WASHINGTON GEOLOGICAL SURVEY

HENRY LANDES, State Geologist

BULLETIN No. 15

A Preliminary Report on the Tertiary Paleontology

OF

Western Washington

By CHARLES E. WEAVER

OLYMPIA, WASH.:
E. L. BOARDMAN PUBLIC PRINTER
1912.

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LETTER OF TRANSMITTAL.

Governor M. E. Hay, Chairman, and Members of the Board of Geological Survey:

GENTLEMEN—I have the honor to submit herewith a report entitled "A Preliminary Report on the Tertiary Paleontology of Western Washington," by Charles E. Weaver, with the recommendation that it be printed as Bulletin No. 15 of the Survey reports.

Very respectfully,

HENRY LANDES,
State Geologist.

University Station, Seattle, August 1, 1912.

CONTENTS.

	Page
Introduction	9
Stratigraphy	10
General Statement	10
Pre-Tertiary Bed Rock Complex	10
Tertiary Formations	11
Eocene	12
General Statement	12
Cowlitz Formation	14
Tejon Formation	14
Oligocene	15
General Statement	15
Post Eocene	17
General Statement	17
Lower Miocene	17
Blakeley Formation	17
Wahkiakum Formation	19
Chehalis Formation	19
Upper Miocene	19
Montesano Formation	19
Geologic History	22
Description of Species	28
Eocene	28
Pelecypoda	28
Pectunculus eocenica n. sp.	28
Pectunculus eocenica n. sp. var. landesi n. var.	28
Pectunculus tejonensis n. sp.	29
Ostrea olequahensis n. sp.	29
Ostrea fettkei n. sp.	30
Pecten cowlitzensis n. sp.	30
Crassatellites cowlitzensis n. sp.	31
Crassatellites washingtoniana n. sp.	32
Corbicula eufaulaensis n. sp.	32
Corbicula cowlitzensis n. sp.	33
Cardium olequahensis n. sp.	34
Meretrix landesi n. sp.	34
Meretrix olequahensis n. sp.	35
Tapes washingtoniana n. sp.	35

Description of Species—*Continued.*
Eocene— *Page*
Gasteropoda 36
Potamides fettkei 36
Potamides lewisiana n. sp..... 37
Rimella canalifera Gabb, var. elongata n. var..... 37
Cassidaria washingtoniana n. sp..... 38
Morio tuberculatus Gabb, var. tri-tuberculatus n. var.... 39
Tritoneum sopenahensis n. sp..... 40
Ranella washingtoniana n. sp..... 41
Ranella cowlitzensis n. sp..... 41
Nassa eocenica n. sp..... 42
Nassa packardi n. sp..... 43
Chrysodomus clallamensis n. sp..... 43
Hemifusus sopenahensis n. sp..... 44
Hemifusus cowlitzensis n. sp..... 45
Hemifusus lewisiana n. sp..... 46
Hemifusus washingtoniana n. sp..... 46
Hemifusus tejonensis n. sp..... 47
Brachysphingus clarki n. sp..... 48
Murex sopenahensis n. sp..... 48
Murex cowlitzensis n. sp..... 49
Fusus washingtoniana n. sp..... 50
Fusus dickersoni n. sp..... 50
Fusus lewisensis n. sp..... 51
Fasciolaria washingtoniana n. sp..... 52
Mitra washingtoniana n. sp..... 52
Ancillaria bretzi n. sp..... 53
Surcula cowlitzensis n. sp..... 53
Conus cowlitzensis n. sp..... 54
Brachiopoda 55
Rhynconella washingtoniana n. sp..... 55
Miocene 56
Pelecypoda 56
Leda chehalisensis n. sp..... 56
Yoldia sammamishensis n. sp..... 56
Pecten porterensis n. sp..... 57
Pecten alockamenensis n. sp..... 58
Mytilus sammamishensis n. sp..... 58
Mytilus stillaguamishensis n. sp..... 59
Mytilus snohomishensis n. sp..... 59
Venericardia chehalisensis n. sp..... 59
Chione chehalisensis n. sp..... 60
Chione montesanoensis n. sp..... 61
Chione cathcartensis n. sp..... 62
Marcia oregonensis Conrad..... 63
Tellina merriami n. sp..... 63

Description of Species—*Continued.*
Miocene—
Pelecypoda— *Page*
Tellina kincaidii n. sp. 64
Macoma montesanoensis n. sp. 65
Macoma snohomishensis n. sp. 66
Macoma wynootcheensis n. sp. 66
Semele montesanoensis n. sp. 67
Semele sylviaensis n. sp. 67
Pseudocardium gabbi Remond var. altus n. var. 68
Pseudocardium gabbi Remond var. elongatus n. var. 68
Pseudocardium gabbi Remond var. robustun n. var. 69
Pseudocardium gabbi Remond var. unduliferum n. var. 69
Pseudocardium landesi n. sp. 69
Cryptomya washingtoniana n. sp. 70
Gasteropoda 70
Turris wynootcheensis n. sp. 70
Chlorostoma arnoldi n. sp. 71
Caliostoma delazinensis n. sp. 72
Turritella blakeleyensis n. sp. 72
Turritella porterensis n. sp. 73
Gyrineum sylviaensis n. sp. 73
Ficus clallamensis n. sp. 74
Nassa andersoni n. sp. 75
Cuma biplicata var. quadranodosum n. var. 75
Fusus montesanoensis n. sp. 76
Pleurotoma chehalisensis n. sp. 77
Pleurotoma washingtoniana 78
Drillia chehalisensis n. sp. 78
Scaphapoda 79
Dentalium porterensis n. sp. 79
Brachiopoda 79
Terebratula oakvilleensis n. sp. 79
Crustacea 80

A PRELIMINARY REPORT ON THE TERTIARY PALEONTOLOGY OF WESTERN WASHINGTON.

INTRODUCTION.

The purpose of this paper is to record as briefly as possible the purely scientific facts concerning the Tertiary Palaeontology of Western Washington. A short account is given of the character and distribution of the several divisions of the Tertiary and their faunas. A northwestern Tertiary province is recognized and an attempt is made to interpret its history from the close of the Cretaceous to the present time. A total Tertiary invertebrate marine fauna of two hundred and forty-six species has been discovered. Eighty-four of these are new and are described and figured for the first time. This report is preliminary to a more detailed one, which will appear later accompanied by maps and a discussion of the economic geology in relation to the occurrence of oil.

The field work upon which this report is based has been carried on by the writer at intervals during the past five years. During the summer of 1911 four months were spent in the field studying and mapping the areal geology of southwestern Washington and a strip along the coast from Gray's Harbor northward to Cape Flattery and thence along the north side of the Olympic Peninsula to Port Angeles. Previous to that year a study had been made of all the bed rock outcrops occurring in the Puget Sound Basin and the Quimper Peninsula. During the summer of 1911 the writer was assisted in this work by Messrs. Charles R. Fettke, Donald Ross, T. A. Bonser and Olaf Stromme. The specific determinations of the fossils were made by the writer in the Palaeontology laboratory of the University of California. The types of the new species described in this report are in the Palaeontological collections of the Uni-

versity of Washington. The writer wishes to express his acknowledgements to all who have aided in this work and especially to Professor John C. Merriam and Mr. Bruce Clark of the Palaeontology Department of the University of California, who kindly placed at his disposal their collections and library facilities.

STRATIGRAPHY.

GENERAL STATEMENT.

The Tertiary formations of western Washington are composed of non-metamorphosed sedimentary and igneous rocks which rest unconformably upon an older complex series of igneous and metamorphic rocks. The Tertiary sedimentary formations comprise materials deposited in lake basins, brackish water estuaries and marine basins. Those of lacustrine origin are confined almost entirely to eastern Washington and the eastern portion of the Cascade Mountains. The deposits in the western foothills of the Cascades are for the larger part of estuarine origin, while those in southwestern Washington and the Puget Sound Basin are mostly marine. The total maximum thickness of the Tertiary formations in western Washington is over thirty-four thousand feet. This thickness, however, is not represented in any one continuous section. The strata are for the most part involved in a complex series of folds. In southwestern Washington the entire structure can be referred to two exceedingly complex westerly pitching geosynclines.

PRE-TERTIARY BED ROCK COMPLEX.

In every locality where the contact between the Tertiary and older formations may be observed there is a marked unconformity. These older rocks compose the entire central core of the Olympic Peninsula, the San Juan Islands and the bulk of the northern portion of the Cascade Mountains. In the southern portion of the Cascades the older rocks pass beneath a thick covering of Tertiary lavas. They do not occur in southwestern Washington, but seem to pass down below sea level from the

southern foothills of the Olympic Mountains until they again reappear in the northern foothills of the Klamath Mountains of southern Oregon. Isolated occurrences, however, may occur in the northern coast ranges of Oregon. The older rocks represent a series of sandstones, shales, limestones, conglomerates, interbedded volcanic tuffs and lavas which have been extensively metamorphosed, largely as the result of numerous intrusions of acidic and basic magmas. The intrusions of igneous magmas seem to have occurred at or near the close of the Jurassic.

The metamorphic rocks belong largely to the Carboniferous, Triassic and Jurassic, and bear a very striking resemblance to the Franciscan formation of California and southern Oregon.

On the northern shore of Vancouver Island and on the northern fringe of the San Juan Islands the Upper Cretaceous occurs resting unconformably upon the older metamorphic complex. These rocks are not metamorphosed. The Lower Cretaceous is absent. No deposits of Cretaceous age are definitely known to exist in any other part of western Washington, although they may lie deeply buried beneath the later Tertiary formations.

TERTIARY FORMATIONS.

The following subdivisions have been made of the Tertiary formations in western Washington:

Pleistocene—

Pliocene—wanting.

Miocene:
- Upper: Montesano formation.
- Lower: Chehalis formation; Wahkiakum formation; Blakeley formation.

Oligocene: Lincoln formation.

Eocene:
- Upper: Tejon formation; Cowlitz formation. (Puget Brackish water group)
- Lower—wanting.

EOCENE.

GENERAL STATEMENT.

The Eocene of western Washington consists of two divisions, an older which is provisionally termed the Cowlitz formation, and a later one which is distinctly Tejon. Both belong to the Upper Eocene. The rocks composing these formations are sandstones, shales, conglomerates and subordinate amounts of shaly limestone, together with numerous intercalated layers of tuff and basaltic lava. The sediments are partly of marine and partly of brackish water origin. The former prevail in the western part of the area examined and the latter to the east, on the western slopes of the Cascades. Eocene strata form the surface outcrops over an area of about 4,000 square miles. This area would be much larger if the thick veneer of glacial drift in the Puget Sound Basin were to be stripped off.

The formations outcropping in the Cowlitz Valley from the Columbia River northward into Thurston County are Eocene. They are partly marine and partly brackish water deposits. In western Lewis, Cowlitz, Wahkiakum, eastern Pacific, Chehalis and western Thurston counties, the marine sediments prevail. To the east they thin out and are replaced by brackish water and occasionally fresh water materials. West of the Cowlitz River marine sediments prevail. In Pierce and King counties they attain a thickness of over eight thousand feet. They have been described as the Puget Group* which is the coal bearing horizon of western Washington. The Puget formation is composed exclusively of brackish water sediments together with interbedded lava flows. It extends eastward into the Cascade Mountains and passes unconformably beneath later Miocene and Pliocene lava flows. The first Eocene deposits to reappear on the eastern margin of these later Tertiary lavas are a part of the Roslyn formation which is coal bearing and belongs to the upper portion of the Eocene. These deposits are regarded as lacustrine in origin. The maximum thickness of the Eocene is at least ten thousand feet. In the type sections

*Tacoma Folio No. 54, U. S. Geological Survey.

where detailed stratigraphic sections have been made, the base of the series has not been reached. In Pierce County the Puget group has been divided into a three-fold division on the basis of its lithologic character. There it has a thickness of at least nine thousand feet. In King County stratigraphic measurements give a thickness of nearly eight thousand feet of sediments which may also be divided into three divisions. In the western part of King County, south of Seattle, these brackish water sediments become partially marine and yield a distinctly Tejon fauna. South, in Lewis County, distinctly Tejon marine faunas occur interbedded with the brackish water beds.

In southern Lewis County, east of Little Falls, there exist shales and shaly limestones containing a fauna seemingly older than the typical Tejon, but more closely related to it than to the Martinez or Lower Eocene of California. A very large number of the species are new and the fauna may represent a transition from the Martinez to the Tejon—a fauna which as yet is unknown in California. In order to distinguish this from the typical Tejon, the term Cowlitz formation is suggested.

The basaltic lavas and tuffs occurring within the Eocene of western Washington have a thickness ranging from fifteen hundred to two thousand feet. They do not constitute a single flow but rather a series of flows poured out on the sea floor at intervals during the deposition of the sediments. They vary in thickness from point to point. Much of this material is tuffaceous and agglomeratic and for the most part has been forced up from below through numerous fissures and small vents rather than through large central volcanic cones.

During the Tejon, volcanic activity prevailed over all of western Washington with the exception of the central and northwestern portion of the Olympic Peninsula. The same may be said concerning the Coast Ranges of northwestern Oregon. With one or two local exceptions, no volcanic materials are found associated with any of the Oligocene or Miocene strata in western Washington. In the Cascades and eastern Washington they constitute the larger part of the later Tertiary.

COWLITZ FORMATION.

The Cowlitz formation contains the following fauna:

PELECYPODA.

Barbatia morsei Gabb
Cardium breweri Gabb
Cardium cooperi Gabb
Corbula sp.
Crassatella washingtoniana n. sp.
Crassatella cowlitzensis n. sp.
Meretrix olequahensis n. sp.
Ostrea fettkei n. sp.
Pecten cowlitzensis n. sp.
Plauconomia inornata Gabb
Venericardia alticosta Gabb
Venericardia planicosta Lamarck

GASTEROPODA.

Ancillaria bretzii n. sp.
Cassidaria washingtoniana n. sp.
Conus cowlitzensis n. sp.
Cylichna costata Gabb
Fusus lewisensis n. sp.
Fusus dickersoni n. sp.
Fusus washingtoniana n. sp.
Galerus excentricus Gabb
Hemifusus sopenahensis n. sp.
Hemifusus cowlitzensis n. sp.
Hemifusus lewisensis n. sp.
Hemifusus tejonensis n. sp.
Hemifusus washingtoniana n. sp.
Fasciolaria washingtoniana n. sp.
Lunatia lewisii Gould
Murex sopenahensis n. sp.
Murex cowlitzensis n. sp.
Mitra washingtoniana n. sp.
Morio tuberculatus Gabb. var. trituberculatus n. var.
Nassa eocenica n. sp.
Nassa packardi n. sp.
Naticinia obliqua Gabb.
Ranella washingtoniana n. sp.
Ranella cowlitzensis n. sp.
Ramilla canalifera Gabb var. elongata n. var.
Sircula cowlitzensis n. sp.
Tritonium sopenahensis n. sp.
Turritella uvasana Conrad.

BRACHYOPODA.

Rhynconella washingtoniana n. sp.

SHARK'S TEETH.

There is a total of forty-five species occurring in this formation. Out of the total fauna thirty are new species. The base of this formation is unknown. Its known thickness is at least five hundred feet. Future studies may show this to be really a part of the Tejon formation.

TEJON FORMATION.

The Tejon formation contains the following fauna:

PELECYPODA.

Barbatia morsei Gabb.
Cardium breweri Gabb.
Cardium olequahensis n. sp.
Ostrea idriaensis Gabb.
Ostrea olequahensis n. sp.
Pecten peckhami Gabb.

Crassatellites grandis Gabb.
Corbicula cowlitzensis n. sp.
Corbicula eufaulaensis n. sp.
Leda gabbi Conrad.
Meretrix landesi n. sp.
Meretrix horni Gabb.
Meretrix ovalis Gabb.
Meretrix uvasana Conrad.
Modiola ornata Gabb.
Nerverita subglobosa Gabb.
Planconomia inornata Gabb.
Pectunculus eocenica n. sp.
Pectunculus eocenica n. sp. var. landesi n. var.
Pectunculus tejonensis n. sp.
Pectunculus sagittata Gabb.
Solen parallelus Gabb.
Tapes washingtoniana n. sp.
Tellina horni Gabb.
Venericardia planicosta Lamarck.

GASTEROPODA.

Amauropsis alveata Conrad.
Brachysphingus clarkii n. sp.
Cylichna costata Gabb.
Ficus mammilatus Gabb.
Fusus remondi Gabb.
Fusus sp.
Potamides lewisensis n. sp.
Potamides fettkei n. sp.
Potamides carbonicola Cooper.
Turritella uvasana Conrad.

SCAPHAPODA.

Dentalium cooperi Gabb.

This fauna is characteristic wherever the marine Upper Eocene is found. It is typically Tejon and it seems best to retain that formational name within this state. The strata involved in the Puget formation are the brackish water equivalents of the marine Tejon. The Tejon is widely distributed and composes practically all of the Eocene outcrops in western Washington. Indirect evidence suggests its correlation with the Roslyn formation of eastern Washington. The data bearing upon this subject will be presented in a future paper.

OLIGOCENE.

GENERAL STATEMENT.

In southern Thurston County strata occur containing a fauna having a very close relationship to the Tejon below. No distinct unconformity can be recognized. So far as observed the strata are entirely of marine origin. The known area is so small that it has not been represented upon the accompanying map. The best exposures outcrop on Lincoln Creek near the boundary line between Lewis and Thurston counties. The total thickness is less than one thousand feet. Upwards it grades into the Porter shales which are correlated with the lower portion of the Blakeley formation in the type section in Kitsap County. Many of the species occurring at Lincoln

Creek are identical with those at Porter, but the fauna as a whole contains a larger percentage of distinctly Tejon species. These strata may be designated as the Lincoln formation. So far as the writer has been able to ascertain they are marine deposits which as yet have not been definitely recognized at any other locality on the coast. They seem to correspond to the time interval represented by unconformities elsewhere. Lithologically they are largely composed of shales or sandy shales with a very little sandstone and no volcanic material. Volcanic activity in western Washington seems to have entirely ceased at the close of the Eocene.

In the type section of the Blakeley formation at Restoration Point, there is a series of shales and sandy shales which are non-fossiliferous and lie below the fossiliferous beds at Port Blakeley and which seem to rest upon an old basaltic mass of probable Eocene age which may possibly correspond to the fossiliferous beds in the Lincoln formation. These outcrop on the south side of Sinclair Inlet opposite Seattle. In the thick series of sediments exposed in the Cape Flattery section there are about 5,000 feet of non-fossiliferous shales and sandy shales. These underlie the thick massive conglomerates forming the backbone of the Cape and are above the old Mesozoic metamorphic mass which constitutes Portage Head. These beds also may represent those at Lincoln Creek but at present there is no definite evidence to make such a correlation.

The following list of species constitutes the fauna characteristic of the Lincoln formation:

PELECYPODA.

Anomia cf subcostata Conrad.
Leda gabbi Conrad.
Marcia oregonensis Conrad.
Meretrix uvasana Conrad.
Pecten porterensis n. sp.
Solen conradi Dall.
Solen parallelus Gabb.

GASTEROPODA.

