						*					
Fusinus stanfordensis Arnold							*				
Fusinus gesteri Dickerson						*					
Fasciolaria gabbi Dickerson						*					
Ficus oregonensis Conrad							*		*		
Ficus restorationensis n. sp.							*				
Galeodea dalli Dickerson						*					
Haminea cf. petrosa (Conrad)						*					
Hipponyx ornata Dickerson						*					
Hipponyx arnoldi Dickerson						*					
Hemifusus lincolnensis n. sp.		*		*							
Hemifusus arnoldi n. sp.						*					
Littorina oligocenica Dickerson						*					
Molopophorous stephensoni Dickerson						*					
Molopophorous lincolnensis Weaver				*							
Miopleiona indurata Conrad				*					*		
Mesalia lincolnensis Weaver				*					*		
Marginella pacifica Dickerson						*					
Murex vaughani Dickerson						*					
Natica oregonensis Conrad							*		*		
Natica lincolnensis Weaver		*		*	*						
Natica washingtonensis Weaver		*		*							
Natica oligocenica n. sp.				*							
Neverita nomlandi Dickerson						*					
Nassa newcombei Merriam			*								
Patella subquadrata Dickerson						*					
Pseudoliva packardi n. sp.						*					
Rissoa lettana n. sp.						*					
Seraphs andersoni Dickerson						*					
Strepsidura packi Dickerson						*					
Strepsidura oregonensis Dall							*				
Strepsidura washingtonensis Weaver				*							
Strepsidura lincolnensis Weaver				*							
Surcula dickersoni (Weaver)				*		*					
Scaphander washingtonensis Weaver		*		*	*						
Scaphander oregonensis Dall							*				
Turritella weaveri n. sp.						*					
Turritella oregonensis Conrad							*		*		
Turritella porterensis Weaver		*		*	*		*				

OLIGOCENE FAUNA—[*Continued*]

	Lower Porter	Upper Porter	Oakville	Lincoln Creek	Winlock	Greece Ranch	Blakeley	Tejon	Monterey	Montesano	Recent
Turritella blakeleyensis Weaver	...	...	...	...	...	...	*	...	...	...	...
Triforis martini Dickerson	...	...	...	...	...	*	...	...	...	...	...
Turris worcesteri n. sp.	...	...	...	*	...	...	...	...	...	...	...
Turris thurstonensis Weaver	...	*	...	*	...	...	*	...	...	...	...
Turris packardi Weaver	...	*	...	*	...	...	*	...	...	...	...
Turris kincaidi Weaver	...	...	...	*	...	...	...	...	...	...	...
Turris lincolnensis Weaver	...	...	...	*	...	...	...	...	...	...	...
Turcicula washingtonensis Dall	...	...	...	...	...	...	*	...	...	...	...
Aturia angustata Conrad	...	*	...	*	...	...	...	...	...	...	...
Hemithyris astoriana Dall	...	...	...	*	...	...	*	...	...	...	...
Terebratula oakvillensis Weaver	...	...	...	...	*	...	...	...	...	...	...
Terebratula occidentalis Dall	...	*	...	...	...	...	...	...	...	...	...
Crustacea	...	*	...	*	...	...	...	...	...	...	...
Sharks teeth	...	...	...	*	...	...	...	...	...	...	...
Barnacle sp.	...	...	...	*	...	...	...	...	...	...	...
Barnacle sp.	...	...	*	...	...	...	...	...	...	...	...
Teredo	...	*	...	...	...	...	...	...	...	...	...
Chiton sp.	...	...	...	...	...	*	...	...	...	...	...

CONDITIONS OF ENVIRONMENT

The faunas occurring in the lower Porter beds as exposed above the Eocene contact on Porter Creek in the conglomerate west of Oakville are typically littoral species, as represented by the Acmaeidae, Ostreidae, Mytilidae, etc. The waters in which these fauna lived were tropical, as indicated by the presence of the genus Cypraea and corals. The marine molluscan fauna found in the vicinity of the Greece ranch, at the south end of the Oligocene Chehalis embayment, appears to have lived in water ranging in depth from possibly two to twenty fathoms. The conglomeratic character of the rock as well as the presence of such shallow water genera as Patella and Littorina indicate a near-shore fauna, but the association with these of such genera as Rissoa, Leda, Lima and Strepsidura point to a depth of water of at least twenty fathoms. The faunal assemblage as a whole may be regarded as typically subtropical.

The faunas occurring at Winlock, Lincoln Creek and the middle portion of the strata exposed on Porter Creek are typically those types which live in moderately deep water and are represented by genera which are decidedly subtropical to tropical. In the upper portion of the Porter section several genera appear which indicate a more temperate climate during the later portion of middle Oligocene time. Such forms as *Phacoides acutilineatus, Thyasira bisecta, Thracia trapezoidea,* are among the most common species found in the upper Oligocene or Acila gettysburgensis Zone of the Puget Sound area. It is quite probable that the uppermost Porter beds were being deposited contemporaneously with the lowermost beds exposed in the Puget Sound embayment.

The Acila gettysburgensis fauna lived in waters ranging from shallow to moderate depth and under climatic conditions which were much more temperate than those in existence during the lower and middle Oligocene.