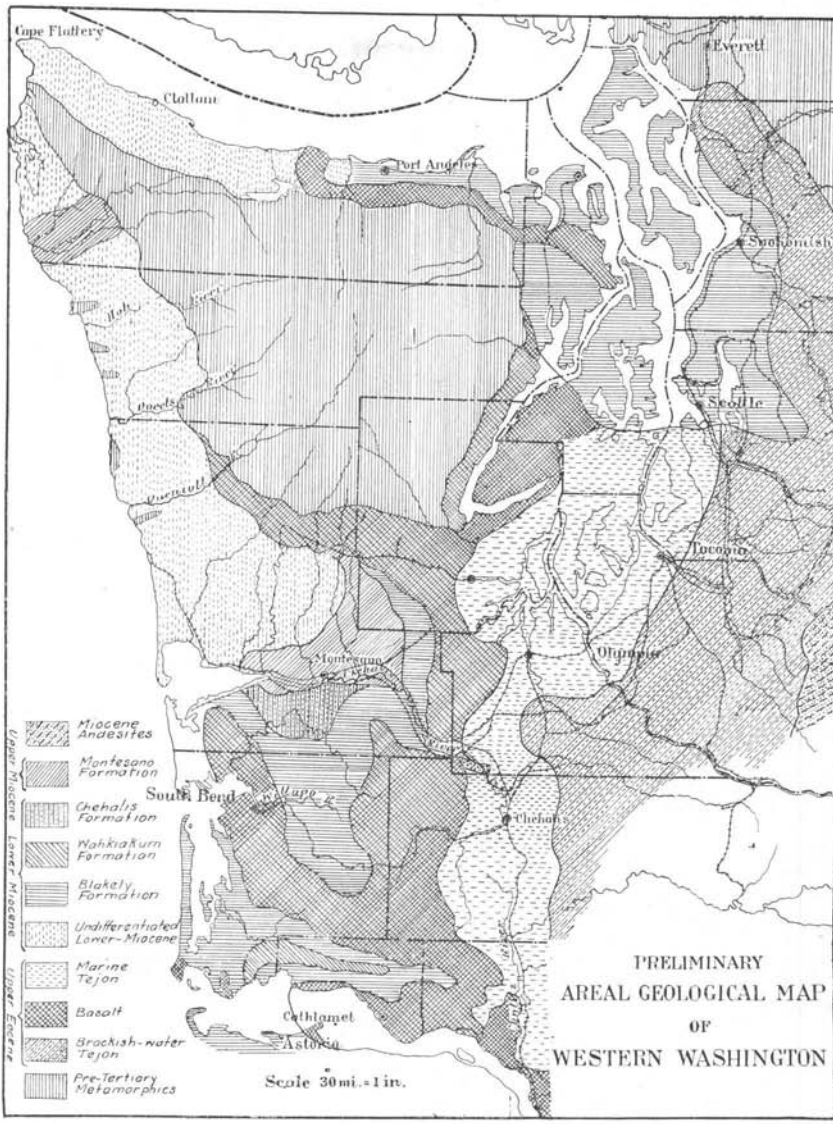
Pleurotoma fresnoensis Arnold.
Pleurotoma lincolnensis n. sp.

CEPHALOPODA.

Aturia angustata Conrad.

BRACHIOPODA.

Terebratula oakvillensis n. sp.


Cape Flattery
Clallam
Port Angeles
Everett
Seattle
Tacoma
Olympia
Montesano
South Bend
Chehalis
Cathlamet
Astoria
Miocene Andesites
Montesano Formation
Chehalis Formation
Wahkiakum Formation
Blakely Formation
Undifferentiated Lower-Miocene
Marine Tejon
Basalt
Brackish-water Tejon
Pre-Tertiary Metamorphics
Upper Miocene
Lower Miocene
Eocene
Scale 30 mi. = 1 in.
PRELIMINARY
AREAL GEOLOGICAL MAP
OF
WESTERN WASHINGTON

POST EOCENE.

GENERAL STATEMENT.

The Miocene is distinctly separated into an upper and lower division by a well marked unconformity. The lower division is widely distributed, is marine, and can be subdivided into three formations on a stratigraphic, lithologic, and fauna basis. It has a maximum thickness of twenty thousand feet. The Upper Miocene is restricted to two small areas, has a thickness of five thousand feet and a large and distinctive fauna somewhat similar to the San Pablo of California.

The Lower Miocene deposits are by far the best developed and constitute a large part of the areal geology from the Columbia River northward to the southern foothills of the Olympic Mountains and extend also as a narrow belt around the central core of those mountains. Where not covered over with glacial drift they outcrop in the Puget Sound Basin and in the lower foothills of the Cascades. The Lower Miocene may be divided into three divisions which may be termed the Blakeley, Wahkiakum and Chehalis formations. Those deposits in the Upper Miocene may be designated as the Montesano formation.

No Pliocene deposits are known.

LOWER MIOCENE.

BLAKELEY FORMATION.

The type section of this formation occurs at Restoration Point, Kitsap County, opposite Seattle, and consists of about eight thousand feet of shales and alternating beds of shales and sandstones overlaid with nearly one thousand feet of conglomerates which are non-fossiliferous. The Blakeley beds are exposed in part at Alki Point, Georgetown, the Newcastle Hills, Cathcart, the Quimper Peninsula, in Chehalis County, and at various points along the Strait of Juan de Fuca. At all of these localities the rocks contain a similar fauna. In this report the Cape Flattery section is regarded as Lower Miocene but has not been differentiated into three divisions; nevertheless a large part of it corresponds to the Blakeley beds at Restora-

tion Point. These strata have been considered Oligocene, or at least in part Oligocene, but with the data now at hand the writer feels warranted in placing them in the Lower Miocene. When a definite understanding has been arrived at as to what is to constitute the Oligocene it may be possible to assign them permanently to that period. The following fauna is characteristic of the Blakeley formation:

PELECYPODA.

Cardium cooperi Gabb var. lorenzianum Arnold.
Cardium vaqueroensis Arnold.
Chione cathcartensis n. sp.
Crenella porterensis n. sp.
Macoma calcarea Gmelin.
Macoma moliana Dall.
Marcia oregonensis Conrad.
Modiolus inflatus Dall.
Modiolus directus Dall.
Mytillus stillaguamishensis n. sp.
Mytillus sammamishensis n. sp.
Mytillus snohomishensis n. sp.
Macoma snohomishensis n. sp.
Malitia chehalisensis Arnold.
Nucula dalli.
Nucula gettysburgensis Reagan.
Ostrea veatchii Gabb.
Pecten peckhami Gabb.
Pecten fucanus Dall.
Pecten propatulus Conrad.
Pecten coosensis Shumard.
Phacoides acutilineatus Conrad.
Solemya ventricosta Conrad.
Tellina oregonensis Conrad.
Tellina conjesta Conrad.
Teredo sp.
Thracia trapezoidea Conrad.
Thyasira bisecta Conrad.
Yoldia submontereyensis Arnold.
Yoldia sammamishensis n. sp.

SCAPHAPODA.

Dentalium conradi Dall.

GASTEROPODA.

Ampulina oregonensis Dall.
Astraea sp.
Chlorostoma arnoldi n. sp.
Caliostoma delazinensis n. sp.
Chrysodomus rectrorostris Carpenter.
Chrysodomus clallamensis n. sp.
Drillia chehalisensis n. sp.
Epitonium condoni Dall.
Epitonium oregonensis Dall.
Epitonium rugiferum Dall.
Epitonium petrosum.
Eudolium petrosum Conrad.
Fusinus coosensis Dall.
Fusus stanfordensis.
Miopleiona indurata Conrad.
Pleurotoma fresnoensis Arnold.
Pleurotoma washingtoniana n. sp.
Scaphander oregonensis Dall.
Turritella blakeleyensis n. sp.
Turritella porterensis n. sp.
Turcicula washingtoniana Dall.

CEPHALOPODA.

Aturia angustata Conrad.

ECHINODERMATA.

Cidaroid spines.

CRUSTACEA.

Crabs (very abundant).

WORM BORINGS.

PLANT REMAINS.

WAHKIAKUM FORMATION.

Certain strata occurring on the north side of the Columbia River in Wahkiakum County near the head of the Alockaman River have a fauna quite different from that characteristic of the Blakeley formation. These strata consist of approximately four thousand feet of sandstones, shales and grits, with sandstones predominating. They rest unconformably upon a series of shales whose faunal position cannot be definitely ascertained, although it seems to correspond to the Blakeley and the Astoria in Oregon. It is largely covered with Pleistocene sands and gravels. These beds seem to be most closely related to the lower Monterey of California. The following species have been found in this formation.

PELECYPODA.

Arca montereyana.
Chione securis Shumard.
Diplodonta paralis Conrad.
Leda acuta Conrad.
Mactra coalingensis Arnold.
Marcia oregonensis Conrad.
Macrocallista vespertina Conrad.
Nucula gettysburgensis Reagan.
Nucula conradi Meek.
Nucula dalli.
Pecten propatulus Conrad.
Pecten alockamanensis n. sp.
Phacoides acutilineatus Conrad.
Solen conradi Dall.
Spisula albaria Conrad.
Tellina albaria Conrad.
Thracia trapezoidea Conrad
Yoldia strigata Dall.

SCAPHAPODA.

Dentalium conradi Dall.

GASTEROPODA.

Calyptraea filosa Gabb.
Fusus stanfordensis.
Fusinus coosensis Dall.
Cuma biplicata Gabb var. quadranodosum n. var.
Crepidula princeps Conrad.
Strepsidura oregonensis Dall.

CEPHALOPODA.

Aturia angustata Conrad.

CHEHALIS FORMATION.

Certain strata possessing a fairly constant lithologic character and a fairly distinct fauna occur in the hills south of the

Chehalis River in Chehalis County. These are designated as the Chehalis formation. They are prevailingly sandy shales and shaley sandstones, the former predominating. They have a characteristic gray to browinsh gray color and a maximum thickness of about seven thousand feet. They rest unconformably upon the Blakeley formation as well as beneath the Upper Miocene sandstones although in one locality the upper portion of the formation may be transitional into the Upper Miocene. If so this portion represents sediments deposited during the time interval between the Lower and Upper Miocene. A part of the fauna ranges down into the Blakeley and a part up into the Upper Miocene, yet there are many species which are distinctive of these strata only. It is quite possible that these beds may be the equivalent of the upper Monterey of California. The following fauna occurs in this formation:

PELECYPODA.

Leda chehalisensis n. sp.
Macoma wynootcheensis n. sp.
Macoma calcarea Gmelin.
Mytilus inflatus.
Nucula dalli Arnold.
Nassa andersoni n. sp.
Pecten coosensis Shumard.
Phacoides acutilineatus Conrad.
Phacoides annulatus.
Solemya ventricosta Conrad.
Spisula albaria Conrad.
Thracia trapezoidea Conrad.
Thyasira bisecta Conrad.
Venericardia chehalisensis n. sp.

GASTEROPODA.

Argobuccinium cammani Dall.
Argobuccinium coosensis Dall.
Chrysodomus clallamensis n. sp.
Cryptomya oregonensis Dall.
Ficus clallamensis n. sp.
Ficus n. sp.
Liomesus sulcatus Dall.
Natica oregonensis Conrad.
Polynices lewisi Gould.
Turris wynootchensis n. sp.
Turris cammani Dall.
Turris coosensis Dall.

CEPHALOPODA.

Aturia angustata Conrad.

SCAPHAPODA.

Dentalium conradi Dall.

PLANT REMAINS.

UPPER MIOCENE.

MONTESANO FORMATION.

Strata of Upper Miocene age outcrop in Chehalis County, north of the Chehalis River, in the vicinity of Montesano. They

consist largely of massive coarse-grained sandstones of a light brown color containing many intercalated lenses of conglomerate and grit. Shales, while subordinate in the lower portion of the formation, are common in the upper. These beds may be designated as the Montesano formation. They possess a maximum thickness of approximately five thousand feet and contain a fairly large fauna which is quite distinct from that in the Lower Miocene. This fauna appears in abundance in the basal conglomerates and is quite persistent throughout the sandstone phase. A very rich fossil locality occurs on Sylvia Creek in conglomerate about six miles north of the town of Montesano in Chehalis County.

The outcrops of this formation occupy an area of about 1,000 square miles in Chehalis County. Farther north on the western side of the Olympic Mountains, in the basin of the Soleduck and Bogachiel rivers, fossiliferous sandstones and shales occur whose fauna is closely related to that of the sandstone portion of the Montesano formation in Chehalis County. It has an estimated thickness of about 500 feet and has been referred to by Reagan* in his report. No deposits of Montesano age are known from the vicinity of the Strait of Juan de Fuca, the Puget Sound Basin, or the eastern and southern portions of southwestern Washington. Apparently these portions of the state were land areas during all of the Upper Miocene as well as Pliocene.

This formation is closely related to the Empire of Coos Bay, Oregon, and to the San Pablo of California. It possesses a characteristic fauna of 61 specimens which are listed below:

PELECYPODA.

Arca trilineata Conrad.
Arca sp.
Cardium corbis Martyn.
Cardium coosensis Dall.
Cardium meekianum Gabb.
Chione securis Shumard.
Chione bisculpta Dall.
Chione temblorensis Anderson.
Nucula conradi Meek.
Panopaea generosa Gould.
Pseudocardium gabbi Remond var. robustum n. var.
Pseudocardium gabbi Remond var. undiliferum n. var.
Pseudocardium gabbi Remond var. elongatus n. var.

*Kansas Academy of Science.

Chione chehalisensis n. sp.
Chione montesanoensis n. sp.
Diplodonta paralis Conrad.
Glycimeris gabbi Dall.
Macoma secta Conrad.
Macoma nasuta Conrad.
Macoma montesanoensis n. sp.
Mactra coalingensis Arnold.
Modiolus piercei.
Mytilus condoni Dall.
Pseudocardium landesi n. sp.
Solen conradi Dall.
Spisula albaria Conrad.
Spisula catiliformis.
Semele montesanoensis n. sp.
Semele sylviaensis n. sp.
Tellina kincaidi n. sp.
Tellina merriami n. sp.
Tellina albaria Conrad.
Tapes staleyi Gabb.

GASTEROPODA.

Bathytoma gabbiana Dall.
Buccinium bogachieli Reagan.
Calyptraea filosa Gabb.
Chrysodomus imperallis Dall.
Chrysodomus bairdi Dall.
Chrysodomus giganticus Reagan.
Columbella ganspata Gould.
Crepidula princeps Conrad.
Cryptomya washingtoniana n. sp.
Eulima smithi Reagan.
Eulima washingtoniana n. sp.
Fusinus montesanoensis n. sp.
Gyrineum sylviaensis n. sp.
Gyrineum mediocre var. corbiculatum Dall.
Natica clausa Broderip and Sowerby
Natica oregonensis Conrad.
Neptunea maxfieldi Reagan.
Olivella pedroana Conrad.
Phalium aequisulcatum Dall.
Polynices lewisi Gould.
Ranella marshalli Reagan.
Sinum scopulosum Conrad.
Thais etchegoinensis Arnold

SCAPHAPODA.

Dentalium conradi Dall.

ECHINODERMATA.

Scutella gabbi Remond.

SHARK'S TEETH.

PLANT REMAINS.

GEOLOGIC HISTORY.

Concerning the geological conditions in western Washington during the Palaeozoic, very little data is at hand. Exposures in the western Cascades suggest that the region at least during the Carboniferous was an open sea with islands or the mainland not far away. Lavas and tuffs seem to have been poured out over the sea floor where they now occur interbedded with sediments. Similar conditions seem to have prevailed during the Triassic and Jurassic. Deep sea marine deposits laid down during these two periods occur in the Olympic Mountains, in the San Juan Islands, in Vancouver Island and in the Cascade

Mountains. There is a strong suggestion that they were a part of the same seas which are known to have existed in Idaho and northern Nevada.*

In Washington at or near the close of the Jurassic there was a series of crustal movements accompanied by intrusions of basic and acidic plutonic magmas. The larger part of Washington seems to have been uplifted above sea level and the older sedimentary formations metamorphosed. Evidence obtained indicates that the upward movement of the earth's crust was differential, resulting in the development of an elevated mountain mass trending in a general northwest direction and occupying the present position of the Okanogan Highlands, the northern Cascades and Vancouver Island. The San Juan Islands and the Olympic Mountains are included in this. A similar uplift at the same time occurred in southern Oregon and northern California.

The area involved between this mountain mass in northern Washington and the Klamath Mountains in southern Oregon, appears for the most part to have been above sea level during the Cretaceous. No Cretaceous deposits of any kind are known to occur within this area, although it is possible there may have been a marine connection with eastern Oregon, somewhere to the north or south of the present site of the Columbia River.

In southern Oregon arms of the sea are known to have extended southward into the Klamath Mountains. On the north side of Vancouver Island and the San Juan Islands, non-metamorphosed marine Cretaceous deposits do occur. They are restricted, however, to the Chico formation or Upper Cretaceous. In the Klamath region all three divisions of the Cretaceous are present.

Crustal movements initiated at or near the close of the Jurassic, and continuing in a milder form during the Cretaceous, are assumed to have developed a structural basin which has served for the accumulation of marine, brackish and fresh water sediments together with lavas and tuffs during the whole of the Tertiary era. The Tertiary history of this area is a

*22nd Ann. Rep't U. S. G. S., pt. 2, p. 580, 1901.

distinct unit in itself and may be referred to as the Pacific Northwest Tertiary Province.

In western Washington the Eocene seems to have been ushered in by a gradual and differential submergence of the land area allowing the marine seas to transgress eastward. Embayments developed and extended eastward to the present position of the western slope of the Cascades. The southern portion of this range of mountains apparently did not exist as such during the Eocene and Miocene but seems to have been occupied by a series of fresh water lakes which at times may have been connected with the brackish water estuaries farther to the west.

The geographical position of the land and water areas was continually shifting during the Eocene. This was caused partly by a continual differential elevation and depression of the entire area involved in this province and partly by the silting up of the basins of deposition. Evidences from fauna and flora point to tropical conditions during the Eocene. At intervals arms of the sea appear to have been cut off and to have become brackish, and certain of its marine fauna developed into brackish water types.

The Eocene as a whole may be characterized by a continual shifting of shore lines. The present line of the Northern Pacific railroad between Seattle and Portland may be taken roughly as the eastern limit of the marine shore line although at times marine embayments seem to have extended further east. At times the shore line was farther west.

The later portion of the Eocene was also characterized by the extrusion of basaltic lavas and tuffs which came up through numerous fissures. These deposits of igneous material often accumulated on the sea floor and were covered by marine sediments and then again by further outpourings of basaltic materials. This seems to have been repeated many times until it absolutely ceased at the close of the Eocene. Volcanic activity did not occur during the Miocene or Pliocene west of the present foothills of the Cascade mountains.

In Washington the time interval immediately following Eo-

cene sedimentation and vulcanism is characterized by evolution of the marine faunas. This change consisted in the development of species adapted to the environment of a colder climate than that of the Eocene. This time interval is designated as the Oligocene.

No sharp break separates the Miocene from the Oligocene. The conditions existing during the early portion of the Miocene were somewhat similar to those of the Eocene. Oscillations of the sea floor were more or less continuous and the marine fauna has a much closer relationship to that of the present day. No brackish water beds are known to have existed nor have any evidences of volcanic activity been observed. About the middle of the Miocene there appears to have been an extensive elevation of the sea floor so as to have elevted above sea level almost the entire area of this northwestern Tertiary province. During the upper Miocene, local depressions or embayments were developed in which accumulated the sandstones and shales of the Montesano formation. These are typically developed on the north side of the Chehalis Valley and in the valleys of the Soleduck and Bogachiel rivers in the Olympic Peninsula.

Nearly all of southwestern Washington, the Puget Sound Basin, and the Strait of Juan de Fuca seem to have been land areas during the upper Miocene.

In western Washington no marine deposits of Pliocene age are known. The region appears to have been undergoing erosion. Near the close of the Pliocene, or perhaps during early Pleistocene a series of crustal movements culminated in the uplift of the Cascade mountains of Oregon and Washington into approximately their present position. Within Washington the Cascades are considered to have been a comparatively level plain. Ample evidence is at hand to suggest that this plane was elevated as a differentially warped dome. Its structure consists of a number of folds whose axes have a general northwest to southeast direction. Within the Puget Sound Basin the Tertiary formations seem to have been also involved in a series of closely folded anticlines and synclines, much faulting accom-

panying these movements. In southwestern Washington the structure resulting from these movements has produced two extensive pitching geosynclines. All the Tertiary formations in southwestern Washington, extending from the Columbia River northward to the foothills of the Olympic Mountains are involved in these two geosynclines. The larger of these occupies most of the drainage basin of the Chehalis River and a portion of the Willapa. The other lies largely within the drainage basin of Columbia River and Willapa Bay. The southern limb of this one diagonally crosses the Columbia from Wahkiakum County to Astoria, Oregon. The sandstones and shales at the town of Astoria, including the underlying basalt at Tongue Point, represent a part of the Eocene and Miocene series involved in the south limb of this structural geosyncline. The elevated anticlinal ridge which separates the two geosynclines forms the drainage divide between the Columbia on the south and the Willapa and Chehalis valleys on the north. It is composed almost entirely of Eocene basaltic lavas and appears originally to have been covered over by Miocene sediments which are found to the north and south in the synclinal folds. These strata seem to have been stripped off by erosion.

Extending northward along the Pacific coast of the Olympic Peninsula there are numerous exposures of Miocene sediments which have also been involved in a series of northwesterly pitching synclines. These are separated by broad outcrops of the older formations. Many extensive faults have accompanied this folding.

In the Strait of Juan de Fuca the Miocene formations have been folded into a series of northwesterly pitching synclines. These extend diagonally across the Strait and are represented on the south side of Vancouver Island by a very narrow fringe resting upon the upturned edges of the older metamorphics. This fringe is more or less continuous from Port San Juan to Sooke Bay.*

A further uplift of the Olympic Mountains seems to have

*Unpublished data obtained by writer.

occurred at this time and extensive erosion, aided by a structural depression, partially developed the channels of Puget Sound and the Strait of Juan de Fuca.

The character of the faunas and floras during the progression of the Tertiary period indicate the gradual approach of a colder climate. During the Pleistocene, conditions allowed the accumulation of extensive ice fields in the higher portions of the Cascade Mountains. These gradually increased in volume and traveled down the various river valleys until they coalesced along the eastern margins of the Puget Sound Basin, forming a great piedmont glacier. Similar conditions occurred along the Pacific coast of British Columbia. These vast ice streams traveled southward until they joined with those in the Puget Sound Basin forming one great ice field extending from the Cascades on the east up into the valleys of the Olympic Mountains on the west. One arm of this ice field seems to have turned westward, passed around the northern side of the Olympic Mountains and extended out to sea through the Strait of Juan de Fuca. The southern margin of this arm may be found on the western side of the Olympics a short distance below Ozette Lake. The southern limits of the Puget Sound ice field seem to have extended below Olympia.

Two advances of the ice have been recorded with one interglacial period. Since the final retreat of the glaciers an uplift, ranging from ten to forty feet has occurred. Evidence of this may be seen in raised beaches.

DESCRIPTION OF SPECIES.

UPPER EOCENE SPECIES.

PELECYPODA.

GENUS PECTUNCULUS LAMARCK.

PECTUNCULUS EOCENICA n. sp.

Plate V, Figures 52, 53.

Description.—Shell sub-circular, thin, equivalve, and nearly equilateral; base regularly convex; sides sloping down directly from the beak, the anterior side much more steeply rounded than the posterior, the latter being regularly convex; junction of posterior end and base very slightly truncated. Surface marked by forty broad nearly flat-topped radiating ribs with very narrow interspaces, between which are raised threads; four or five very prominent lines of interrupted growth are present with fainter intervening concentric lines. Hinge robust with radiating teeth; palial line very distinct, inner margin coarsely crenulated.

Dimensions.—Altitude 23 mm.; longitude 25 mm.; thickness 7 mm.

Occurrence.—Very common at Loc. No. 227. (University of Washington Palaeontological Collection).

Horizon.—Tejon formation, Upper Eocene.

PECTUNCULUS EOCENICA n. sp. VAR. LANDESI n. var.

Plate V, Figure 54.

Description.—Shell sub-oval, thin, equivalve, inequilateral; base regularly rounded; posterior margin sloping down sharply to the posterior end; anterior margin sloping at an angle of 25 degrees for a short distance, then broadly rounded toward the anterior end; beaks small and moderately incurved. Surface marked by thirty radiating ribs, broad and flat-topped with narrow interspaces. Interior margin coarsely crenulated; hinge robust with radial teeth. A large number of specimens of this variety have been collected and each is characterized by the steeply sloping truncated posterior margin.

Dimensions.—Altitude 29 mm.; longitude 27 mm.; thickness 7.5 mm.

Occurrence.—Common at Loc. No. 227 (University of Washington Palaeontological Collection).

Horizon.—Tejon formation, Upper Eocene.

PECTUNCULUS TEJONENSIS n. sp.

Plate XV, Figure 134.

Description.—Shell moderately large, thick, elongated, equivalve and nearly equilateral; posterior and anterior margins very slightly convex, sloping steeply and nearly equally from the beak where they meet at a sharp angle; below they gradually grade into the base which is broadly and regularly rounded (posterior margin slightly more convex than anterior); beaks fairly prominent and incurved; a very slight depression on the posterior side of the umbones. Surface sculptured by numerous well-developed lines of growth and about thirty fairly distinct radiating ribs which are broad and flat with very narrow intermediate grooves.

Dimensions.—Altitude 33 mm.; longitude 29 mm.; thickness 11 mm.

Occurrence.—Abundant at Loc. No. 227. (University of Washington Palaeontological Collection).

Horizon.—Tejon formation, Upper Eocene.

GENUS OSTREA LINNAEUS.

OSTREA OLEQUAHENSIS n. sp.

Description.—Shell medium sized, slightly inequilateral, wide, thick, slightly curved; lower valve very convex and nearly smooth except for irregular wavy lines of growth; a faint radial sculpture is present in some specimens. Central portion of valve most convex with marked slope; posterior margin sloping at a steep angle and broadly rounded; anterior margin gradually and nearly straight to the anterior end which is acutely rounded; base broadly rounded; upper valve about one-half as convex as lower.

Dimensions—Altitude 55 mm.; longitude 48 mm.; thickness of lower valve 24 mm.

Occurrence.—Common at Loc. No. 2 (University of Washington Palaeontological Collection). On Olequah Creek, one mile above junction of Olequah and Stillwater creeks, back of the Cantwell place in Sec. 29, T. 11 N., R. 2 W.

Horizon.—Tejon formation, Upper Eocene.

OSTREA FETTKEI n. sp.

Plate IV, Figures 37, 39.

Description.—Shell small, thin, somewhat curved, right valve nearly flat, left valve convex; hinge deflected to the left and median groove very well marked; internal margins in both old and young forms are pitted; shell inequivalve and slightly inequilateral; left valve ornamented by a marked median ridge extending from beak to basal margin; anterior to this ridge are two radiating ribs becoming obsolete toward the beaks; posterior surface with six radiating ribs extending to the beak; these are crossed by a large number of concentric ribs and lines of growth.

Dimensions.—Left valve, altitude 27 mm.; longitude 17 mm.; thickness 7 mm.

Occurrence.—Common at Loc. No. 1 (University of Washington Palaeontological Collection). One-half mile east of Sopenah (Little Falls) in the bank of the Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS PECTEN MULLER.

PECTEN COWLITZENSIS n. sp.

Plate V, Figure 46.

Description.—Shell small, somewhat higher than long, thin, nearly equivalve, equilateral, and with very slightly serrate margins; anterior and posterior margins slightly concave, sloping equally and steeply from the beak and merging into the regularly rounded base; angle at which margins intersect at beak is

80°; surface ornamented by forty-four equally spaced broadly rounded radiating ribs, separated from each other by narrower flat-bottomed to slightly concave interspaces; hinge line nearly two-thirds the length of the shell; ears unequal; surface sculptured by numerous fine concentric lines of growth.

Dimensions.—Altitude 17 mm.; longitude 14.5 mm.; thickness 2.5 mm.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection). One and one-half miles east of Sopenah (Little Falls) in the bluffs of the Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS CRASSATELLITES KRUGER.

CRASSATELLITES COWLITZENSIS n. sp.

Plate IV, Figure 40.

Description.—Shell small, comparatively thin, sub-triangular to sub-quadrate; beak situated about one-third the length of the shell from the anterior end; anterior margin slopes down steeply at first and then at an angle of 30° to the anterior end, which is sharply arcuate; base broadly rounded, with pronounced upward slope at the anterior end; posterior margin nearly straight and sloping down to the posterior end where it is abruptly truncated; an angular ridge extends from beak to posterior end and is situated a little in front of the posterior margin. Surface sculptured by numerous well developed concentric lines of growth. Lunule long, narrow, and not very deeply impressed; escutcheon absent; hinge plate not very heavy; muscular scars well developed as well as palial line.

Dimensions.—Altitude 20 mm.; longitude 26 mm.; thickness 5 mm.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection). One and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

CRASSATELLITES WASHINGTONIANA n. sp.

Plate IV, Figure 42, and Plate V, Figure 51.

Description.—Shell of moderate size, elongate, sub-trigonal, thick, equivalve, and very inequilateral; beaks about one-fourth of the length of the shell from the anterior end; incurved and pointing slightly forwards; anterior margin straight and sloping downwards steeply at an angle of 60°. It is then broadly rounded and merges into the base; posterior margin very slightly convex and sloping downwards at an angle of 25°; posterior end broadly truncated; base broadly rounded; a fairly distinct ridge passes downwards on the surface from beak to posterior end and is situated a little in front of the posterior margin; lunule cordate, fairly large, distinct and deeply impressed. Surface sculptured by a well defined series of concentric ribs and lines of growth. Palial line distinct and some distance from margin of shell; muscle scars strong and nearly equally developed; hinge plate heavy and teeth typically developed.

Dimensions.—Altitude 26 mm.; longitude 34 mm.; thickness 10 mm.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection). One and one-half miles east of Sopenah (Little Falls) in banks of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS CORBICULA MEGERLE.

CORBICULA EUFAULAENSIS n. sp.

Plate XIV, Figure 119, and Plate XV, Figure 131.

Description.—Shell sub-circular, about one-fifth longer than high and very thick; beaks very prominent and situated nearly central, sometimes anterior to the center; valves very convex; anterior and posterior margins sloping at nearly the same angle, the former very slightly concave and the latter very slightly convex; both ends acutely but evenly rounded. Surface sculp-

tured by prominent concentric lines of growth. Hinge plate and teeth well developed.

Dimensions.—Altitude 32 mm.; longitude 38 mm.; thickness 12.5 mm.

Notes.—Beds over five feet in thickness, composed exclusively of the remains of this genus. These beds represent a brackish water phase of the Tejon formation and are overlaid and underlaid by marine beds. This intercalation of marine and brackish water strata is repeated several times in Cowlitz and Lewis counties.

Occurrence.—Very common at Loc. No. 8 (University of Washington Palaeontological Collection) on Coal Creek, one mile north of Inmann-Polson store, Cowlitz County, Sec. 35, T. 9 N., R. 3 W.

Horizon.—Brackish water Tejon, Upper Eocene.

CORBICULA COWLITZENSIS n. sp.

Plate XIV, Figure 117, and Plate XV, Figures 132, 135.

Description.—Shell sub-triangular in outline, nearly one-fourth longer than high, thick; beaks prominent, elevated and situated about two-fifths the length of shell from the anterior end; valves convex; anterior margin slightly concave, short and sloping downwards at an angle of 50°; anterior end broadly rounded; basal margin evenly but very slightly rounded; posterior margin nearly straight, long and sloping downwards at an angle of 30°; posterior end obliquely truncated and narrow. Surface marked by well developed concentric lines of growth. Hinge plate thick, cardinal teeth very large, lateral teeth prominent.

Dimensions.—Altitude 28 mm.; longitude 36 mm.; thickness 10 mm.

Occurrence.—Common at Loc. No. 8 (University of Washington Palaeontological Collection) on Coal Creek one mile north from Inmann-Polson store, Cowlitz County, Sec. 35, T. 9 N., R. 3 W.

Horizon.—Brackish water Tejon, Upper Eocene.

GENUS CARDIUM LINNAEUS.

CARDIUM OLEQUAHENSIS n. sp.

Plate V, Figure 55.

Description.—Shell moderate in size, inequilateral, and about as long as wide; beak central, incurved and inclined considerably forwards; anterior margin slightly concave sloping downwards rather steeply and merging into the base which is regularly rounded; posterior margin convex sloping downward steeply and finally becoming vertical; posterior end slightly truncated. A prominent ridge extends from the beak to the base on the surface of the shell a little in front of the posterior margin. Surface ornamented by forty very slightly rounded radiating ribs which are very prominent on the central portion of the surface but less distinct near the anterior margin; interspaces are flat and about three-fourths the width of the ribs. These are crossed by concentric lines of growth.

Dimensions.—Altitude 20 mm.; longitude 20 mm.; thickness 6.5 mm.

Occurrences.—At Loc. No. 6 (University of Washington Palaeontological Collection). About one mile west of the junction of the Stillwater and Olequah creeks, on the former stream.

Horizon.—Tejon formation, Upper Eocene.

GENUS MERETRIX LAMARCK.

MERETRIX LANDESI n. sp.

Plate IV, Figures 41, 43.

Description.—Shell large, sub-triangular and thick; beak situated slightly anterior to the center, prominent and directed forwards; anterior margin slightly concave and sloping downward at an angle of 45°; anterior end acutely rounded; posterior margin slightly concave and sloping less steeply to the posterior end; base broadly and evenly rounded; surface ornamented by well developed nearly equally spaced concentric lines of growth; no radiating ribs present. Lunule large, cordate, and deeply impressed; escutcheon much larger and also

impressed; hinge plate heavy; lateral teeth well developed; muscular scars large.

Dimensions.—Altitude 53 mm.; longitude 68 mm.; thickness 20 mm.

Occurrence.—At Loc. No. 2 (University of Washington Palaeontological Collection). On Olequah Creek one mile above junction with Stillwater Creek, back of the old Cantwell place.

Horizon.—Tejon formation, Upper Eocene.

MERETRIX OLEQUAHENSIS n. sp.

Plate V, Figures 47, 48, 49, 50.

Description.—Shell thick, robust, somewhat inflated, sub-triangular; beaks nearly central, prominent and strongly incurved; anterior margin sloping downward steeply and nearly straight, then extending outward with a decreasing slope until broadly truncated at the anterior end; base evenly rounded; posterior margin sloping steeply at first then decreasing and merging into the broadly rounded posterior end. Surface sculptured with somewhat prominent concentric ribs. No radiating ribs are present. Surface deeply excavated under the beaks. Inner surface smooth with strong pits and moderately deep palial sinus; lateral teeth well developed.

Dimensions.—Altitude 35 mm.; longitude 38 mm.; thickness 15 mm.

Occurrence.—At Loc. No. 2 (University of Washington Palaeontological Collection). On Olequah Creek, one mile above junction of Olequah and Stillwater creeks, west of the Cantwell place.

Horizon.—Tejon formation, Upper Eocene.

GENUS TAPES MEGERLE.

TAPES WASHINGTONIANA n. sp.

Description.—Shell of moderate size, thin and inequilateral; beaks about one-third the length of shell from anterior end and directed forwards; anterior margin concave and sloping at an angle of 45° to the anterior end which is very acutely rounded;

base broadly rounded; posterior margin slightly convex and sloping at a very low angle to the posterior end where it is broadly truncated. Surface ornamented by numerous well developed concentric ribs and lines of growth; no radiating ribs present. Lunule large, distinct and somewhat narrow, escutcheon absent.

Dimensions.—Altitude 25 mm.; longitude 32 mm.; thickness 7 mm.

Occurrence.—At Loc. No. 6 (University of Washington Palaeontological Collection). About one mile west of the junction of Stillwater and Olequah creeks, on the former.

Horizon.—Tejon formation, Upper Eocene.

GASTEROPODA.

GENUS POTAMIDES BRONGT.

POTAMIDES FETTKEI n. sp.

Plate II, Figures 23, 24.

Description.—Shell small, elongated, and turreted; whorls nine, very slightly convex and somewhat angulated; suture fairly distinct and linear. Surface ornamented with thirteen revolving ribs, three above and ten below the revolving angle; each rib is set with numerous small beadlike nodes. Between each set of nodose ribs there is a small revolving thread which is smooth. The revolving angle is set with ten large flattened nodes; whorls of spire similarly sculptured. Aperture moderately broad, ovate; inner lip very slightly thickened; outer lip smooth.

Dimensions.—Altitude 19 mm.; diameter 5 mm.; angle of spire 23°.

Occurrence.—Common at Loc. No. 2 (University of Washington Palaeontological Collection). On Olequah Creek one mile above junction with Stillwater Creek, back of Cantwell place, Sec. 29, T. 11 N., R. 2 W.

Horizon.—Tejon formation, Upper Eocene.

POTAMIDES LEWISIANA n. sp.

Plate II, Figures 22, 25.

Description.—Shell small, elongate, turreted; whorls nine to ten, slightly convex and in some specimens faintly angulated. Suture distinct and impressed. Surface sculptured by fourteen distinct revolving ribs each of which is set with small beadlike nodes; no intervening revolving threads present. Longitudinal ribs are sometimes present, sometimes confined to the whorls of the spire only and sometimes confined to the body whorl. The faint angulation which is often present is confined to the surface just below the suture. Aperture narrow and elliptical; inner lip incrusted; outer lip thin.

Dimensions.—Altitude 24 mm.; diameter 7 mm.; angle of spire 20°.

Occurrence.—Common at Loc. No. 2 (University of Washington Palaeontological Collection.) On Olequah Creek one mile above junction with Stillwater Creek, back of Cantwell place, Sec. 29, T. 11 N., R. 2 W.

Horizon.—Tejon formation, Upper Eocene.

GENUS RIMELLA AGASSIZ.

RIMELLA CANALIFERA GABB, VAR. ELONGATA n. var.

Plate II, Figures 18, 19.

Description.—Shell small, fusiform, elongate; spire very much elevated; whorls ten (a constant character), slightly convex; suture moderately deep. Surface marked by twenty-three narrow knife-like longitudinal ribs. These extend over all the whorls except the last two which form the apex; interspaces twice as broad as the ribs and broadly concave. These ribs extend over the upper two-thirds of the body whorl and over all the whorls of the spire. They are crossed by thirty-three distinct revolving ribs which are very closely spaced on that part of the surface where the longitudinal ribs are present; below that the revolving ribs are twice as far apart. Aperture long and narrow; posterior angle of the mouth is continued in a deep canal (in some specimens fairly broad), slightly curved

along the spire to the apex; anterior canal short; outer lip somewhat thickened; inner lip heavily incrusted by a callous.

Dimensions.—Altitude 19 mm.; diameter 7 mm.; altitude of spire 11 mm.; angle of spire 32°.

Notes.—This variety is characterized by ten instead of six or seven whorls, by its more slender form, and differences in external ornamentation. Specimens are numerous and excellently preserved.

Occurrence.—Common at Loc. No. 1 (University of Washington Palaeontological Collection), one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS CASSIDARIA LAMARCK.

CASSIDARIA WASHINGTONIANA n. sp.

Plate III, Figure 28.

Description.—Shell large, thick, angulated, globularly ovate and profusely ornamented; whorls eight, upper three smooth and rounded; body whorl large; spire relatively short. On the spire are two very large revolving ribs or carinae which are set with tubercles or spines. The carinae form an upper and lower angle to the whorl; between these the surface is concave; above the upper angle the surface is flat and forms nearly a right angle with the surface of the central part of the whorl. Surface below the lower angle slightly concave and sloping downwards to the canal; on it are two less prominent revolving ribs carrying spines. Whorls of spire are similarly developed. Surface ornamented by eleven longitudinal ribs beginning at the suture and covering the whorl but less conspicuous on the lower portion of whorl. Surface crossed by nine prominent revolving ribs; the upper two situated on the angle of the whorl forming the carinae. Where these intersect the longitudinal ribs, nodes or spines are developed. Sometimes a third carinae is developed. Between each set of the large revolving ribs is one less prominent rib and on either side of that, two small re-

volving threads. Spire similarly ornamented. Suture distinct and slightly undulating. Inner lip expanded and with heavy callous covering the surface up to the upper angle of the body whorl; outer lip thick and crenulated; posterior sinus distinct but small; aperture broad and oval; canal broken.