CORRELATION

In a preliminary report by Dr. C. E. Weaver[1] in 1912, the Oligocene and lower Miocene formations in western Washington were described and provisionally divided into four formations. In the following year Arnold and Hannibal[2] divided the Oligocene of Washington into three divisions, which they termed the San Lorenzo, the Seattle, and the Twin River. They grouped them as the Astoria series.

Later more detailed field studies were made by Dr. Weaver[3] on the Oligocene formations in western Washington, and he divided the faunas of the Oligocene as a whole into three faunal zones, which he termed the Molopophorous lincolnensis Zone, the Turritella porterensis Zone and the Acila gettysburgensis Zone. The sediments containing these faunas he referred to as the Lincoln, Porter and Blakeley horizons. The Lincoln was regarded as the oldest or basal portion of the Oligocene.

Studies made by Dr. Dickerson[4] in the Greece ranch locality show that the fauna represented there is probably to be correlated with the lower portion of the Molopophorous lincolnensis Zone.

The fauna contained in the lower Porter beds as exposed at Oakville and on Porter Creek consist of thirteen species, all of which are typical shallow water or shore forms. This fauna resembles that of the Sooke beds on Vancouver Island, but sufficient evidence is not available for direct correlation. The lower Porter fauna is tropical to subtropical, as evidenced by the presence of Cypraea. This may be hereafter referred to as the Barbatia merriami Zone. The upper Porter fauna, which has been designated as the Turritella porterensis Zone, consists of thirty-five species. This fauna is a typical moderate to deep water group, and thus accounts for the small number of species in common with the lower Porter zone.

The fauna found in the Lincoln Creek beds, which are referred to as the Molopophorous lincolnensis Zone, consists of fifty-nine species. These are moderate to deep water types and subtropical in character. Twenty-six species of the Molopophorous lincolnensis fauna are found in the upper Porter beds.

The Acila gettysburgensis Zone as exposed in the Puget Sound Oligocene embayment, consists of forty-nine species, eighteen of which are common to the Molopophorous Zone and fifteen common to the Porter beds. The fauna contained in the uppermost part of the Porter beds consists of such species as *Thyasira bisecta* Conrad, *Thracia trapezoidea* Conrad, *Phacoides acutilineatus* Conrad, which do not

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[1] Weaver, C. E. A Preliminary Report on the Tertiary Paleontology of Western Washington. Bull. 15, Wash. Geol. Surv., pp. 15-17, 1912.

[2] Arnold, R., and Hannibal, H. The Marine Tertiary Stratigraphy of the North Pacific Coast of America, Proc. Amer. Phil. Soc., vol. 52, p. 582, 1913.

[3] Weaver, C. E. Tertiary Faunal Horizons of Western Washington, Univ. of Wash. Pub. in Geology, vol. 1, No. 1, pp. 4-6, 1916.

[4] Dickerson, Roy E. Climate and Its Influence on the Oligocene Faunas of the Pacific Coast, with Descriptions of some new Species from the Molopophorous lincolnensis Zone, Proc. Cal. Acad. Sci., Fourth Series, vol. 7, pp. 157-159, 1917.

occur in the middle or lower portion of the Porter beds nor in the fauna of the Molopophorous lincolnensis Zone. These forms are, however, characteristic of the entire Acila gettysburgensis Zone. It would seem therefore that the Molopophorous lincolnensis fauna is to be correlated with the lower part of the upper Porter beds and that the uppermost portion of the Porter beds are correlative with the lower portion of the Acila gettysburgensis Zone.

The fauna represented at the Greece ranch locality at the south end of the Chehalis Valley embayment is subtropical and lived in shallow water. This fauna consists of fifty-seven species, five of which are common to the Molopophorous lincolnensis Zone. However, a more detailed study of the fauna in this locality will result in the finding of a larger number of species, many of which will probably be common to the Lincoln Creek beds. The reason for the small number of species in common between the Greece ranch fauna and the Molopophorous lincolnensis fauna can probably be accounted for in the fact that the former lived in comparatively shallow water, while the Molopophorous lincolnensis fauna is typically a moderate to deep water facies.

CORRELATION TABLE OF THE OLIGOCENE IN WASHINGTON

	Greece Ranch	Lincoln Creek	Oakville	Porter	Puget Sound
OLIGOCENE					Acila gettysburgensis Zone. Climate temperate. Depth 0 to 200 fathoms.
				Turritella porterensis Zone. Upper portion, climate temperate. Depth 50 to 200 fathoms.	
		Molopophorous lincolnensis Zone. Climate subtropical. Depth 0 to 200 fathoms.		Lower portion, climate subtropical. Depth 20 to 200 fathoms.	
	Climate subtropical. Depth 0 to 75 fathoms.		Barbatia merriami Zone. Climate tropical. Depth 0 to 10 fathoms.	Barbatia merriami Zone. Climate tropical. Depth 0 to 10 fathoms.	
EOCENE	Post Tejon Eocene represented by folding, faulting, uplift and erosion.				
	Tejon epoch of western Washington represented by marine and brackish water embayments in which sediments were accumulating. Volcanic activity at intervals.				

CONCLUSIONS

(1) Following the close of the Tejon epoch in Washington the upper portion of Eocene time was characterized by uplift, folding, faulting and erosion of the Tejon sediments.