Dimensions.—Altitude from broken end of spire 44 mm.; diameter 32 mm.; altitude of spire 13 mm.; angle of spire 98°.

Notes.—These specimens are beautifully preserved and in some cases show the original coloring.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS MORIO MONTF.

MORIO TUBERCULATUS, GABB, var. TRI-TUBERCULATUS n. var.

Plate III, Figure 35.

Description.—This form is undobutedly M. tuberculatus Gabb, as described in Vol. 1, Palaeontology of California, but there are certain variations from his original description which are constant on every specimen collected in Washington. Since the California and Washington localities are so widely separated and the material here so perfectly preserved it seems best to place this form on record as a variety. Gabb states that his figure is partially a restoration based on several fragments especially the aperture. Gabb's description is here quoted:

"Shell short, robust, thin; whorls seven, spire low. Surface marked by two, rarely three, rows of small tubercles; two bounding the widest portion of the volution, with a plane or slightly concave surface between them; the third, which occurs rarely, is placed below the others; besides these, the whole surface is ornamented by fine revolving striae. Aperture broad; outer lip thick, longitudinally striate externally, inner surface crenulate; columellar lip covered by a broad plate, plicate or crenulate anteriorly. Canal strongly recurved. A distinct

varix, nearly as large as the outer lip, occurs on the body whorl, and sometimes there is a smaller one on the penultimate volution. I have not always been able to detect the latter."

In the variety of tri-tuberculatus the whorls always carry three rows of tubercles (never only two). The varix on the body whorl is much smaller; canal much more strongly recurved than shown in Gabb's figure; columellar lip less extensively developed; aperture narrower. These variations are characteristic of all specimens collected.

Dimensions.—Altitude 24 mm.; diameter 17 mm.; altitude of spire 4 mm.; angle of spire 85°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS TRITONIUM LINK.

TRITONIUM SOPENAHENSIS n. sp.

Plate I, Figure 6.

Description.—Shell fusiform, small and robust; whorls seven and convex; spire moderately elevated. Surface ornamented by ten very prominent, narrow, rounded longitudinal ribs which extend over the whole surface of the shell except the very lowermost part of the body whorl. These ribs are crossed by twenty-one well defined, sinuous, equally spaced and developed revolving ribs with broad concave interspaces. Suture distinct, impressed and sinuous. Aperture subelliptical, narrow and prolonged as nearly closed canal anteriorly. Canal short and slightly bent backwards; inner lip smooth; outer lip crenulated within; varices few and small.

Dimensions.—Altitude 18 mm.; diameter 8 mm.; altitude of spire 7 mm.; angle of spire 58°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) in banks of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS RANELLA LAMARCK.

RANELLA WASHINGTONIANA n. sp.

Plate II, Figure 14.

Description.—Shell medium size and robust; spire moderately high; whorls seven to eight, angulated and convex, last two of apex being smooth and not sculptured; body whorl with pronounced revolving angle about one-fourth the length of the whorl down from the suture; surface between angle and suture nearly straight (occasionally slightly concave); surface below the angle broadly convex. Suture compressed, distinct but somewhat undulating; varices prominent, bladelike and continuous. In addition to the varices the surface is ornamented by nine distinct longitudinal ribs. These are crossed by seventeen prominent revolving lines. The one on the angle and the four immediately below it are set with sharp spine like nodes at the intersection with the longitudinal ribs. Surface above the angle sculptured by a very large number of fine revolving threads but no prominent revolving ribs. Between the more prominent revolving ribs below the angle there are numerous fine revolving threads. Aperture broad, sub-oval, narrowing at the posterior end; inner lip not heavily incrusted; canal short and not strongly recurved; outer lip thickened by the varix.

Dimensions.—Altitude 35 mm.; diameter 23 mm.; altitude of spire 17 mm.; angle of spire 60°.

Occurrence.—Very common at Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

RANELLA COWLITZENSIS n. sp.

Plate II, Figure 15, and Plate III, Figures 26, 27.

Description.—Shell small and robust; spire high; whorls six, convex and without any angle. Suture distinct and impressed. Varices very large and extending over all of the whorls. Surface sculptured by eight unequally developed longitudinal ribs

extending over the entire surface of the whorls. These are crossed on the body whorl by nine equally developed and equally spaced revolving ribs. Where these intersect the longitudinal ribs, low rounded nodes are developed, which are most conspicuous on the central part of the whorl. Between each of the revolving ribs there are four or five fine revolving threads. Aperture small, elliptical, equally acuminate above and below, anterior end forming a nearly closed canal which is short and strongly curved backwards. Inner lip very heavily incrusted; outer lip thick and crenulated.

Description.—Shell small, fusiform; spire moderately high; spire 12 mm.; angle of spire 40°.

Notes.—Specimens of this species are exceedingly well preserved.

Occurrence.—Very common at Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS NASSA MARTINI.

NASSA EOCENICA n. sp.

Plate III, Figure 32.

Description.—Shell small fusiform; spire moderately high; whorls eight and convex, last two on apex, smooth, rounded and without ornamentation; upper portion of each whorl surrounded by a deep depression, above which a low collar extends upward to the suture; suture distinct. Surface of shell ornamented by eighteen longitudinal ribs which are very distinct on the spire but faint in the body whorls; they begin at the suture and extend the length of the whorls with the exception of the body whorl where they disappear a short distance below the convex portion; body whorl sculptured by eleven very prominent revolving ribs; alternating with these are eleven less prominent revolving lines on either side of which is a fine but distinct revolving thread. Sculpture similar on the spire. Canal short and fairly strongly

recurved; aperture moderately narrow and tapering towards the end of the canal; inner lip slightly incrusted; outer lip crenulated.

Dimensions.—Altitude 18 mm.; diameter 10 mm.; altitude of spire 6 mm.; angle of spire 57°.

Occurrence.—Very common at Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

NASSA PACKARDI n. sp.

Plate III, Figure 34.

Description.—Shell small, short, fusiform; whorls five; suture distinct; body whorl very convex; upper surface below suture broadly grooved. Surface ornamented by twenty-five longitudinal ribs which extend from upper groove to base of whorl; these are crossed by sixteen equally spaced revolving ribs. Aperture broad, elliptical and evenly rounded. Canal short and not strongly recurved. Columella strongly incrusted.

Dimensions.—Altitude 15 mm.; diameter 9 mm.; altitude of spire 5 mm.; angle of spire 65°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS CHRYSODOMUS SWAINS.

CHRYSODOMUS CLALLAMENSIS n. sp.

Plate XV, Figure 136.

Description.—Shell of moderate size, sub-fusiform; spire moderately high; whorls seven, convex; body whorl regularly convex with very faint angulation a short distance below the suture; suture distinct and impressed. Surface ornamented with thirty very low revolving ribs between each pair of which

there is a very fine revolving thread; about twenty-five faint longitudinal ribs are present. This sculpture is present on all the whorls. Canal of medium length and somewhat bent backwards; inner lip incrusted; outer lip somewhat thickened; aperture broad.

Dimensions.—Altitude 37 mm.; diameter 18 mm.; altitude of spire 16 mm.; angle of spire 45°.

Occurrence.—At Loc. No. 105 (University of Washington Palaeontological Collection) at Slip Point just east of Clallam Bay, Clallam County.

Horizon.—Upper part of Lower Miocene.

GENUS HEMIFUSUS SWAINSON.

HEMIFUSUS SOPENAHENSIS n. sp.

Plate I, Figures 2, 3.

Description.—Shell large, robust, moderately elongate and convex; whorls seven to eight and very convex; suture undulating and fairly distinct; middle three-fifths of each whorl convex; upper part concave, then vertical to the suture; lower part slightly concave; upper or seventh whorl of shell smooth and rounded; other whorls highly ornamented. Surface ornamented by ten very prominent longitudinal ribs which extend over almost the whole shell, except a small area just below the suture; at the extreme lower portion of the body whorl they become somewhat obscure. Surface of body whorl up as far as the upper portion of the convex part sculptured by fifteen very prominent revolving ribs. Alternating with these is a less prominent rib, on either side of which is a fine raised thread. This sculpture extends to the end of the canal. Surface of the whorl above upper end of convex portion is sculptured by seven revolving ribs alternating with fine threads. At the intersection of the revolving lines and longitudinal ribs on the convex part of the shell, distinct, short spines are developed; sculpture of whorls on spire similar. Canal short and bent to the left. Anterior sinus fairly deep; inner lip smooth and calloused; outer lip smooth;

aperture large, semi-elliptical and extending to the end of the canal.

Dimensions.—Altitude 45 mm.; diameter 22 mm.; altitude of spire 15 mm.; angle of spire 45°.

Notes.—Exceedingly well preserved.

Occurrence.—Very common at Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

HEMIFUSUS COWLITZENSIS n. sp.

Plate I, Figures 1, 4.

Description.—Shell unequally fusiform, spire low, whorls five, the last always tri-carnate, the others with rounded carinae. Last two whorls forming the apex smooth and rounded. Whorls convex; portions between the carinae concave; that above the upper carina nearly straight and sloping up at a low angle to the suture; that below the lower carina very slightly concave. Surface of body whorl sculptured by three carinae which are crossed by twenty-six longitudinal ribs extending from the suture to the extreme lower end of the shell. Their intersections are marked by nodes or tubercles. Between the longitudinal ribs are lines of growth. Between the carinae above and below them are numerous distinct revolving threads; eight above the upper carina, eight between upper and middle carinae, seven between the middle and lower, and twenty-three on the surface below the lowest carina. On the lower surface every alternating thread is a little more distinct. Aperture generally broad and extending to the end of the canal; canal much longer than spire and slightly curved outwards; inner lip smooth and somewhat calloused; outer lip thin.

Dimensions.—Altitude 40 mm. and 32 mm.; diameter 22 mm. and 18 mm.; altitude of spire 5 mm and 3 mm.; angle of spire 65° and 61°.

Notes.—This species resembles somewhat *Fusu horni* Gabb but has a greater number of longitudinal ribs. Specimens are abundant and as well preserved as though living.

Occurrence.—Very common at Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

HEMIFUSUS LEWISIANA n. sp.

Plate I, Figure 9.

Description.—Shell of moderate size, elongate and fusiform; spire high and acute; whorls seven and rounded; upper two smooth with no ornamentation; body whorl convex; whorls of spire slightly convex and relatively long; suture distinct. Surface ornamented by eighteen fairly distinct longitudinal ribs which are more prominent on the spire than on body whorl; they become indistinct on lower surface of body whorl; these are crossed by nineteen distinct flat topped revolving ribs alternating with nineteen fine revolving threads. Aperture moderately large, relatively narrow; canal short and slightly deflected outwards; two indistinct plications are generally present; inner lip moderately calloused; outer lip thick and crenulated within.

Dimensions.—Altitude 25 mm.; diameter 10 mm.; altitude of spire 10 mm.; angle of spire 37°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

HEMIFUSUS WASHINGTONIANA n. sp.

Plate II, Figures 11, 12.

Description.—Shell of moderate size and fusiform; whorls eight, convex, and slightly angulated; body whorl concave above

angle; suture distinct and sinuous. Surface ornamented with thirteen longitudinal ribs which are most prominent on the middle portion of whorl. These are crossed by twenty distinct revolving ribs which are set with spiny nodes at the intersections with the longitudinal ribs. Alternating with each revolving rib is a revolving thread. Aperture moderately broad, somewhat elongated and continuing to end of canal. Canal straight and moderately long; inner lip smooth and calloused; outer lip thin.

Dimensions.—Altitude 29 mm.; diameter 15 mm.; altitude of spire 10 mm.; angle of spire 57°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

HEMIFUSUS TEJONENSIS n. sp.

Description.—Shell of moderate size, robust; spire moderately low; whorls seven and very slightly convex; upper portion of body whorl very slightly concave; suture not very distinct and slightly sinuous. Surface ornamented by fifteen fairly well developed longitudinal ribs which are most prominent on middle portion of whorl. They are not present on the extreme upper and lower portions. These ribs are crossed by eighteen prominent revolving ribs, alternating with as many minor revolving threads. Low nodes are present on middle six or seven revolving ribs at the intersections with the longitudinal ribs. Aperture moderately broad, acute at posterior and anterior ends; canal straight; inner lip smooth and much calloused; outer lip thin.

Dimensions.—Altitude 28 mm.; diameter 16 mm.; altitude of spire 7 mm.; angle of spire 63°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS BRACHYSPHINGUS GABB.

BRACHYSPHINGUS CLARKI n. sp.

Plate IV, Figure 38, and Plate VI, Figure 57.

Description.—Shell of moderate length, heavy and thick; spire moderately high (never as low as in *B. sinuatus* Gabb); body whorl very large; whorls of spire five and distinct (never hidden); suture linear and distinct; body whorl moderately convex with often a faint depression on the upper portion just below the suture. Surface smooth except for well developed sinuous lines of growth; no revolving ribs are present on any specimens examined. Aperture broad and long, and very deeply notched at the anterior end; a prominent fold extends from the upper part of this notch around lower part of whorl; inner lip thickly incrusted; outer lip thin.

Dimensions.—Altitude 34 mm.; diameter 18 mm.; altitude of spire 8 mm.; angle of spire 65°.

Locality.—At Loc. No. 5 (University of Washington Palaeontological Collection).

Horizon.—Tejon formation, Upper Eocene.

GENUS MUREX LINNAEUS.

MUREX SOPENAHENSIS n. sp.

Plate I, Figure 8.

Description.—Shell moderately large, heavy and somewhat spinose; spire moderately high; whorls nine and angular; body whorl with revolving angle at base of upper third of whorl; surface above this angle straight to slightly convex; surface below angle slightly convex. Surface sculptured by eight prominent revolving ribs below the angle and between each two there are three minor revolving threads; above the angle there are ten small, but well developed revolving threads. Varices are present but weakly developed. On the angle at the intersections with the varices are flattened or spinose nodes; sometimes these are present on the varices a short distance below the angle. Angle formed by upper and lower surfaces of the body whorl is 88°. Aperture broad and oval and narrowing a short distance from

anterior end of canal. Canal long and bent; inner lip smooth and calloused; outer lip moderately thin.

Dimensions.—Altitude to broken end 28 mm.; diameter 19 mm.; altitude of spire 11 mm.; angle of spire 63°.

Occurrence.—Common at Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

MUREX COWLITZENSIS n. sp.

Plate I, Figure 7.

Description.—Shell of moderate size, heavy and spinous; spire short; whorls six, angulated and with six varices continuous on all whorls; angle situated on upper third of body whorl; surface below angle very slightly concave; surface above straight and sloping upward at a low angle; angle between upper and lower surfaces of whorl 78°; suture impressed and distinct. Whorls of spire flattened. Surface ornamented with fifteen revolving ribs each of which is separated from the adjoining one by two very small closely set revolving striae. At the intersection of angle and varices large rough spines are developed. Aperture broad, oval, nearly closed at anterior end and extending nearly to the end of canal. Canal long, heavy and bent; inner lip heavily calloused; outer lip moderately thick.

Dimensions.—Altitude 40 mm.; diameter 28 mm.; altitude of spire 11 mm.; angle of spire 80°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS FUSUS LAMARCK.

FUSUS WASHINGTONIANA n. sp.

Plate II, Figure 10.

Description.—Shell moderately small; spire pagodaform and elongate; whorls eleven and very sharply angulated; body whorl with angle at lower half of middle third of surface. Surface above angle straight and sloping upwards at an angle of 45°; lower surface straight and sloping downwards making an angle with the upper surface of 100°; lower surface of whorls of spire straight and nearly horizontal. Surface ornamented with thirteen longitudinal ribs which are limited to flattened nodes on the angle and gradually disappear toward the suture; twenty-eight equally spaced revolving ribs are present. Suture distinct and undulating. Longitudinal lines of growth well developed. Canal long and straight; inner lip incrusted; outer lip thin.

Dimensions.—Altitude, apex to broken end of spire 25 mm.; diameter 13 mm.; altitude of spire 15 mm.; angle of spire 50°.

Notes.—This species is very well preserved and resembles very closely *F. pagodaformis* of the Clayborne of Alabama.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

FUSUS DICKERSONI n. sp.

Plate III, Figure 29, and Plate XIV, Figure 124.

Description.—Shell elongated, slender and fusiform; spire longer than aperture; whorls eleven, very slightly convex; suture very distinct, impressed and linear. Surface ornamented with fifteen prominent longitudinal ribs which extend over all the whorls; these are crossed by twenty-two revolving ribs on the body whorl; between these ribs are broad, deep, flat-bottomed interspaces. Aperture narrow; inner lip highly incrusted; outer lip thin. Canal moderately long.

Dimensions.—Altitude 45 mm.; diameter 9 mm.; altitude of spire 28 mm.; angle of spire 23°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

FUSUS LEWISENSIS n. sp.

Plate III, Figure 33.

Description.—Shell moderate in size, fusiform; whorls eight to nine and somewhat angulated; body whorl convex in middle portion; nearly straight above and sloping up steeply to the suture. Suture distinct and slightly sinuous. Surface ornamented by eleven not very distinct longitudinal ribs; these are most prominent on the convex portion of the surface; above the angle they are faint and disappear before reaching the suture; they are entirely absent from lower portion of body whorl; they are present on all whorls of spire. The longitudinal ribs are crossed by fifteen distinct revolving ribs, four of which on the convex part of whorl carry sharp spinose nodes; between each of the prominent ribs there are four or five less distinct revolving threads with broad deep interspaces. Aperture moderately broad; inner lip smooth and slightly calloused; outer lip smooth; canal moderately long and bent outwards.

Dimensions.—Altitude 28 mm.; diameter 13 mm.; altitude of spire 8 mm.; angle of spire 49°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS FASCIOLARIA LAMARCK.

FASCIOLARIA WASHINGTONIANA n. sp.

Plate I, Figure 5.

Description.—Shell moderately large, robust and turreted; spire high; whorls eight, angulated; angle situated at lower part of upper third of body whorl, concave above and concave to flat below. Surface ornamented by thirteen very distinct revolving ribs confined almost entirely to the angulated area where they exist as short spine-like nodes; twenty-five revolving ribs are present each of which is separated from the one next to it by a very small revolving thread; they all appear beaded, due to the intersections with the prominent lines of growth. Lines of growth are sinuous and above the angle curved to the right in accordance with the posterior sinus. Suture distinct and sinuous. Canal very narrow, angle in outer lip; columella slightly bent in advance with two very faint plications; inner lip calloused; outer lip thin.

Dimensions.—Altitude 44 mm.; diameter 22 mm.; altitude of spire 8 mm.; angle of spire 49°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County, Sec. 27, T. 11 N., R. 2 W.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS MITRA LAMARCK.

MITRA WASHINGTONIANA n. sp.

Plate II, Figure 16.

Description.—Shell very small, sub-fusiform and smooth; spire moderately long; whorls seven and very convex; body whorl regularly convex; suture distinct and moderately deep; surface sculptured by fine microscopic revolving threads and very fine closely set lines of growth. This sculpture is very indistinct with the unaided eye but can clearly be made out with a hand lens; the upper surface of each whorl immediately below the suture is set with minute, closely-spaced longitudinal

ribs which disappear a short distance below on the whorl. Aperture narrow, elongate, continuing but becoming very narrow at end of canal; canal short; inner lip somewhat incrusted and set with four oblique folds, the posterior of which are the larger.