(2) Early in the Oligocene epoch a marine embayment was formed in the Grays Harbor region and extended inland along the present site of Chehalis Valley at least as far south as the Cowlitz River.

(3) The oldest fauna recognized within the Chehalis Valley basin occurs in the lowermost beds on Porter Creek and at Oakville. The fauna is subtropical in character and composed of shallow water to shore genera.

(4) The Lincoln Creek beds are correlative with the middle portion of the Porter beds and contain a subtropical fauna.

(5) The uppermost portion of the Turritella porterensis Zone is correlative with the lower portion of the Acila gettysburgensis Zone of the Puget Sound Oligocene embayment. It represents a more temperate climate than that of the middle or lower Oligocene.

(6) The Greece ranch fauna is a shallow water representative of the lower portion of the Molopophorous lincolnensis Zone.

(7) The fauna of the middle and upper portions of the Acila gettysburgensis Zone is not represented in the Chehalis Valley embayment of southwestern Washington. Presumably this embayment was being drained during the upper Oligocene.

DESCRIPTION OF NEW SPECIES

Pelecypoda

GENUS BARBATIA GRAY

BARBATIA MERRIAMI n. sp.

Plate VI, Figure 1

Description—Shell of moderate size, thick, roughly rectangular in outline and inequilateral; dorsal margin nearly straight and merging into the posterior margin, which slopes to the posterior end of the umbonal ridge; ventral margin broadly arcuate; beaks situated about one-fourth the length of the shell from the anterior end. A marked umbonal ridge extends from the beaks to the posterior basal extremity; a deep broad umbonal groove situated immediately above this ridge and extending to the dorsal margin. Surface sculpture consists of numerous slightly sinuous radiating ribs with interspaces of about one-half their width. Lines of growth, which become more pronounced near the ventral margin, cross the radiating ribs.

Dimensions—Altitude 19 mm.; longitude 40 mm.; thickness 22 mm.

Occurrence—At locality 364 (University of Washington Paleontological Collection) situated at the old dam on Porter Creek about two and one-half miles above its junction with Chehalis River in Section 14, Township 17 North, Range 5 West.

Horizon—Lowermost Oligocene; Barbatia merriami Zone.

BARBATIA ANDERSONI n. sp.

Plate VI, Figure 2

Description—Shell small, roughly rectangular in outline; dorsal margin straight, posterior end truncate and sloping at a low angle from the dorsal margin; ventral margin straight; anterior end broadly rounded; beaks very close to the anterior end. A poorly developed umbonal ridge extends from the beaks to the posterior extremity; a very slight radial depression extends from the middle of the shell to the ventral margin. The surface is ornamented with numerous radial ribs with interspaces of equal width.

Barbatia andersoni differs from Barbatia merriami in the constancy of its smaller size, in the absence of a marked umbonal ridge and in the lack of the groove above it.

Dimensions—Altitude 7 mm.; longitude 13 mm.; thickness 5 mm.

Occurrence—At locality 364 (University of Washington Paleontological Collection) situated at the old dam on Porter Creek about two and one-half miles above its junction with Chehalis River in Section 14, Township 17 North, Range 5 West.

Horizon—Lowermost Oligocene; Barbatia merriami Zone.

GENUS MYTILUS LINNAEUS

MYTILUS BUWALDANA n. sp.

Plate VI, Figure 6

Description—Shell of moderate size, elongate, ventricose, moderately thick; hinge line nearly straight; the posterior dorsal margin slightly concave. At a distance of three-fourths the length of the shell from the anterior end the surface slopes rapidly to form a broadly rounded posterior margin where it merges at a very sharp angle into a slightly concave base. The maximum width of the shell is situated about one-third the length of the shell from the posterior end. A very pronounced umbonal ridge extends from the beaks through the middle portion of the shell and terminates near the junction of the ventral and posterior margins. This ridge is most strongly pronounced near the middle portion of the shell. Surface of shell is sculptured by very prominent concentric lines of growth, giving the surface of the shell a roughened appearance.

Dimensions—Altitude 21 mm.; longitude 38 mm.; thickness 18 mm.

Occurrence—At locality 161 (University of Washington Paleontological Collection) about one mile west of Oakville on the Northern Pacific Railway.

Horizon—Lowermost Oligocene; Barbatia merriami Zone.

GENUS MODIOLUS LAMARCK

MODIOLUS RESTORATIONENSIS n. sp.

Plate VI, Figure 5

Description—Shell of moderate size and somewhat elongate; hinge line nearly straight and about two-thirds the length of the shell. The posterior dorsal margin, which is nearly straight, extends to the posterior end of the shell, where it merges abruptly into a very wide and broadly arcuate posterior margin. The maximum height of the shell is at the posterior end. The ventral margin is very slightly concave; anterior margin is narrow and slightly arcuate; beaks low, anteriorly pointed and very near to the anterior end. A well-defined umbonal ridge extends

from the beaks to the junction of the posterior and basal margin, but becoming less conspicuous at the posterior end. Surface of shell ornamented with well developed concentric lines of growth as well as very fine radiating ribs.

Dimensions—Altitude 44 mm.; longitude 67 mm.; thickness 20 mm.

Occurrence—At locality 13 (University of Washington Paleontological Collection) situated on the north side of Restoration Point, Kitsap County, Washington.

Horizon—Upper Oligocene; Blakeley Horizon.