Dimensions.—Altitude 12 mm.; diameter 5.5 mm.; altitude of spire 4.5 mm.; angle of spire 58°.

Occurrence.—Common at Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS ANCILLARIA LAMARCK.

ANCILLARIA BRETZI n. sp.

Plate II, Figure 21.

Description.—Shell small, robust; spire high; whorls seven, convex; suture distinct; just below the suture there is a small band formed by a grooving of the upper margin of whorl. Surface of shell sculptured with twenty-five longitudinal transverse ribs extending over the entire whorl from suture to plications; between each rib are five fine longitudinal threads; no revolving lines are present. Aperture broad; posterior end narrowing; anterior very wide; inner lip somewhat incrusted; columella with four plications; outer lip thin; anterior sinus deep.

Dimensions.—Altitude 15 mm.; diameter 8 mm.; altitude of spire 4 mm.; angle of spire 52°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS SURCULA H. AND A. ADAMS.

SURCULA COWLITZENSIS n. sp.

Plate III, Figures 30, 36, and Plate IX, Figure 86.

Description.—Shell slender, elongate, biconical and fusiform; length of spire equal to that of canal; whorls eleven and sharply

angulated; suture distinct, impressed and linear; surface below angle slightly convex, that above distinctly concave; surface of body whorl ornamented with fifteen longitudinal ribs which extend over whorls of spire; these entirely disappear just above the angle and a short distance below and form conspicuous nodes on the angle; there are sixteen equally spaced revolving ribs from base to angle and between each is a broad flat-bottomed interspace containing a fine revolving thread; in addition there are fine lines of growth which are sinuous and conform to the posterior sinus. Aperture narrow and elongate terminating in a long narrow canal; posterior end with deep sinus; inner lip smooth and incrusted; outer lip thin; canal long and straight.

Dimensions.—Altitude 45 mm.; diameter 7 mm.; altitude of spire 22 mm.; angle of spire 30°.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County.

Horizon.—Cowlitz formation, Upper Eocene.

GENUS CONUS LINNAEUS.

CONUS COWLITZENSIS n. sp.

Plate II, Figure 20.

Description.—Shell biconical; spire a little over one-fourth of total length; whorls seven and a half to eight, and very sharply angulated; upper two forming the apex are smooth and rounded; angle set with nodes. Body whorl conical below the angle; nearly flat above but sloping close to the suture making the upper surface of each whorl decidedly convex; eighteen very distinct nodes on the angle; these do not continue above or below as ribs; although blunt and rounded they are pointed slightly to the left. Surface marked by forty revolving lines below the angle which are more distinct toward base of whorl; portion of whorl above angle obscurely sculptured by revolving lines. Numerous faint lines of growth are present. Aperture linear and narrow, and extending to end of spire. The spire varies some-

what in length, but the upper surface of whorls are extremely convex.

Dimensions.—Altitude 38 mm.; diameter 15 mm.; altitude of spire 13 mm.; angle of spire 50°; angle of lower part of body whorl 33°.

Occurrence.—Common at Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County.

Horizon.—Cowlitz formation, Upper Eocene.

BRACHIOPODA.

GENUS RHYNCONELLA FISCHER.

RHYNCONELLA WASHINGTONIANA n. sp.

Plate V, Figures 44, 45.

Description.—Shell sub-circular medium size, thin and very slightly longer than wide; hinge line narrow and situated at middle of shell; dorsal valve evenly convex, sub-circular with no trace of medial fold; ventral valve with same convexity as dorsal; sinus distinct; margin sloping down at an angle of 40° from beak; base arcuate; beak prominent, incurved. Sculptured with about thirty radiating ribs, many of which are dichotomous; these are crossed by numerous concentric lines of growth; medial groove fairly distinct, but not deep; more pronounced towards basal margin.

Dimensions.—Ventral valve, altitude 20 mm.; longitude 17 mm.; thickness 2.5 mm. Dorsal valve, altitude 18 mm.; longitude 18 mm.; thickness 2.5 mm.

Occurrence.—At Loc. No. 1 (University of Washington Palaeontological Collection) one and one-half miles east of Sopenah (Little Falls) in bank of Cowlitz River, Lewis County.

Horizon.—Cowlitz formation, Upper Eocene.

MIOCENE SPECIES.

PELECYPODA.

GENUS LEDA SCHUMACHER.

LEDA CHEHALISENSIS n. sp.

Plate XII, Figures 104, 105.

Description.—Shell small, moderately convex, equivalve and nearly equilateral; beaks slightly elevated and curved forwards; lunule very large; cordate elongate and fairly deeply impressed; escutcheon long and narrow; anterior margin of shell concave, at first sloping steeply for a short distance from the beaks, and then straight to the anterior end; anterior end bluntly truncated upward; base broadly rounded; posterior margin very slightly convex and sloping downwards at a low angle; posterior end acutely rounded. Sculptured by equally spaced closely set concentric ribs with deeply grooved interspaces equal in width to the ribs.

Dimensions.—Altitude 10 mm.; longitude 15 mm.; thickness 3.5 mm.

Occurrence.—At Loc. No. 63, in northwest quarter of Section 28, T. 17 N., R. 17 W.

Horizon.—Chehalis formation, upper part of Lower Miocene.

GENUS YOLDIA MOLLER.

YOLDIA SAMMAMISHENSIS n. sp.

Plate XIII, Figure 106.

Description.—Shell thin, moderately compressed, equivalve, slightly inequilateral. Anterior end slightly longer than posterior; anterior margin slopes slightly upwards from the beak, then bends rather sharply, passes broadly around the anterior end and slopes at 45° to the base. Basal margin straight for some distance and then slopes upward at 20° and finally is obliquely truncated upwards at the posterior end; posterior margin slopes down 45° from beak and then extends at an angle of 15° to the posterior end; posterior end slightly bent. Beaks low and directed posteriorly. Surface ornamented by moderately coarse to fine evenly spaced concentric ridges. There

are nineteen posterior hinge teeth, anterior number undeterminable.

Dimensions.—Longitude 60 mm.; altitude 32 mm.; diameter 9 mm.

Occurrence.—Occurs in the basal Miocene overlying the Puget [Eocene] sandstones, two miles northeast of Issaquah, King County.

Horizon.—Blakeley formation, Lower Miocene.

GENUS PECTEN MULLER.

PECTEN PORTERENSIS n. sp.

Plate VIII, Figures 70, 72.

Description.—Shell slightly higher than long, inequivalve, equilateral. Margins somewhat serrate, base rounded; sides sloping above; sides considerably concave above, the posterior being more so than the anterior; right valve with twenty nearly equal slightly rounded radiating ribs, which are always dichotomous and often trichotomous, and begin so about 40 mm. from the beak; interspaces unequal, nearly twice as broad as the ribs and always ornamented by at least one auxiliary rib which begins near the beak and often attains at least one-half the size of the regular ribs. The four anterior interradials are strongly imbricated or crenulated. Whole surface ornamented by very fine concentric striations; ears subequal; anterior ear with six radials and moderately fine concentric lines; byssal notch very pronounced; posterior ear with eight radials, strongly crenulated and truncated by a convex curve.

Dimensions.—Longitude 86 mm.; altitude 100 mm.; diameter 23 mm.

Occurrence.—In the sandstones overlying the basalt, one mile west of Oakville, Chehalis County, in Northern Pacific railroad cut.

Horizon.—Blakeley formation, Lower Miocene.

PECTEN ALOCKAMANENSIS n. sp.

Plate XIII, Figure 115.

Description.—Shell small, much higher than long, equivalve, equilateral; sides straight and sloping regularly at an angle of 50° from the beak; base regularly rounded; left valve has 13 or 14 equally rounded ribs which are not sulcated; interspaces are flat-bottomed and slightly wider than the radiating ribs. Surface ornamented with fine incremental lines; anterior ear about one-third longer than posterior; byssal area moderately deep; posterior ear truncated and both ornamented by fine concentric lines.

Dimensions.—Longitude 18 mm.; altitude 24 mm.; diameter 3 mm.

Occurrence.—Common at Loc. No. 54 (University of Washington Palaeontological Collection) near the head of Alockaman River, Cowlitz County, in Sec. 2, T. 9 N., R. 5 W.

Horizon.—Near base of Wahkiakum formation, Lower Miocene.

GENUS MYTILUS LINNAEUS.

MYTILUS SAMMAMISHENSIS n. sp.

Plate XIII, Figure 111.

Description.—Shell small, moderately thick, elongate; left valve larger than right; beaks small, terminal; anterior margin nearly straight with an upward slope for some distance from the beaks and then broadly rounded to the posterior end; basal margin nearly straight but curving slightly toward the beak. Shell thickest about one-third distance up from the base, sloping sharply to the base and gradually to the anterior margin. Surface ornamented by numerous faint concentric striations and a few irregular lines of growth. Still possesses dark coloration.

Dimensions.—Longitude 30 mm.; altitude 17 mm.; diameter 8 mm.

Occurrence.—Occurs abundantly two miles northeast of Issaquah, King County, in the lower part of the Blakeley formation. Loc. No. —— (University of Washington Palaeontological Collection).

Horizon.—Lower Blakeley formation, Lower Miocene.

MYTILUS STILLAGUAMISHENSIS n. sp.

Description.—Shell large, thick, elongated; beaks terminal and not prominent; anterior margin broadly arcuate, basal margin nearly straight but in some specimens slightly concave; posterior end sharply rounded; greatest thickness of the shell about one-fourth the distance up from the base. Surface sloping steeply to the base and gradually to the anterior margin; surface ornamented by faint concentric lines of growth.

Dimensions.—Longitude 90 mm.; altitude 37 mm.; diameter 28 mm.

Occurrence.—Occurs abundantly in the sandstones in the banks of the Stillaguamish River about four miles northwest of the town of Granite Falls, Snohomish County.

Horizon.—Blakeley formation, Lower Miocene.

MYTILUS SNOHOMISHENSIS n. sp.

Plate XIII, Figure 110.

Description.—Shell small, moderately thick, elongate, narrow; beaks terminal and small; dorsal slope arcuate with a pronounced angle about one-third distance from the beak; base straight or very slightly concave; posterior end sharply rounded. Surface convex, sloping at a lower angle to the dorsal area and steeply to the base; ornamented by fine concentric striae and irregular lines of growth.

Dimensions.—Longitude 33 mm.; altitude 15 mm.; diameter 7 mm.

Occurrence.—Common at Fiddler's Bluff, three miles south of Snohomish City, Snohomish County. Loc. No. 228 (University of Washington Palaeontological Collection).

Horizon.—Blakeley formation, Lower Miocene.

GENUS VENERICARDIA LAMARCK.

VENERICARDIA CHEHALISENSIS n. sp.

Plate XII, Figures 101, 102, and Plate XV, Figures 133, 137.

Description.—Shell robust, thick, sub-triangular, equivalve and inequilateral; beaks not especially prominent for the genus

with anteriorly recurved umbones; lunule very small, cordate; escutcheon absent; anterior margin very slightly concave and slopes at about 45° to anterior end where it rounds and merges into the base, which slopes at an angle of 40° to the posterior end, when it curves sharply upwards; posterior margin slopes gently at first from the beak for a short distance and then drops decidedly to the posterior end. Surface ornamented by twenty equally spaced radiating rounded, fairly well marked ribs; the interspaces are not deep and are nearly as wide as the ribs. These are crossed by numerous well developed concentric lines of growth. Hinge plate large; muscular scars very pronounced; palial line distinct and about one-sixth the distance of shell from margin.

Dimensions.—Longitude 23 mm.; altitude 28 mm.; diameter 10 mm.

Occurrence.—One of the most common species in the Chehalis formation. Two miles southwest of Montesano.

Horizon.—Chehalis formation, upper part of Lower Miocene.

GENUS CHIONE MEGERLE.

CHIONE CHEHALISENSIS n. sp.

Plate VIII, Figure 71.

Description.—Shell large, sub-trigonal, very inequilateral, very thick, equivalve; beaks elevated, situated at the anterior fourth of the shell, medium sized and pointing anteriorly; lunule short, cordate and strongly impressed; escutcheon large and elongate but not very well defined; posterior margin rounded and gradually sloping from the beaks until it becomes vertical; it is sharply flexed where it joins the basal margin. Basal margin evenly arcuate and sharply inclined upward to the anterior end. Anterior end slopes down abruptly from the beaks and then slopes about 40° to the anterior end; posterior portion of shell curved around broadly so as to form an angle of 110° bringing the real posterior margin 10 mm. anterior to the axis of the fold. Surface sculptured with about eighty rounded radial ribs which show up prominently as the outer surface of the shell

becomes worn. The anterior twenty and the posterior twelve ribs are very fine and closely set, the medial forty-eight are about 1 mm. broad and 1 mm. apart, and more pronounced toward the base than towards the beak. These are crossed by numerous irregularly spaced crenate concentric lamellae.

Dimensions.—Longitude 65 mm.; altitude 65 mm.; diameter 33 mm.

Notes.—This species occurs with *Chione securis*, but differs from it in its sub-trigonal form, pronounced in-bending of posterior end, thickness and escutcheon.

Occurrence.—Common at Loc. No. 46 (University of Washington Palaeontological Collection) about one-half way between Montesano and Aberdeen on the south side of the Chehalis River, in Chehalis County.

Horizon.—Montesano formation, lower part of Upper Miocene.

CHIONE MONTESANOENSIS n. sp.

Plate XII, Figures 95, 97, 103.

Description.—Shell small, sub-angular to rounded, moderately thick, inequilateral, equivalve; lunule cordate, concentrically striated, projecting along the medial line and surrounded by a moderately deep groove. No escutcheon observed; beaks moderately high. Posterior dorsal margin nearly straight excepting just behind the beak where it is slightly concave. It slopes downwards at an angle of 45° and then drops nearly vertical and merges into the evenly rounded base; anterior margin slopes steeply from the beak and then flares out and is slightly truncated at the anterior end, where it gently curves and merges into the basal margin. Surface sculptured by numerous concentric ridges evenly spaced and nearly equally developed from the beak to the base; these ridges are crossed by twenty-eight prominent radiating ribs which are equally developed from the beak to the base; at the posterior end of the shell these ribs are narrow; in the center and on the posterior portion of the shell they are broad with deep narrow grooves

between them. The beak is sculptured as well as the surface of the shell. Hinge with three cardinal teeth and one obscure posterior lateral; muscular scars prominent; palial line distinct with a small triangular sinus only extending into the shell about 4 mm.

Dimensions.—Longitude 25 mm.; altitude 18 mm.; diameter 8 mm.

Notes.—C. *Montesanoensis* is most closely related to C. *bisculpta* Dall, but may be distinguished from it by the difference in the sculpture which does not vary in a large number of unworn specimens, in the smaller size of the palial sinus and in the greater altitude compared with length. It is common in the conglomerate of the Montesano formation.

Occurrence.—Occurs abundantly at Loc. No. 68 (University of Washington Palaeontological Collection) in the Montesano conglomerate on Sylvia Creek about six miles north of Montesano, Chehalis County.

Horizon.—Montesano formation, lower part of Upper Miocene.

CHIONE CATHCARTENSIS n. sp.

Plate X, Figure 79.

Description.—Shell of moderate size, subtriangular, thick and very inequilateral; beaks situated a distance of one-sixth of the length of the shell from the anterior end, and strongly inclined forwards; anterior margin slightly concave and sloping downwards at an angle of 65°; anterior end very acutely rounded; posterior margin arcuate from beak to posterior end, where it forms a sharp angle with the base which slopes up decidedly to the anterior end and gradually to the posterior; sharp angular ridge extending from beak to posterior end and situated just in front of posterior margin; surface sculptured by numerous well developed roughened concentric lines of growth; lunule moderately large but not much impressed.

Dimensions.—Altitude 33 mm.; longitude 44 mm.; thickness 10 mm.

Occurrence.—At Loc. N. 228 (University of Washington Palaeontological Collection) at Fiddler Bluff, Cathcart, in Northern Pacific Railway cut.

Horizon.—Blakeley formation, Lower Miocene.

GENUS MARCIA ADAMS.

MARCIA OREGONENSIS CONRAD.

Plate XII, Figure 96.

This species is very common in the Lincoln and Blakeley formations. It varies somewhat in shape but the specimen figured in this report is most characteristic and was collected from the Lincoln shales in southern Thurston County. It ranges up into the Wahkiakum and Chehalis formations but is not especially common.

GENUS TELLINA LINNAEUS.

TELLINA MERRIAMI n. sp.

Plates IX, X, XIII, Figures 74, 81.

Description.—Shell elongate, attenuated posteriorly, compressed slightly, inequivalve and nearly equilateral; surface smooth; beaks low, curved slightly forward; anterior margin very slightly convex and sloping at an angle of 15° which increases to 30° near the anterior end, which terminates in a sharp angle and is evenly rounded; posterior margin slopes from beak at an angle of about 40° with a very slight convexity midway between beak and posterior end; posterior end abruptly truncated; basal margin a broad regularly curved line excepting just anterior to the posterior end, when it is very slightly concave; posterior surface of right valve flexed, making an angle of about 125° and forming a ridge from the beak to posterior extremity; an obscure groove extends from beak to posterior end of basal margin. Surface sculptured by fine concentric incremental lines and near the margin a few prominent lines of interrupted growth.

Dimensions.—Longitude 48 mm.; altitude 28 mm.; diameter 7 mm.

Notes.—*T. merriami* is very close to *T. kincaidi* but may be distinguished by the more central position of the beaks, the more attenuated posterior end and the more pronounced folding of the posterior margin. It occurs with *T. kincaidi* in the conglomerate of the Montesano formation.

Occurrence.—Occurs at Loc. No. 68 (University of Washington Palaeontological Collection) in the basal conglomerate of the Montesano formation on Sylvia Creek, six miles north of the town of Montesano, in Chehalis County.

Horizon.—Montesano formation, lower part of Upper Miocene.

TELLINA KINCAIDI n. sp.

Plate X, Figure 82.

Description.—Shell elongate, sub-oval, moderately narrow, compressed, inequilateral, slightly inequivalve, attenuated anteriorly; beaks low and situated about one-third the distance from the posterior end of shell. Anterior dorsal margin of shell nearly straight and sloping downward to anterior end of shell at an angle of about 15°. At the anterior end it is sharply angulated and sharply curved to the basal margin which is nearly straight except near posterior end, where it is slightly incurved, due to the minor flexing of the valve. Posterior margin is slightly convex and slopes at an angle of 65° from beak to posterior end of shell where it forms a sharp angle of 60° with the base. Posterior margin sharply bent inwards forming a prominent ridge from beak to base; just anterior to this ridge is an obscure groove more prominent near base. Surface sculptured by numerous fine concentric incremental lines irregularly spaced and occasional lines of growth.

Dimensions.—Longitude 52 mm.; latitude 30 mm.; diameter 7 mm.

Notes.—This form is common in the conglomerate at the base of the Montesano formation and is generally fairly well preserved. It is named in honor of Prof. Trevor Kincaid of the Department of Zoology at the University of Washington.

Occurrence.—Occurs at Loc. No. 68 (University of Washington Palaeontological Collection) in the basal conglomerate of the Montesano formation on Sylvia Creek, six miles north of the town of Montesano, in Chehalis County.

Horizon.—Montesano formation, lower part of Upper Miocene.

GENUS MACOMA LEACH.

MACOMA MONTESANOENSIS n. sp.

Plate X, Figure 80.

Description.—Shell large, sub-oval to rounded triangular, inequilateral, slightly inequivalve; valves moderately convex, concentrically sculptured; beaks low, small, situated nearly medial, but in some specimens slightly posterior to middle. The anterior dorsal margin slopes gently at an angle of about 15° for a short distance, then curves more steeply; anterior end evenly rounded; posterior dorsal margin very slightly concave, sloping at an angle of 45° to the posterior end where it is sharply truncated; ventral margin regularly curved. On the right valve a sharp ridge, forming an angle of 75° to 80° extends from the beak to the posterior extremity; immediately in front of this there is a very slight obscure fold more noticeable near the margin. A very faint ridge is noticeable along the anterior margin. Surface sculptured by numerous impressed incremental lines somewhat irregularly distributed. Interior inaccessible.

Dimensions.—Longitude 68 mm.; altitude 50 mm.; diameter of right valve 10 mm.

Notes.—*M. montesanoensis* resembles *M. piercei* Arnold, but can be distinguished from it by its more trigonal shape, the greater slope of the posterior margin, the convexity of the posterior margin, the more posterior position of the beak and the sculpture. It is fairly abundant in a fine conglomerate at the base of the Montesano formation on Slyvia Creek, six miles north of the town of Montesano in Chehalis County. It has been found only at Locality No. 68 (University of Washington Palaeontological Collection).

Horizon.—Montesano formation, Upper Miocene.

MACOMA SNOHOMISHENSIS n. sp.

Plate XIII, Figure 109.

Description.—Shell small, thin, decidedly inequilateral, slightly inequivalve, attenuated posteriorly. Surface smooth and sculptured with fine concentric lines; beaks small, low and situated near the anterior end; posterior margin straight and slopes at an angle of 15°; posterior end evenly rounded; basal margin nearly straight. Anterior margin short and slopes down 45° from the beak and then slopes gradually around the anterior end and merges with the base.

Dimensions.—Longitude 23 mm.; altitude 12 mm.; diameter of entire shell 8 mm. (4 mm. for each valve).

Occurrence.—Common at Fiddler's Bluff, 3 miles south of Snohomish, Snohomish County. Locality No. 228 (University of Washington Palaeontological Collection).

Horizon.—Blakeley formation, Lower Miocene.

MACOMA WYNOOTCHEENSIS n. sp.

Plate XV, Figures 128, 129, 130.

Description.—Shell of moderate size, thin, equivalve, inequilateral; beaks small and situated about two-fifths the length of shell from anterior end. Anterior margin slightly concave and sloping downward at an angle of 37°, obliquely truncated at anterior end; base broadly rounded; posterior margin straight and sloping at an angle of 18° to anterior end, which is acutely rounded. Surface sculptured by close set fine concentric lines of growth.

Dimensions.—Altitude 37 mm.; longitude 50 mm.; thickness of both valves 14 mm.

Occurrence.—At Loc. No. 131 (University of Washington Palaeontological Collection) at a point one mile west of the town of Montesano on logging road cut.

Horizon.—Chehalis formation, upper part of Lower Miocene.

GENUS SEMELE SCHUMARCK.

SEMELE MONTESANOENSIS n. sp.

Plate XII, Figures 98, 99.

Description.—Shell medium sized, sub-quadrate, inequilateral, equivalve, and moderately inflated; beaks somewhat prominent, pointing forwards and situated about two-thirds distance from the anterior end. Posterior margin slopes nearly straight at an angle of about 50° from beak to a point about two-thirds the distance up from the base, where it is truncated at the posterior end; base broadly rounded; anterior margin slopes down sharply from the beak for a very short distance and slopes off at a lower angle for about 6 mm. and then passes as a broad curve around the anterior end where it merges with the base. Surface ornamented with well defined concentric lines of growth. Shell material moderately thin and interior of right valve showing cardinal and lateral teeth fairly well developed; palial line distinct.

Dimensions.—Longitude 29 mm.; altitude 24 mm.; diameter 8 mm.

Occurrence.—This species is very common at Loc. No. 68 (University of Washington Palaeontological Collection) on Sylvia Creek, six miles above town of Montesano, Chehalis County.

Horizon.—Montesano formation, Upper Miocene.

SEMELE SYLVIAENSIS n. sp.

Plate XII, Figure 100.

Description.—Shell moderately large, nearly as high as long, sub-equivalve, nearly equilateral, sub-oval and moderately thick; beaks not very prominent and pointing slightly forwards, and situated nearly central. Anterior margin sloping downwards about 45° just in front of beaks and then sloping gradually downwards at 30° to the anterior end, which is truncated and then rounds off into the base. Base regularly rounded; posterior margin slightly convex and sloping about 45° to posterior end,

which is sharply rounded. Surface ornamented by fairly well developed concentric lines of growth.

Dimensions.—Longitude 33 mm.; altitude 29 mm.; diameter 9 mm.

Occurrence.—Common at Loc. No. 68 (University of Washington Palaeontological Collection) in conglomerate on Sylvia Creek, six miles north of Montesano, Chehalis County.

Horizon.—Montesano formation, Upper Miocene.

GENUS PSEUDOCARDIUM GABB.

PSEUDOCARDIUM GABBI REMOND var. ALTUS n. var.

Plate VII, Figure 69.

Description.—This variety is large, somewhat compressed; beaks moderately high but not especially prominent for the genus. Anterior and posterior margins have steep slopes, the latter being more pronounced. The altitude is much greater in proportion to the longitude than in the case of the other varities.

Dimensions.—Longitude 75 mm.; altitude 78 mm.; diameter 30 mm.

Occurrence.—Common in the uppermost Montesano massive sandstone about two miles northwest of Elma, Chehalis County, Loc. No. 61 (University of Washington Palaeontological Collection).

Horizon.—Montesano formation, Upper Miocene.

PSEUDOCARDIUM GABBI REMOND var. ELONGATUS n. var.

Plate X, Figure 78.

Description.—This variety differs from variety *altus* in its relatively greater length and thickness. It might seem best to regard them as the same, but out of a large number of specimens they can be distinctly separated and do not show gradations from one to the other. They occur at a definite horizon in the same formation and can be used for stratigraphic purposes.

Dimensions.—Longitude 73 mm.; altitude 55 mm.; diameter 34 mm.

Occurrence.—Six miles northeast of Satsop, Chehalis County.

Horizon.—Upper Monterey formation, Upper Miocene.

PSEUDOCARDIUM GABBI REMOND var. ROBUSTUM n. var.

Plate VII, Figure 68.

Description.—A line passed from the beak along the outer surface of the shell to the base forms a nearly perfect semicircle; just back of the anterior margin of the shell a prominent ridge occurs on this point; about two thirds distance from the beak is a blunt protuberance or shoulder; a less marked one occurs on the posterior margin.

Dimensions.—Longitude 80 mm.; altitude 70 mm.; diameter 35 mm.

Occurrence.—Two miles northeast of Satsop, Chehalis County.

Horizon.—Montesano formation, Upper Miocene.

PSEUDOCARDIUM GABBI REMOND var. UNDILIFERUM n. var.

Plate IX, Figure 76.

Description.—Shell typically small, anterior margin slightly convex with a slope of 60°; posterior margin nearly straight with slope of 45°; posterior surface of shell undulatory because of broad groove extending from beak to margin. These characters are constant and do not seem to grade into the other varieties. Several hundred specimens from the same locality show these characteristics.

Dimensions.—Longitude 50 mm.; altitude 40 mm.; diameter 20 mm.

Occurrence.—Common in the basal Montesano conglomerate on Sylvia Creek, six miles north of Montesano, Chehalis County, Loc. No. 68 (University of Washington Palaeontological Collection).

Horizon.—Montesano formation, lower part of Upper Miocene.

PSEUDOCARDIUM LANDESI n. sp.

Plate IX, Figure 75.

Description.—Shell thick, equivalve, nearly equilateral; anterior and posterior margins sloping steeply and at about same angle; base evenly rounded; beaks prominent and pointing

slightly forwards; escutcheon narrow but fairly well defined. Surface ornamented with heavy concentric lines of growth; hinge moderately heavy.

Dimensions.—Longitude 45 mm.; altitude 53 mm.; diameter 25 mm.

Occurrence.—Occurs fairly abundant in the conglomerate at the base of the Montesano formation, six miles north of Montesano, Chehalis County, Loc. No. 68 (University of Washington Palaeontological Collection).

Horizon.—Montesano formation, lower part of Upper Miocene.

GENUS CRYPTOMYA CONRAD.

CRYPTOMYA WASHINGTONIANA n. sp.

Plate XIII, Figure 114.

Description.—Shell small, slightly inequilateral, inequivalve, beaks small; posterior margin sloping abruptly for a very short distance and then nearly straight at an angle of 45° until it drops off nearly vertical to the posterior end; base evenly arcuate. Anterior margin straight and slopes at about 20° to the anterior end which is regularly rounded and merges into the base. Surface ornamented by fairly well developed concentric lines of growth.

Dimensions.—Longitude 31 mm.; altitude 24 mm.; diameter 5 mm.

Occurrence.—Common at Loc. No. 68 (University of Washington Palaeontological Collection) on Sylvia Creek, six miles north of Montesano, Chehalis County.

Horizon.—Montesano formation, Upper Miocene.

GASTEROPODA.

GENUS TURRIS BOLTEN.

TURRIS WYNOOTCHEENSIS n. sp.

Plate XI, Figures 87, 88, 89, 94.

Description.—Shell large with eight whorls; each whorl sharply angulated by a carina near the upper portion; surface of body whorl below angle convex, above very concave; it slopes

at a sharp angle from the carina and then just below the suture abruptly bends and extends outward to the suture where it terminates in a very narrow band or cord; the surface of each whorl of the spire below the carina is nearly flat and nearly vertical; the surface above the carina is similar to the body whorl; the carina is crossed with ribs, producing fourteen sharp nodes which entirely disappear on the surface immediately above the carina as well as within 2 mm. below it, except on the whorls of the spire where they extend down to the suture; transverse sculpture consists of numerous spiral threads which are much more pronounced on the surface of the whorl below the carina than above; on body whorl, below carina, there are fourteen evenly spaced major threads; midway between each of these is a less prominent thread and on each side of this a minor thread; above the carina up to the suture the same sculpture prevails, only less prominent; axial sculpture consists of numerous lines of growth conforming to the posterior sinus whose angle is above the carina. Inner lip smooth and calloused; outer lip smooth; aperture moderately broad. Extreme end of canal broken in every specimen but tending to bend slightly outwards. Older specimens relatively more elongate.

Dimensions.—Altitude 35 mm. and 60 mm.; diameter 17 mm. and 25 mm.; elevation of spire 14 mm. and 22 mm. Angle of spire 52° and 38°.

Occurrence.—Common at Loc. No. 31 (University of Washington Palaeontological Collection) in the shales about one mile west of town of Montesano, Chehalis County.

Horizon.—Chehalis formation, upper part of Lower Miocene.

GENUS CHLOROSTOMA SWAINS.

CHLOROSTOMA ARNOLDI n. sp.

Plate VI, Figure 62.

Description.—Shell very small; spire low, whorls five; suture distinct and impressed; body whorl flattened; convex above; sharply angulated and flat below; sculptured by five distinct revolving ribs on upper surface and set with nodes; between these

ribs the interspaces are broad and concave; under surface similarly sculptured.

Dimensions.—Altitude 9 mm.; diameter 13 mm.; altitude of spire 4 mm.; angle of spire 110°.

Locality.—No. 160 (University of Washington Palaeontological Collection) at Porter Bluff, Chehalis County.

Horizon.—Blakeley formation, Lower Miocene.

GENUS CALIOSTOMA SWAINS.

CALIOSTOMA DELAZINENSIS n. sp.

Plate VI, Figures 59, 60, 61, 63.

Description.—Shell small, largest specimens not over 12 mm. in altitude, conical; whorls six, convex; body whorl with upper surface very slightly convex and sloping up to suture at an angle of 45°; lower surface broadly convex and nearly horizontal; sculpture on body whorl with eight prominent revolving ribs above the angle and ten below, all equally spaced; lines of growth fairly well marked; on some specimens these ribs are very slightly nodose, but it is not characteristic. Interspaces concave, smooth and contain no revolving thread. Sculpture of spire similar to body whorl. Suture distinct and impressed; aperture sub-oval; inner lip smooth; outer lip thin.

Dimensions.—Altitude 13 mm.; diameter 20 mm.; altitude of spire 8 mm.; angle of spire 80°.

Locality.—Six miles up Delazine Creek, Chehalis County, in T. 17 N., R. 6 W., Sec. 20. Loc. No. 44 (University of Washington Palaeontological Collection).

Horizon.—Blakeley formation, Lower Miocene.

GENUS TURRITELLA LAMARCK.

TURRITELLA BLAKELEYENSIS n. sp.

Plate XI, Figure 85, and Plate VI, Figures 64, 67.

Description.—Shell elongated; whorls twelve and flattened to slightly concave; suture impressed; just above the suture is one small revolving rib; above that a deep groove; then the surface slopes outwards and upwards forming an angle; on this

angle are one or two large revolving ribs; the remainder of the surface up to the suture is flat to concave and sculptured with five not very distinct revolving ribs; aperture sub-oval.

Dimensions.—Altitude 65 mm.; width of base 16 mm.; angle of spire 14°.

Occurrence.—At Loc. No. 13 (University of Washington Palaeontological Collection) at Restoration Point, Kitsap County, on north side of Point.

Horizon.—Near top of Blakeley formation, Lower Miocene.

TURRITELLA PORTERENSIS n. sp.

Plate XI, Figures 83, 84.

Description.—Shell of moderate size, elongated, sub-conical; whorls ten to twelve, convex; suture impressed; the lower third of each whorl is broadly angulated; there are three revolving ribs on the angulated area; above this convex angulated portion of the whorl the surface slopes decidedly upwards; it is flat to slightly concave; near the suture the upper portion of whorls become decidedly impressed; at the base of each whorl is a deep wide unsculptured groove; aperture ovoid, broadly rounded below; inner lip incrusted; outer lip simple.

Dimensions.—Altitude 34 mm.; width of body whorl 10.5 mm.; angle of spire 19°.

Occurrence.—Very common at Loc. No. 160 (University of Washington Palaeontological Collection) in the bluff along Northern Pacific Railroad track at Porter, Chehalis County.

Horizon.—Blakeley formation, Lower Miocene.

GENUS GYRINEUM LINK.

GYRINEUM SYLVIAENSIS n. sp.

Plate XIV, Figure 126.

Description.—Shell large, moderately elongated, with six rounded whorls; suture distinct; four continuous rounded lateral varices, which are very distinct, on the body whorl and the first whorl of the spire; on the remaining whorls they are obscure; between each of the varices there are four distinct broad rounded

ribs extending from suture to suture over the body whorl and all of the whorls of the spire; interspaces equally developed (about two-thirds the width of the ribs and concave); canal moderately short and curved. On the specimen figured it is broken; aperture obscured. Surface of body whorl sculptured by 23 broad nearly flat topped revolving ribs separated by moderately deep grooves each of which contains a smaller intermediate riblet; the same sculpture occurs on each whorl of the spire.

Dimensions.—Altitude of figured specimen from base of broken canal 56 mm.; maximum diameter 30 mm.; elevation of spire 20 mm.; angle of spire 30 mm.

Occurrence.—Occurs at Loc. No. 68 (University of Washington Palaeontological Collection) in basal conglomerate of Montesano formation on Sylvia Creek, six miles north of Montesano, Chehalis County.

Horizon.—Blakeley formation, Upper Miocene.

GENUS FICUS CONRAD.

FICUS CLALLAMENSIS n. sp.

Plate IX, Figure 73.

Description.—Shell large, subpyroform, robust, sub-angulated; top of body whorl flattened, and very slightly convex; upper part of whorl sharply angulated, angle about 125°, and carries a series of thirteen unequally spaced nodes which are more or less flattened towards the outer lip; interspaces between the nodes equal in width to the nodes; these nodes die out a short distance above the angle as well as below; an obscure lower angle occurs but carries no nodes; spire very low but rises as a distinct cone above the nearly level upper surface of the body whorl; whorls four; surface of body whorl ornamented with fourteen widely spaced but not very prominent revolving ribs, four of which are above the row of nodes and ten below; interspaces broad and flat with no additional ribs. Surface of shell crossed by numerous very fine lines of growth. Aperture broad and canal short.

Dimensions.—Altitude of shell 90 mm. from broken portion of canal; latitude 75 mm.; altitude of body whorl from broken portion of canal 83 mm.; altitude of spire above body whorl 6 mm.

Occurrence.—At Loc. No. 107 (University of Washington Palaeontological Collection). Slip Point, just east of Clallam on the Strait of Juan de Fuca.

Horizon.—Upper part of Lower Miocene.

GENUS NASSA MARTINI.

NASSA ANDERSONI n. sp.

Plate VI, Figure 56.

Description.—Shell small and symmetrical; spire moderately high; body whorl somewhat inflated; surface of body whorl evenly convex; suture distinct; linear and slightly impressed; aperture elliptical to oval; columella very short and sharply bent backwards with a distinct, though not especially deep, sulcus; inner lip incrusted; outer lip with well developed varix. Surface sculptured with especially well developed longitudinal and revolving ribs; body whorl with twenty-two equally developed and equally spaced longitudinal ribs, crossed by eight equally spaced and equally developed flat topped revolving ribs with flat-bottomed interspaces of double width; these are equally prominent between the longitudinal ribs as well as upon them.

Dimensions.—Altitude 9 mm.; diameter 4.5 mm.; altitude of spire 4 mm.; angle of spire 50°.

Occurrence.—At Loc. No. 117 (University of Washington Palaeontological Collection) from middle fork of Wishkah River, in Sec. 31, R. 8 W., T. 20 N.

Horizon.—Chehalis formation, upper part of Lower Miocene.

GENUS CUMA HUMPH.

CUMA BIPLICTA var. QUADRANODOSUM n. var.

Plate XI, Figures 91, 92, 93, and Plate XIV, Figure 122.

Description.—Shell small, thick, with five angulated, sculptured whorls; the two whorls of apex rounded and smooth; each

of the remaining whorls has its upper portion terminating in a collar set with nodes agreeing in number with those on the body of the whorl; body whorl convex in center, straight or very slightly concave above the center and just below the collar. Same true on lower two whorls of spire. Spire moderately low; on the surface are sixteen to eighteen axial ribs which extend down to the base of the body whorl although less distinct than on the center; they do not extend up to the collar but reappear as nodes on the rim of the collar. These are crossed by eleven or twelve smaller revolving ribs which are closely set on the lower part of whorl, but more widely spaced on convex portion where their intersection with axial ribs produces nodes. In over 100 specimens examined there are always four nodes to each axial rib on the convex part of whorl and 16 to 18 rows. Spire moderately low; suture distinct; canal short; slightly bent with two plications; inner lip heavily calloused, extending up to central part of convex portion of shell; outer lip thin; aperture broad.

Dimensions.—Altitude 32.5 mm.; diameter 22 mm.; elevation of spire 6 mm.; angle of spire 70°.

Occurrence.—Loc. No. 57 (University of Washington Palaeontological Collection) up branch of Wilson Creek, Sec. 36, T. 10 N., R. 6 W., Wahkiakum County.

Horizon.—Wahkiakum formation, Lower Miocene.

GENUS FUSUS LAMARCK.

FUSUS MONTESANOENSIS n. sp.

Plate VI, Figure 58.

Description.—Shell large, solid, with six rounded whorls; suture distinct and slightly appressed; apex acute; body whorl plump with four faint but distinct angles, the upper one being most pronounced; spirally sculptured by five major revolving ribs between each of which are four or five less distinct ribs; about 13 or 14 faint varices cross the whorls and appear especially on the angles of the whorls of the spire as nodes. They are not very prominent on the body whorl. In addition there

are numerous barely noticeable fine incremental lines; aperture moderately wide; canal long and nearly straight. Some of these specimens retain their original coloring.

Dimensions.—Altitude of specimen 60 mm.; maximum diameter 37 mm.; apical angle 35°.