GENUS PAPHIA BOLTON

PAPHIA LANDESI n. sp.

Plate VI, Figure 3

Description—Shell minute, approximately rectangular in outline, convex and very inequilateral; beaks low and situated about one-fifth the length of the shell from the anterior end; posterior dorsal margin elongate and nearly straight, merging abruptly into a sharply arcuate posterior margin. Ventral margin is straight and parallel to the dorsal margin; anterior dorsal margin slopes vertically from the beaks and then extends downwards at an angle of about 60°, where it curves sharply and merges into the ventral margin. Exterior of shell characterized by very strong ornamentation, especially on the posterior portion of the surface. Posterior surface decorated with seven very prominent radial ribs which tend to become obscure toward the beaks but which greatly increase in size at the posterior margin. Middle surface of shell is ornamented with similar radiating ribs, which progressively become less well defined, until at the anterior end they are scarcely perceptible. The radiating sculpture is crossed by very prominent concentric ribs or lines of growth which have a somewhat wavy outline. At the intersections of the radial ribs and the lines of growth conspicuous scale like nodes have been developed. The external ornamentation is impressed on the inner surface of the shell.

Dimensions—Altitude 3 mm.; longitude 5 mm.; thickness 4 mm.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

GENUS TELLINA LINNAEUS

TELLINA GIBSONENSIS n. sp.

Plate VI, Figure 7

Description—Shell small, thin, inequilateral and smooth; beaks low, and situated about two-fifths the length of the shell from the anterior end; posterior end

extended; posterior dorsal margin slopes down from the beaks at an angle of about 15° and gradually merges into the sharply arcuate posterior margin, which in turn merges into a very broadly rounded base; anterior margin sloping down from the beaks very sharply at first and then much more gently to the anterior end; anterior end truncated. A ridge or fold extends from the umbones to the anterior basal margin. Posterior to this fold there is a faint concavity which extends half-way down the surface and merges into the basal margin.

Dimensions—Altitude 15 mm.; longitude 20 mm.; thickness 6 mm.

Occurrence—At locality 367 (University of Washington Paleontological Collection) situated on Gibson Creek, a few hundred feet up from the Northern Pacific Railway crossing, in Section 2, Township 16 North, Range 5 West.

Horizon—Middle Oligocene; Turritella porterensis Zone.

Gastropoda

GENUS ACMAEA ESCHOCHOLTZ

ACMAEA OAKVILLENSIS

Plate VII, Figure 18

Description—Shell small, thin and moderately low; apex situated about one-third the length of the shell from the anterior end; anterior end with moderate slope; outline of shell oval; surface sculptured with numerous radiating ribs with wider interspaces. These are crossed by revolving lines of growth.

Dimensions—Altitude 4 mm.; diameter of base 13 mm by 9 mm.

Occurrence—At locality 161 (University of Washington Paleontological Collection) situated about one mile west of Oakville on the Northern Pacific Railway.

Horizon—Lowermost Oligocene; Barbatia merriami Zone.

ACMAEA DICKERSONI n. sp.

Plate VII, Figure 15

Description—Shell small and high; apex situated about one-third the length of the shell from the anterior end; base semi-oval in outline; anterior end steep. Surface marked by numerous radiating ribs which are crossed by faint revolving lines of growth.

Dimensions—Altitude 7 mm.; diameter of base 7 mm. by 10 mm.

Occurrence—At locality 161 (University of Washington Paleontological Collection) situated about one mile west of Oakville on the Northern Pacific Railway.

Horizon—Lowermost Oligocene; Barbatia merriami Zone.

Acmaea clarki n. sp.

Plate VI, Figure 4

Description—Shell small, high and thin; smooth except for concentric lines of growth; apex situated about midway between the anterior and posterior ends.

Acmaea clarki differs from Acmaea dickersoni in being on the average slightly higher; the apex more central and in the absence of radiating ribs.

Dimensions—Altitude 8 mm.; diameter of base 10 mm. by 12 mm.

Occurrence—At locality 161 (University of Washington Paleontological Collection) situated about one mile west of Oakville on the Northern Pacific Railway.

Horizon—Lowermost Oligocene; Barbatia merriami Zone.

genus EULIMA risso

Eulima smithi n. sp.

Plate VII, Figure 22

Description—Shell minute, conical in outline and smooth except for very faint lines of growth; whorls seven in number; spire about twice the length of the body whorl; suture distinct, linear and appressed; aperture oval; canal short, broad and twisted to the left; outer lip thin; inner lip slightly calloused and reflected.

Dimensions—Altitude 3 mm.; altitude of spire 1.5 mm.; maximum diameter of shell 1 mm.; angle of spire 37°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

Eulima hiltoni n. sp.

Plate VII, Figure 12

Description—Shell minute, slender, thin and elongate; smooth except for very faint lines of growth; whorls seven in number; suture distinct linear and very appressed; aperture semi-oval as observed on other specimens.

This species differs from Eulima smithi in that the former is conical. Eulima hiltoni averages much longer and is more slender.

Dimensions—Altitude of shell 4 mm.; altitude of spire 3 mm.; maximum diameter 1.5 mm.; angle of spire 25°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

GENUS NATICA SCOPOLI

NATICA OLIGOCENICA n. sp.

Plate VII, Figure 23

Description—Shell small with five whorls the surfaces of which are evenly rounded except the posterior which is somewhat flattened; spire a little elevated for the genus; shell smooth except for faintly developed longitudinal lines of growth; suture distinct and appressed. The lower portion of body whorl merges into the base with a rounded angulation; surface of base below the angulation is deep and broad with the umbilical opening at its center.

Dimensions—Altitude of shell 5 mm.; altitude of spire 1.5 mm.; maximum diameter 4.5 mm.; angle of spire 90°.

Occurrence—At locality 352 (University of Washington Paleontological Collection) in railway cuts on the line of the O.-W. R. R. & N. Co., one-fourth mile northwest of Lincoln Creek Station, in Section 27, Township 15 North, Range 3 West.

Horizon—Lower Oligocene; Molopophorous lincolnensis Zone.

GENUS RISSOA FREM

RISSOA LETTANA n. sp.

Plate VII, Figure 13

Description—Shell minute, thick and moderately robust; whorls five and broadly convex; suture distinct and linear; surface ornamented by 21 well developed longitudinal ribs which extend over the upper two-thirds of the surface of the body whorl and become obsolete below; on the body whorl these are crossed by 18 equally spaced and equally developed revolving ribs; between each of these is an interspace of about one-half the width of the ribs; aperture approximately oval but incurving slightly posteriorly; inner lip thickened but not calloused; outer lip entire and moderately thick.

Dimensions—Altitude of shell 1.5 mm.; altitude of spire, .75 mm.; maximum diameter of shell 1 mm.; angle of spire 35°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

GENUS TURRITELLA LAMARCK

TURRITELLA WEAVERI n. sp.

Plate VII, Figure 14

Description—Shell minute, elongate and thin; whorls seven and slightly convex; suture sunken in a deep groove the larger part of which groove lies immediately above the suture line. The lower portion of the surface of each whorl is decorated with two very pronounced revolving ribs with interspaces of double width but containing no intervening threads; upper half of each whorl decorated with two similar but less well developed revolving ribs and interspaces. Longitudinal sculpture is absent except for numerous lines of growth; aperture oval; outer lip thin; inner lip slightly calloused.

Dimensions—Altitude of shell 2.5 mm.; altitude of spire 1.5 mm.; maximum diameter of shell 1 mm.; angle of spire 35°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

GENUS CERITHIOPSIS FORBES

CERITHIOPSIS FASTENI n. sp.

Plate VII, Figure 8

Description—Shell minute, slender and elongate; whorls eight in number and decorated with twelve very prominent longitudinal ribs which extend over the surface of all the whorls; these are crossed by four broad, well defined revolving ribs with interspaces of double width; within each interspace there is a single revolving thread. At the intersection of the longitudinal and revolving ribs are rounded moderately prominent nodes; suture distinct with a fine revolving cord immediatel yabove it; lower end of the middle portion of the body whorl merges at a sharp angle into a nearly flat base, which is decorated with four revolving ribs; aperture roughly oval in outline; canal short and incised.

Dimensions—Altitude of shell 5 mm.; altitude of spire 3 mm.; maximum diameter of shell 2 mm.; angle of spire 35°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

GENUS CYPRAEA LINNAEUS

CYPRAEA OAKVILLENSIS

Plate VII, Figure 19

Description—Shell moderately large, sub-oval in outline and thick; broadest about one-third the length of the shell from the posterior end; surface smooth except for very faint lines of growth; aperture narrow and of about equal width from the anterior to posterior ends; outer lip strongly incurved and bearing fourteen teeth or crenulations on both the inner and outer lips.

Dimensions—Altitude of shell 23 mm.; maximum diameter of shell 15 mm.

Occurrence—At locality 161 (University of Washington Paleontological Collection) situated about one mile west of Oakville on the Northern Pacific Railway.

Horizon—Lowermost Oligocene; Barbatia merriami Zone.

GENUS FICUS BOLTON

FICUS RESTORATIONENSIS n. sp.

Plate VII, Figure 20

Description—Shell large and moderately thin; spire low; whorls six and rounded; body whorl very large and somewhat elongate; suture distinct; surface ornamented with 43 revolving ribs with interspaces of triple width. In the middle of each interspace are small revolving threads. The revolving ribs are crossed by very prominent longitudinal lines of growth; aperture narrow; canal very slightly twisted.

Dimensions—Altitude of shell 69 mm.; altitude of spire 10 mm.; maximum diameter of shell 40 mm.; angle of spire 85°.

Occurrence—At locality 13 (University of Washington Paleontological Collection) situated on the north side of Restoration Point, Kitsap County, Washington.

Horizon—Upper Oligocene; Blakeley Horizon.

GENUS HEMIFUSUS SWAINSON

HEMIFUSUS ARNOLDI n. sp.

Plate VII, Figure 11

Description—Shell minute, slender and moderately thick; whorls seven in number; suture distinct, appressed and sinuous; upper surface of body whorl concave; spire about equal in length to body whorl and canal; whorls sharply angulated about one-third the distance below the suture line; surface of whorls decorated by 13 prominent longitudinal ribs which become obscure on the posterior surface of the body whorl; these are crossed by six prominent, rounded revolving ribs; surface of whorls above the angle ornamented by four small revolving ribs with interspaces of triple width. On the angulated portion of the whorls somewhat prominent nodes are formed by the intersection of the longitudinal and revolving ribs; body whorl ornamented by 18 prominent, flat-topped revolving ribs which progressively become less developed toward the end of the canal; between these are interspaces of double width which contain no revolving threads; outer lip moderately thick; inner lip slightly calloused; aperture elongate-elliptical; canal short, broad and slightly reflected to the left.