Occurrence.—At Station No. 68 (University of Washington Palaeontological Collection) in the basal conglomerates of Montesano formation on Sylvia Creek about six miles north of Montesano, Chehalis County.

Horizon.—Montesano formation, Upper Miocene.

GENUS PLEUROTOMA LAMARCK.

PLEUROTOMA CHEHALISENSIS n. sp.

Plate XI, Figure 90.

Description.—Shell moderately large, slender, fusiform; apex acute, whorls nine, nodose, spirally sculptured and distinctly angulated; surface of whorls above angle flat to concave; lower surfaces flat in whorls of spire but decidedly concave on body whorl; an obscure angle occurs on lower part of body whorl; on the angle of the body whorl there are 18 not very well developed nodes which disappear immediately above and below the angle, with interspaces of about twice their width. On the whorls of the spire they keep becoming more pronounced and extend as ridges from the angles down to the suture and range in number from 10 to 14. These nodes do not, however, extend on the surface from the angle up to the suture. Surface of all the whorls is ornamented by numerous clearly defined regularly alternating major and minor raised revolving lines; posterior sinus well developed; surface of all whorls crossed by numerous bowing incremental lines which conform to the posterior sinus; inner lip smooth, extreme end of canal broken, but apparently nearly straight; aperture elliptical; angle of spire 40°.

Dimensions.—Altitude from end of spire to broken end of canal 44 mm.; restored length 52 mm.; latitude 20 mm.; length of spire 25 mm.

Occurrence.—At Station No. 31 (University of Washington Palaeontological Collection) in sandy shale one-half mile west of Lincoln Creek Station, Thurston County, in railway cut.

Horizon.—Lincoln formation, Oligocene.

PLEUROTOMA WASHINGTONIANA n. sp.

Plate III, Figure 31.

Description.—Shell small, slender, apex acute; whorls 7 to 8, distinctly angulated and nodose; lower surface of whorl slightly convex; upper surface concave; surface of body whorl sculptured by ten distinct revolving ribs all of which are confined to the angulated ridge and the surface below it. Three obscure ribs appear above in some specimens; of those occurring below three are stronger than the remainder; angular ridge of body whorl set with 16 nodes which also occur on all whorls of spire; surface of shell strongly sculptured with incremental lines which are undulating and correspond to the sharply incised posterior sinus; apex of sinus above angular ridge. Canal moderately long and nearly straight with one faint plication; inner lip smooth; outer lip thin; aperture narrow, and elongate.

Dimensions.—Altitude to broken end of canal 28 mm.; diameter 10 mm.; elevation of spire 16 mm.; angle of spire 20°.

Occurrence.—At Loc. No. 90 (University of Washington Palaeontological Collection) in bluff one-half mile west of Porter, Chehalis County, along railway track.

Horizon.—Blakeley formation, Lower Miocene.

GENUS DRILLIA GRAY.

DRILLIA CHEHALISENSIS n. sp.

Plate VI, Figures 65, 66.

Description.—Shell large, slender, fusiform; apex acute; whorls 9 or 10, angulated, very slightly concave above the angle, slightly convex below the angle on the body whorl, but approximately straight on the whorls of the spire; suture distinct, appressed. Ten well defined wave-like ridges cross each whorl at the angle forming nodes; above the angle these twist to the right and dwindle away half way to the suture; below the angle

they twist downwards to the left for a very short distance and disappear. Body whorl sculptured by 30 rounded, well defined, equally developed revolving lines; between each of these are one and sometimes two minor revolving lines. This ornamentation is also characteristic of the spire. Canal long and twisted outward; inner lip smooth and heavily incrusted with callous. Outer lip sharp; posterior sinus fairly well marked; aperture elongate and elliptical; surface ornamented by numerous lines of growth corresponding in curvature to the posterior sinus; angle of spire 25°.

Dimensions.—Altitude 80 mm. and 75 mm.; diameter 25 mm. and 22 mm.; length of spire 39 mm. and 37 mm.

Occurrence.—Very common and characteristic at Porter; Loc. No. 160 (University of Washington Palaeontological Collection) and Port Blakeley Loc. No. 13.

Horizon.—Blakeley formation, Lower Miocene.

SCAPHAPODA.

GENUS DENTALIUM LINNAEUS.

DENTALIUM PORTERENSIS n. sp.

Plate XIII, Figure 113.

Description.—Shell large, slightly curved; angle of divergence 9° to 14°; cross section circular; shell substance very thick in both young and old specimens; surface nearly smooth but showing about 35 very faint longitudinal lines; maximum diameter 9 mm.

Occurrence.—At Loc. No. 90—about one-half mile west of Porter on bluff on north side of Chehalis River, Chehalis County.

Horizon.—Blakeley formation, Lower Miocene.

BRACHIOPODA.

GENUS TEREBRATULA KLEIN.

TEREBRATULA OAKVILLEENSIS n. sp.

Plate XIII, Figure 107.

Description.—Shell medium sized, elongate; posterior valve thin, beak small and moderately incurved; greatest width about

two-fifths the length of the shell from posterior end; above this the margins of shell taper sharply and evenly to the beak; anterior end very evenly and broadly rounded; dorsal valve thin but slightly more convex than the ventral. There is no distinguishable fold on the dorsal, nor sinus on the ventral valve. Surface of both valves ornamented by numerous very fine concentric striae. There are no radiating ribs.

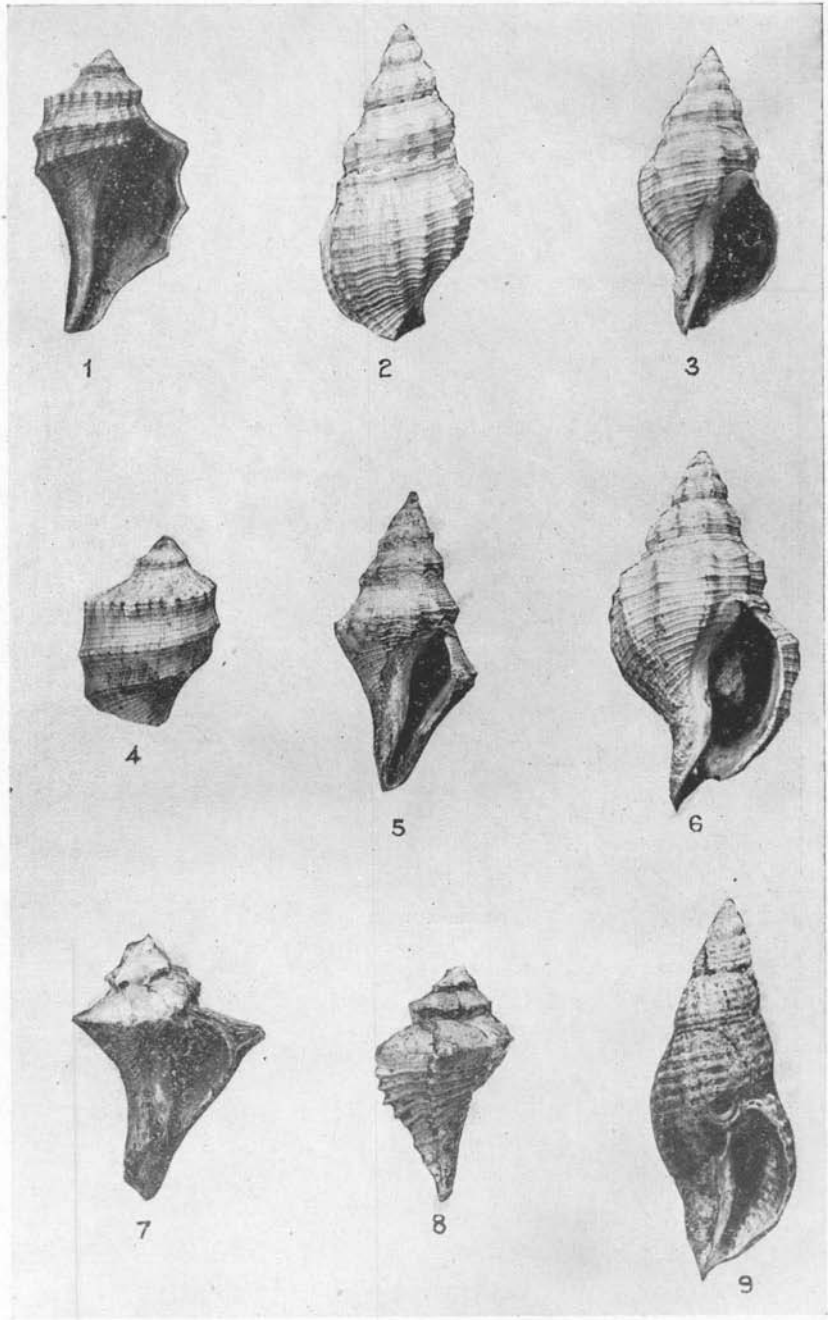
Occurrence.—From Station No. — (University of Washington Palaeontological Collection) about one mile west of Oakville on Northern Pacific track, in sandstone overlying basalt.

Horizon.—Blakeley formation, Lower Miocene.

ARTHROPODA.

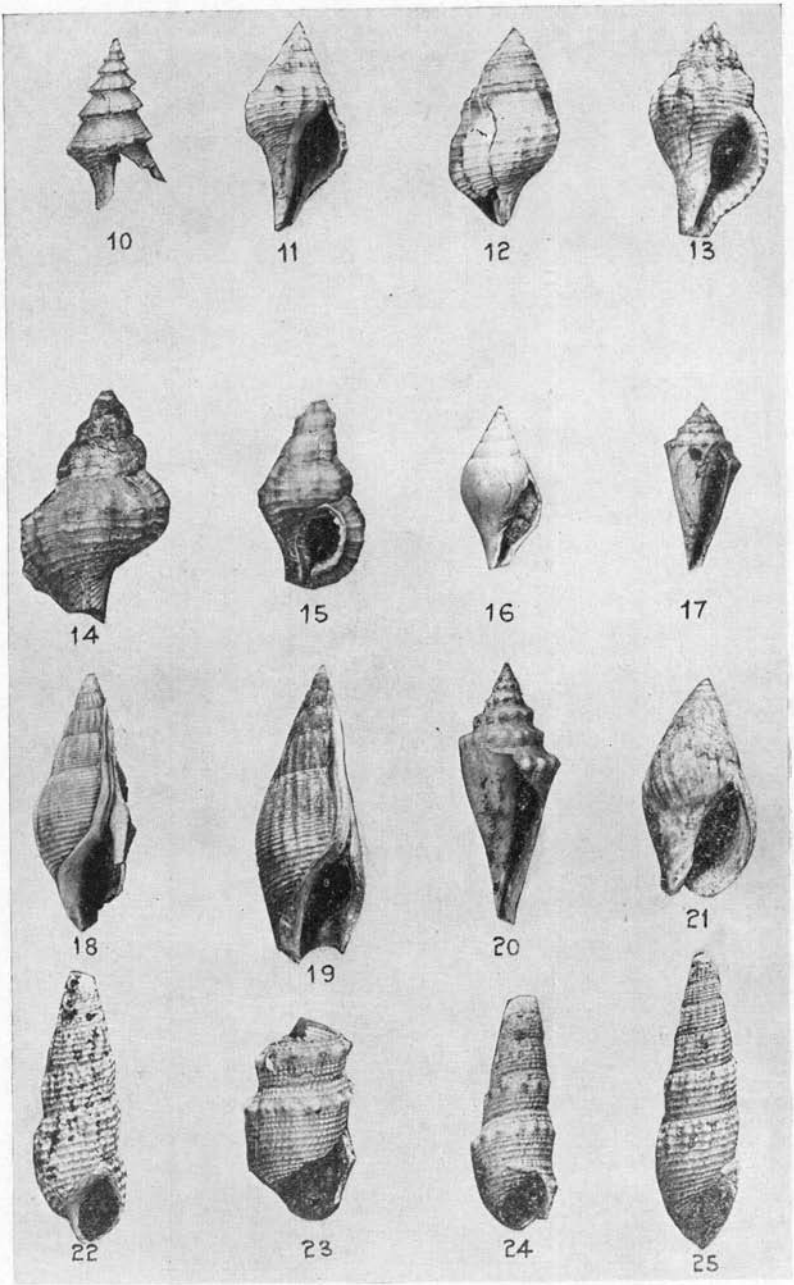
CRUSTACEA.

Certain portions of the Blakeley formation are characterized by hard flinty semi-calcareous concretions which, when cracked open nearly always contain the fossil remains of crabs. Many of these are well preserved. They occur most abundantly in the shale bluffs at Porter, Chehalis County and in the northern part of Pacific County, north of the town of Menlo.



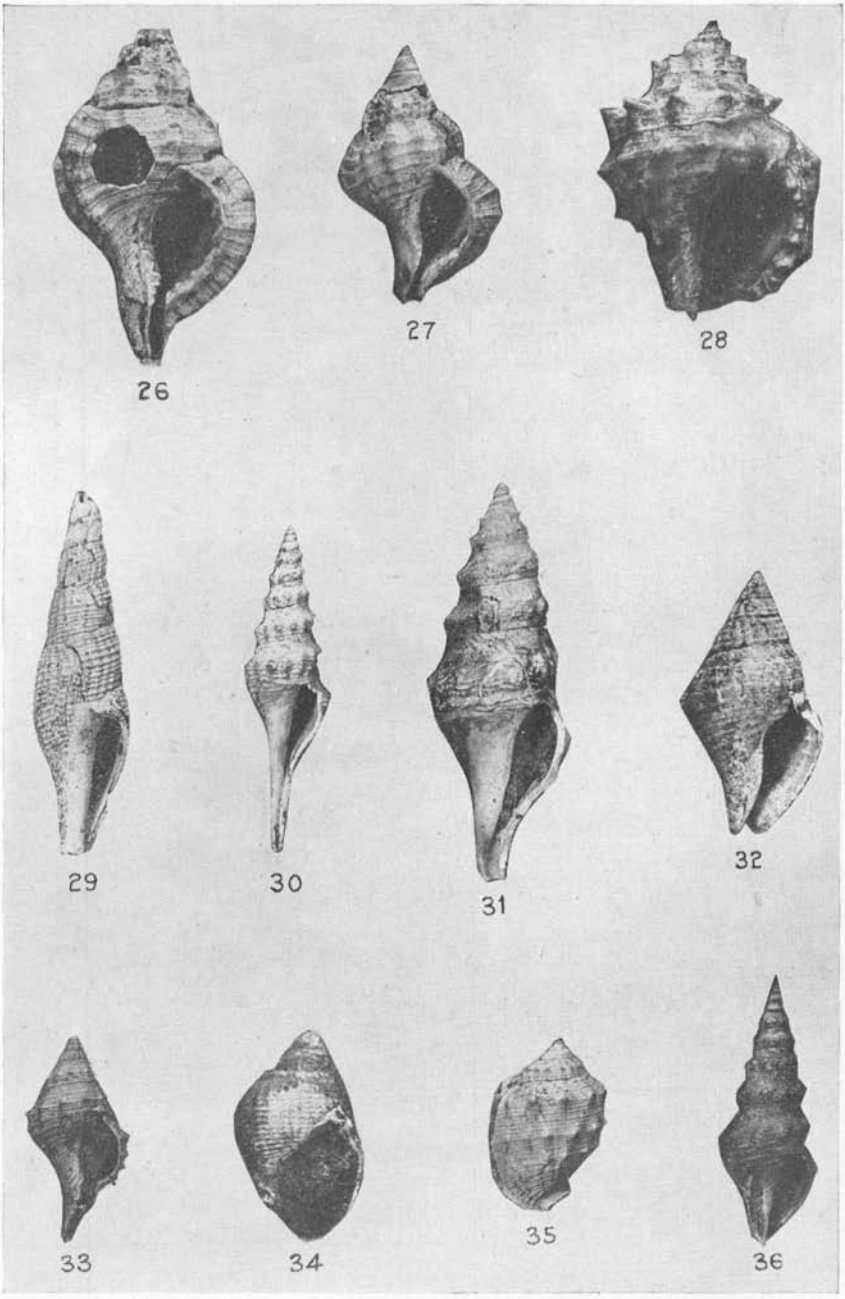
1. Hamifusus cowlitzensis.
2. Hemifusus sopenahensis.
3. Hemifusus sopenahensis.
4. Hemifusus cowlitzensis.
5. Fasciolaria washingtoniana.
6. Tritonium sopenahensis.
7. Murex cowlitzensis.
8. Murex sopenahensis.
9. Hemifusus lewisiana.

(All new species.)

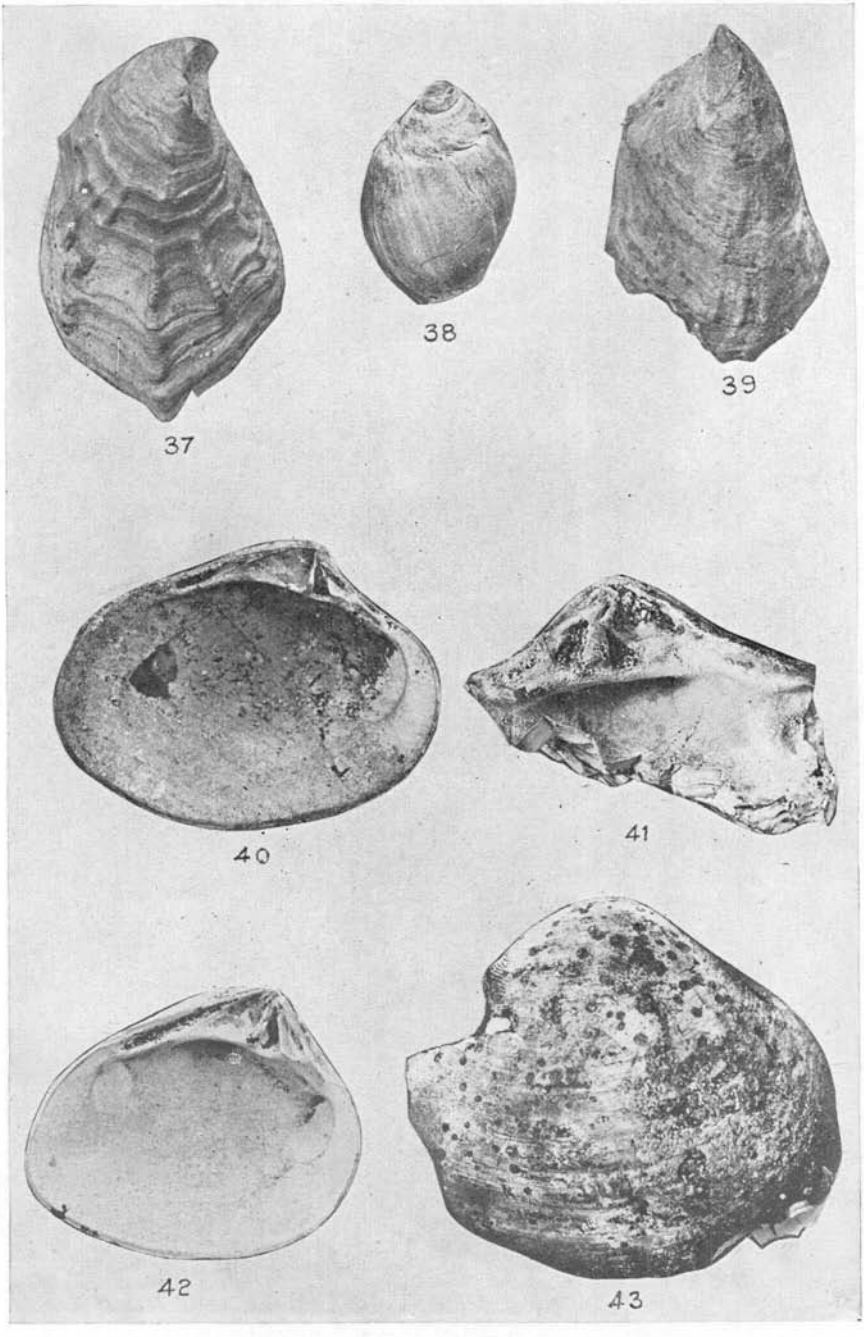


10. Fusus washingtoniana.
11. Hemifusus washingtoniana.
12. Hemifusus washingtoniana.
13. Hemifusus.
14. Ranella washingtoniana.
15. Ranella cowlitzensis.
16. Mitra washingtoniana.
17. Conus horni Gabb.
18. Rimella canalifera Gabb, var. elongata n. var.
19. Rimella canalifera Gabb, var. elongata n. var.
20. Conus cowlitzensis.
21. Ancillaria bretzi.
22. Potamides lewisiana.
23. Potamides fettkei.
24. Potamides fettkei.
25. Potamides lewisiana.