Dimensions—Altitude of shell 6 mm.; altitude of spire 3.5 mm.; maximum diameter of shell 3 mm.; angle of spire 35°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

HEMIFUSUS LINCOLNENSIS n. sp.

Plate VII, Figure 10

Description—Shell of moderate size and moderately convex; whorls seven in number and slightly angulated; upper surface of body whorl above the angle moderately concave; middle portion strongly convex and merging into a sharply sloping base; the upper portion of the surface of the whorl develops into a collar which comes in contact with the whorl above along a well developed suture line. Surface of whorl ornamented by 13 well defined longitudinal ribs which are present on all of the whorls but are confined to the middle portion of each; they disappear entirely on the upper and lower thirds of the surface; they are crossed by numerous well defined revolving ribs and intervening threads; two well marked ribs are present on the collar just below the suture; eight nearly square topped, moderately well defined lines ornament the upper third of the surface of the body whorl; these are equally spaced and equally developed; they are separated by interspaces of double

width and contain no revolving threads; the middle portion of the whorl possesses four very prominent revolving ribs which are equally spaced and which when crossing the longitudinal ribs form fairly well developed nodes; between each of these four prominent ribs there are three less well defined minor ribs of about the same magnitude as those on the upper third of the surface of the body whorl; between each of the minor ribs are interspaces of approximately equal width but containing no ornamentation. The lower portion of the body whorl including the canal is ornamented with 13 equally developed and fairly prominent rounded revolving ribs with interspaces of triple width; in the middle of each interspace is a minor revolving thread; canal about one and one-half times as long as the spire, twisted to the left and backward; aperture elliptical and terminating in an open canal; inner lip moderately calloused, callous extending for some distance over on to the sculpture of the body whorl; outer lip thin.

This species differs from Hemifusus washingtonensis Weaver in possessing a longer canal which in all specimens of the species is reflected backwards. Hemifusus washingtonensis is characterized by having a straight canal.

Dimensions—Altitude of shell 33 mm.; altitude of spire 8 mm.; maximum diameter of shell 16 mm.; angle of spire 53°.

Occurrence—At locality 352 (University of Washington Paleontological Collection) in cuts on the line of the O.-W. R. R. & N. Co., one-fourth mile west of Lincoln Creek Station, in Section 27, Township 15 North, Range 3 West.

Horizon—Lower Oligocene; Molopophorous lincolnensis Zone.

GENUS PSEUDOLIVIA SWAINSON

PSEUDOLIVIA PACKARDI n. sp.

Plate VII, Figure 16

Description—Shell minute, smooth and moderately thick; whorls four in number; spire very inconspicuous; body whorl swollen; suture linear and indistinct; aperture elongate, narrow at posterior end but gradually increasing in width toward the anterior end where it merges into a very short canal, which is slightly notched.

Dimensions—Altitude of shell 4 mm.; altitude of spire .75 mm.; maximum diameter of shell 2 mm.; angle of spire 82°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

GENUS CANCELLARIA LAMARCK

CANCELLARIA LANDESI n. sp.

Plate VII, Figure 17

Description—Shell small; whorls five in number; body whorl greatly enlarged; whorls angulated and decorated with four broad, flat topped revolving ribs with interspaces of equal width; the upper rib lies upon the angulated portion of the whorl; body whorl ornamented by seven broad, prominent, revolving ribs with equal interspaces. There is a prominent shoulder on body whorl a short distance below the suture; ten prominent axial ribs cross the revolving ribs, giving the surface an angulated appearance. Suture distinct and slightly sinuous; aperture oval and slightly notched at the anterior end; outer lip thin and slightly crenulated; inner lip slightly calloused; canal very short; columella with one strong oblique fold.

Dimensions—Altitude of shell 7 mm.; altitude of spire 2 mm.; maximum diameter of shell 5 mm.; angle of spire 61°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25, Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

GENUS TURRIS BOLTEN

TURRIS WORCESTERI n. sp.

Plate VII, Figure 21

Description—Shell small or slender with six or seven whorls; the middle portion of the whorls are marked by broad, sharply angulated, revolving folds; on the surface between these folds and the suture are two revolving ribs. Body whorl is ornamented with 14 revolving ribs with interspaces of equal width; the first two ribs just below the prominent revolving fold are moderately prominent, the others decreasing in size as they approach the anterior end; aperture elongate-elliptical, wider posteriorly; canal short, wide and twisted to the left; inner lip calloused.

This species differs from Turris thurstonensis Weaver in the fact that in all specimens of the species there are two constant revolving ribs between the suture and the angulated portion of the whorls. The intercalary threads are also absent between the revolving threads. The adult specimens of the species are smaller than in the case of Turris thurstonensis.

Dimensions—Altitude of shell 10 mm.; altitude of spire 4 mm.; maximum diameter of shell 14 mm.; angle of spire 44°.

Occurrence—At locality 352 (University of Washington Paleontological Collection) in railroad cuts of the O.-W. R. R. & N. Co., one-fourth mile west of Lincoln Creek Station in Section 27, Township 15 North, Range 3 West.

Horizon—Lower Oligocene; Molopophorous lincolnensis Zone.

Turris lincolnensis n. sp.

Plate VII, Figure 24

Description—Shell small; spire elevated; whorls six in number; each whorl is characterized by a very pronounced angle situated at about one-third the distance of the length of the whorl below the suture; the angle between the upper and lower surface of each whorl is approximately 110°. The surface above the angle is very slightly concave; below the angle it is straight to very slightly convex; suture greatly impressed. Surface of whorls is ornamented with numerous very fine revolving striae; longitudinal ornamentation is absent except for fine lines of growth; aperture roughly trigonal in outline; outer lip with a sharp angle at its junction with the shoulder of whorl; canal short with a very slight notch at its anterior end; outer lip thin; inner lip with very slight callous.

Dimensions—Altitude of shell 16 mm.; altitude of spire 5.5 mm.; maximum diameter of shell 9 mm.; angle of spire 53°.

Occurrence—At locality 352 (University of Washington Paleontological Collection) in railroad cuts of the O.-W. R. R. & N. Co., one-fourth mile west of Lincoln Creek Station in Section 27, Township 15 North, Range 3 West.

Horizon—Lower Oligocene; Molopophorous lincolnensis Zone.

genus CONUS linnaeus

Conus washingtonensis n. sp.

Plate VII, Figure 9

Description—Shell minute; spire high, averaging between two-thirds and three-fourths of the length of the body whorl; whorls seven to seven and a half in number; suture linear and appressed; on the middle of the surface of each whorl, just above the shoulder, there is a revolving groove; between the groove and the suture there is a convex revolving fold. Ornamentation of the shell consists of very faintly developed flat topped revolving ribs with interspaces of equal width; outer lip thin; inner lip without callous; aperture narrow.

This species differs from Conus ruckmani Dickerson, in the constancy of the greater length of the spire and in the entire absence on all specimens of nodes on the shoulder of the whorls.

Dimensions—Altitude of shell 3.5 mm.; altitude of spire 1 mm.; maximum diameter of shell 2 mm.; angle of spire 60°.

Occurrence—At locality 330 (University of Washington Paleontological Collection) situated at the Greece ranch, four miles east of Vader, on the east bank of Cowlitz River, in Section 25. Township 11 North, Range 2 West.

Horizon—Lower Oligocene; lower phase of Molopophorous lincolnensis Zone.

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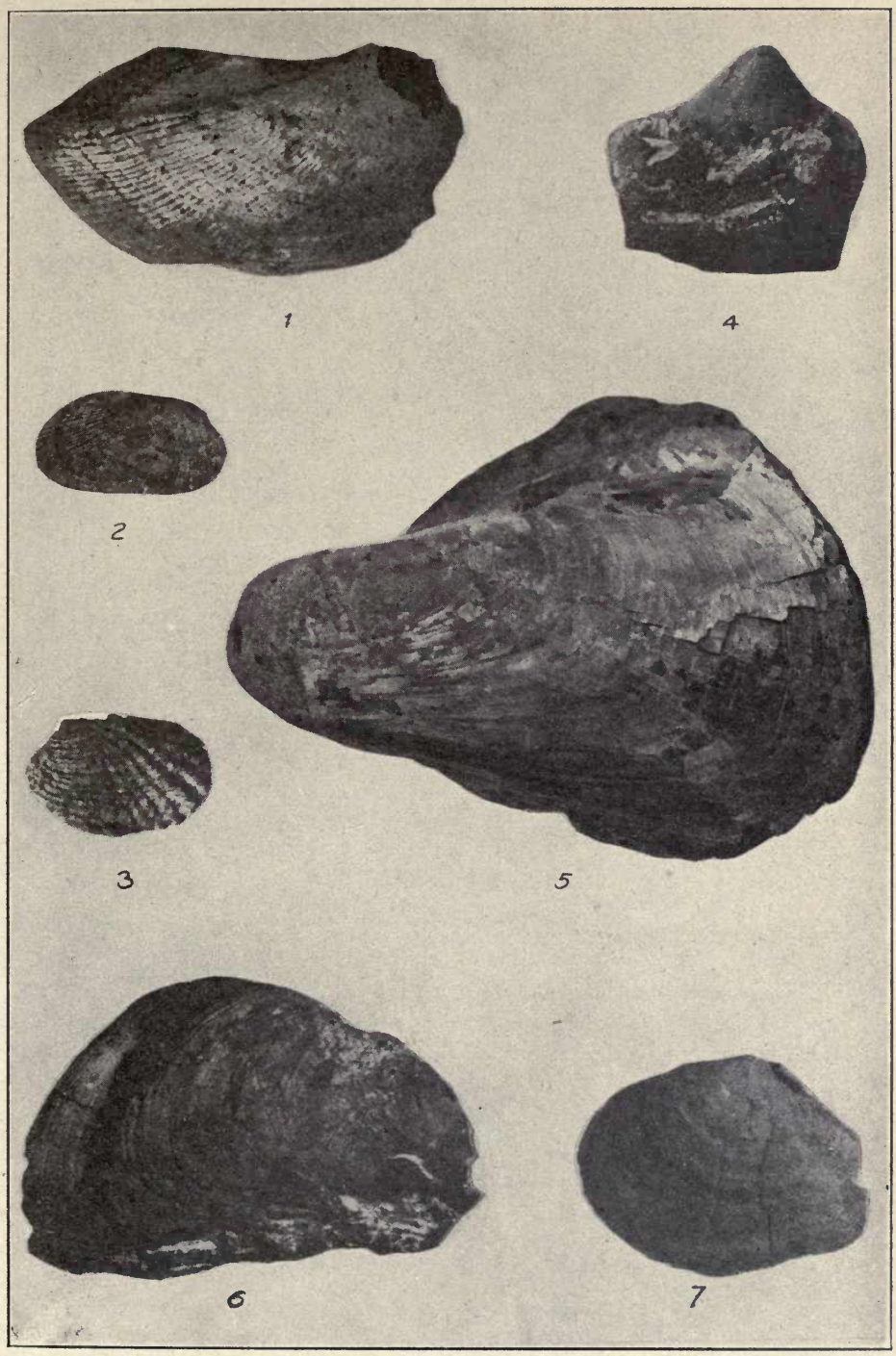
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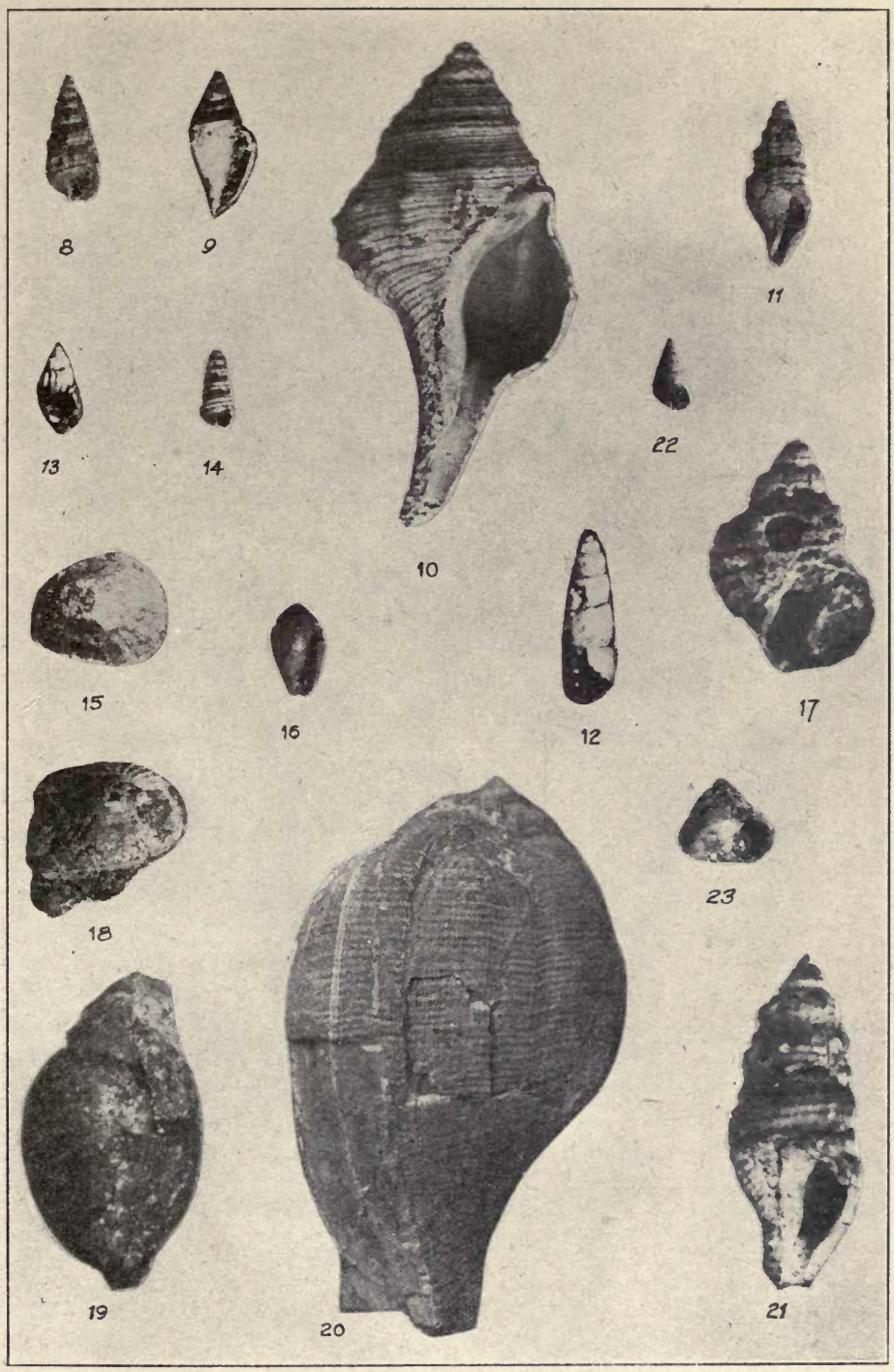
Fig. 23. *Natica oligocenica* n. sp. x2 ..... p. 86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