(All new species.)

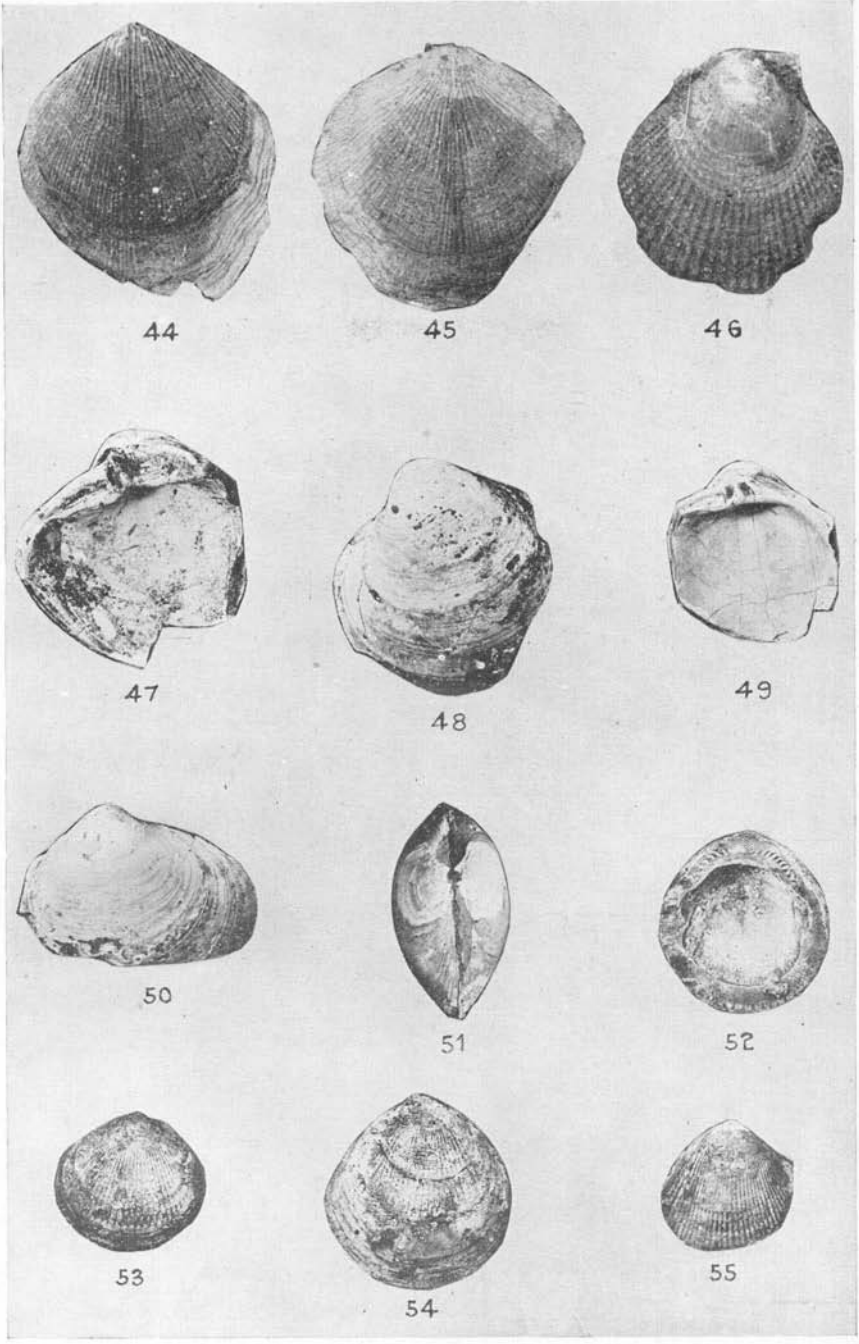


26. Ranella cowlitzensis.
27. Ranella cowlitzensis.
28. Cassidaria washingtoniana.
29. Fusus dickersoni.
30. Surcula cowlitzensis.
31. Pleurotoma washingtoniana.
32. Nassa eocenica.
(Enlarged twice.)
33. Fusus lewisensis.
34. Nassa packardi. (Enlarged twice.)
35. Morio tuberculatus Gabb, var. tri-tuberculatus.
36. Surcula cowlitzensis.
(All new species.)



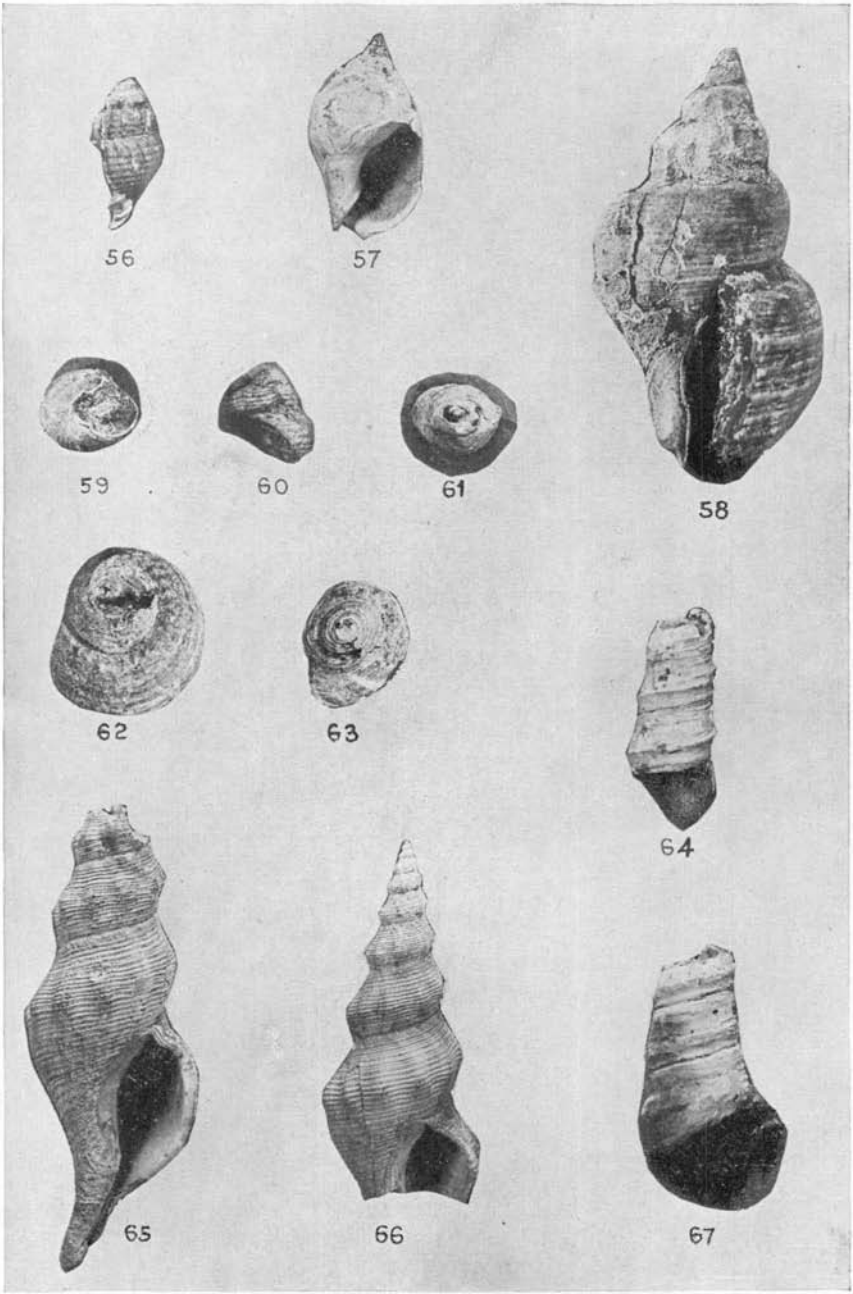
37. Ostrea fettkei.
38. Brachysphingus charki.
39. Ostrea fettkei.
40. Crassatellites cowlitzensis.
41. Meretrix landesi.
42. Crassatellites washingtoniana.
43. Meretrix landesi.

(All new species.)



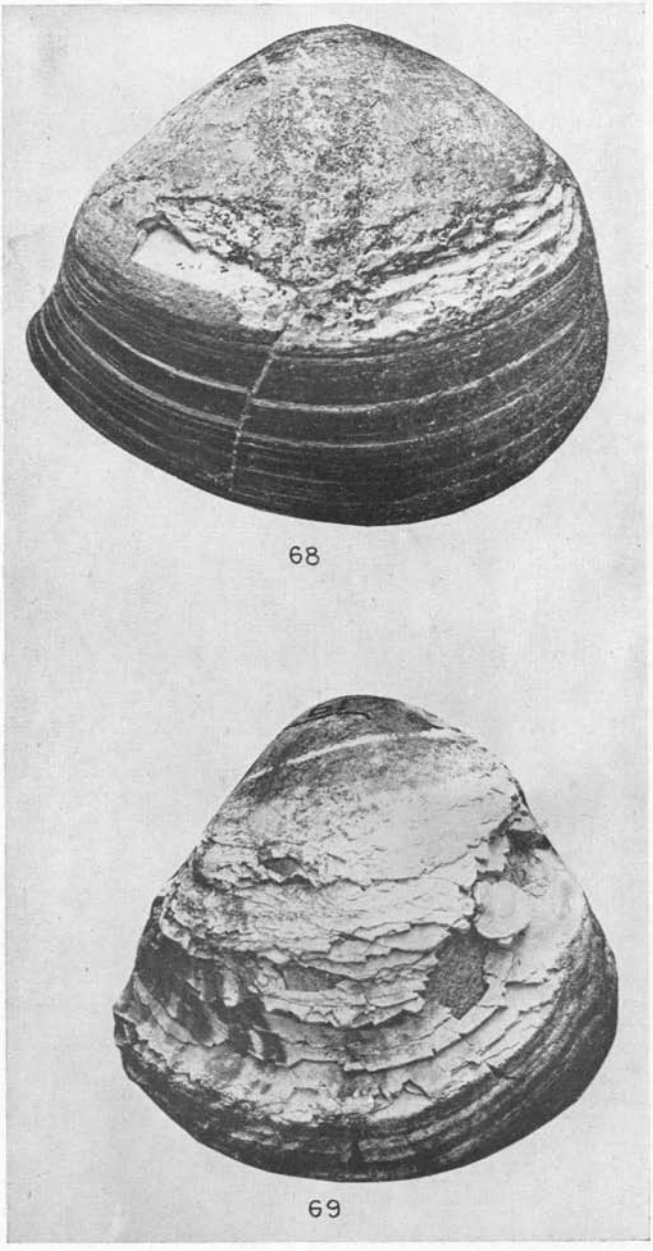
44. Rhynconella washingtoniana.
45. Rhynconella washingtoniana.
46. Pecten cowlitzensis.
47. Meretrix olequahensis.
48. Meretrix olequahensis.
49. Meretrix olequahensis.
50. Meretrix olequahensis.
51. Crassatellites washingtoniana.
52. Pectunculus eocenica. (Natural Size.)
53. Pectunculus eocenica. (Natural Size.)
54. Pectunculus eocenica, var. landesi n. var. (Natural Size.)
55. Cardium olequahensis. (Natural Size.)

(All new species.)



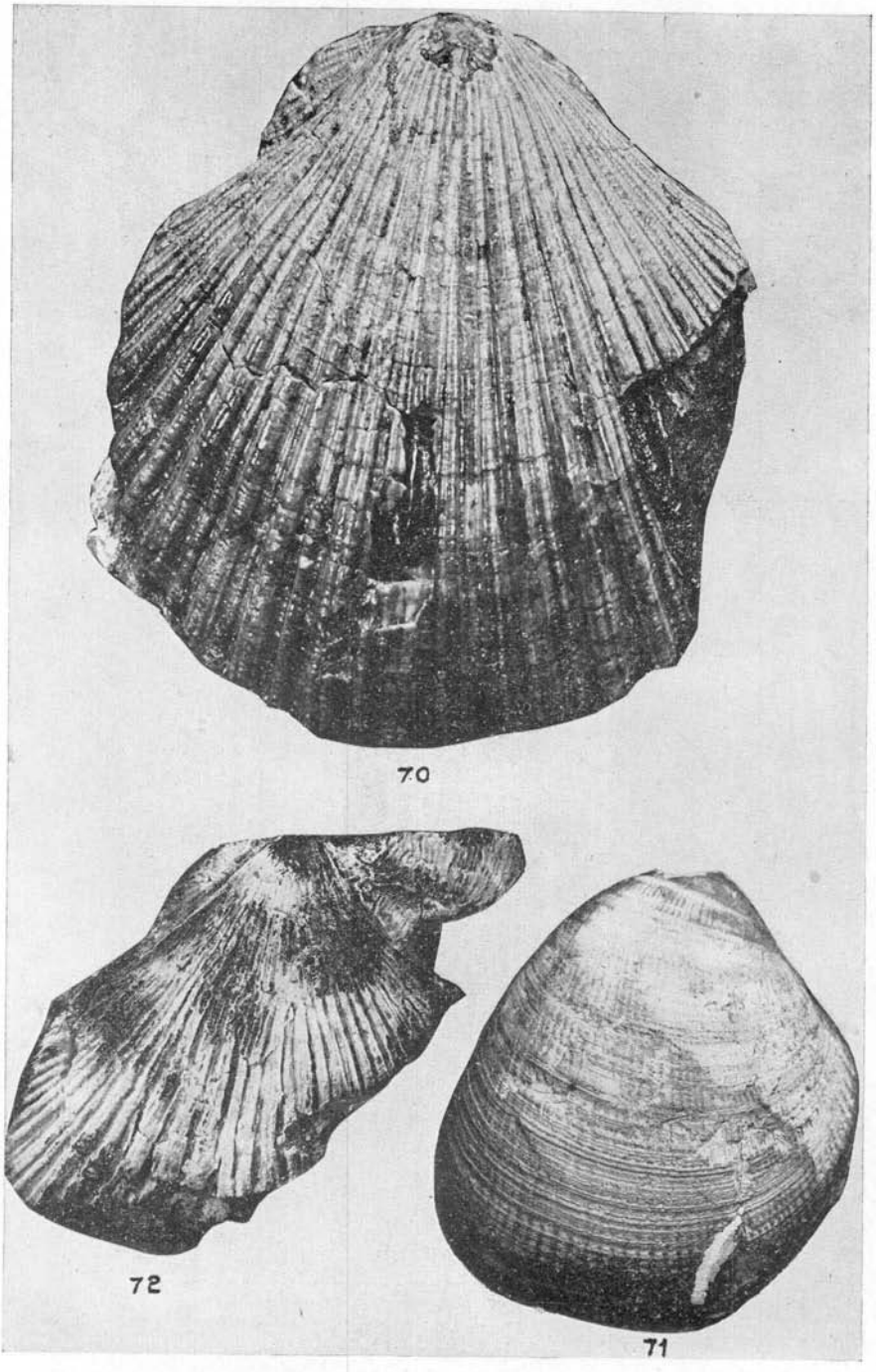
56. Nassa andersoni. (Enlarged twice.)
57. Brachysphingus clarkii.
58. Fusus montesanoensis.
59. Caliostoma delazinensis.
60. Caliostoma delazinensis.
61. Caliostoma delazinensis.
62. Chlorostoma arnoldi.
63. Caliostoma delazinensis.
64. Turritella blakeleyensis.
65. Drillia chehalisensis.
66. Drillia chehalisensis.
67. Turritella blakeleyensis.

(All new species.)



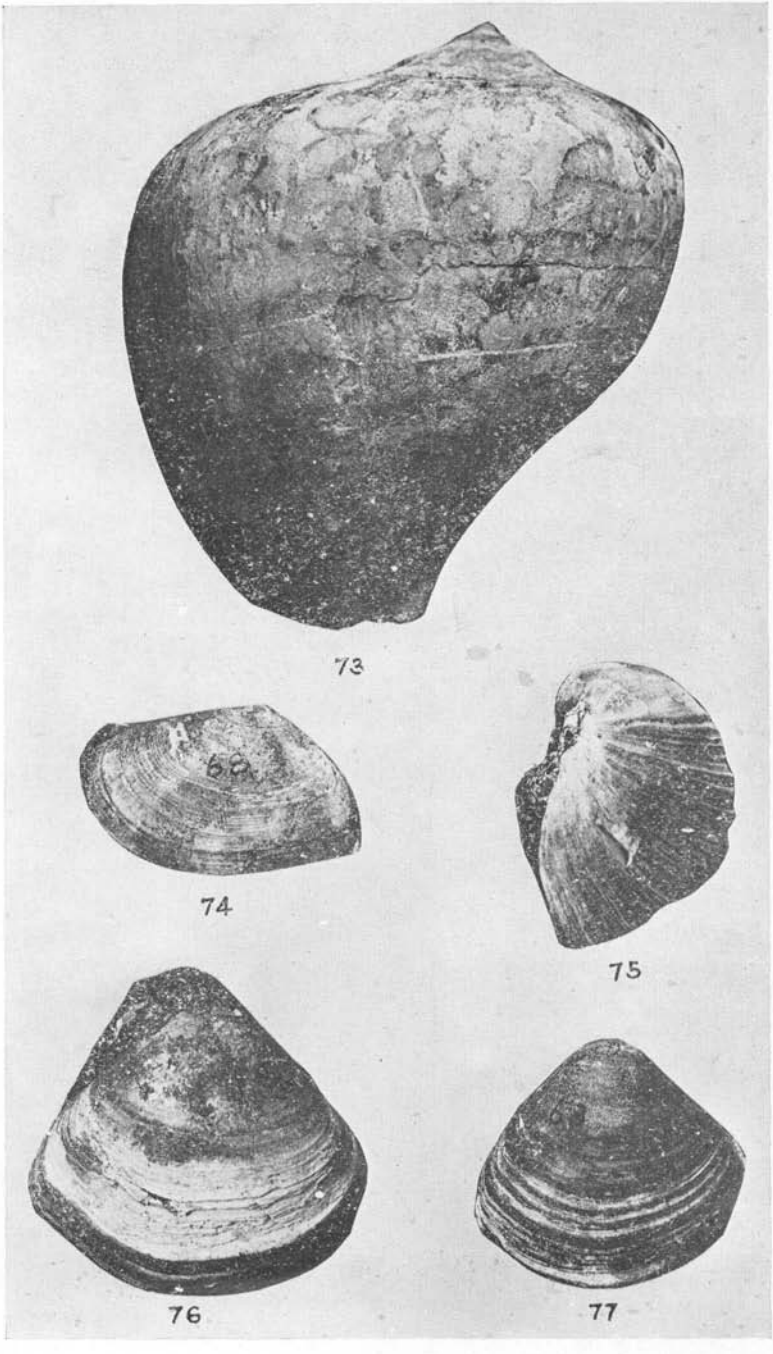
68. Pseudocardium gabbi Remond var. robustum.
69. Pseudocardium gabbi Remond var. altus.

(New varieties.)

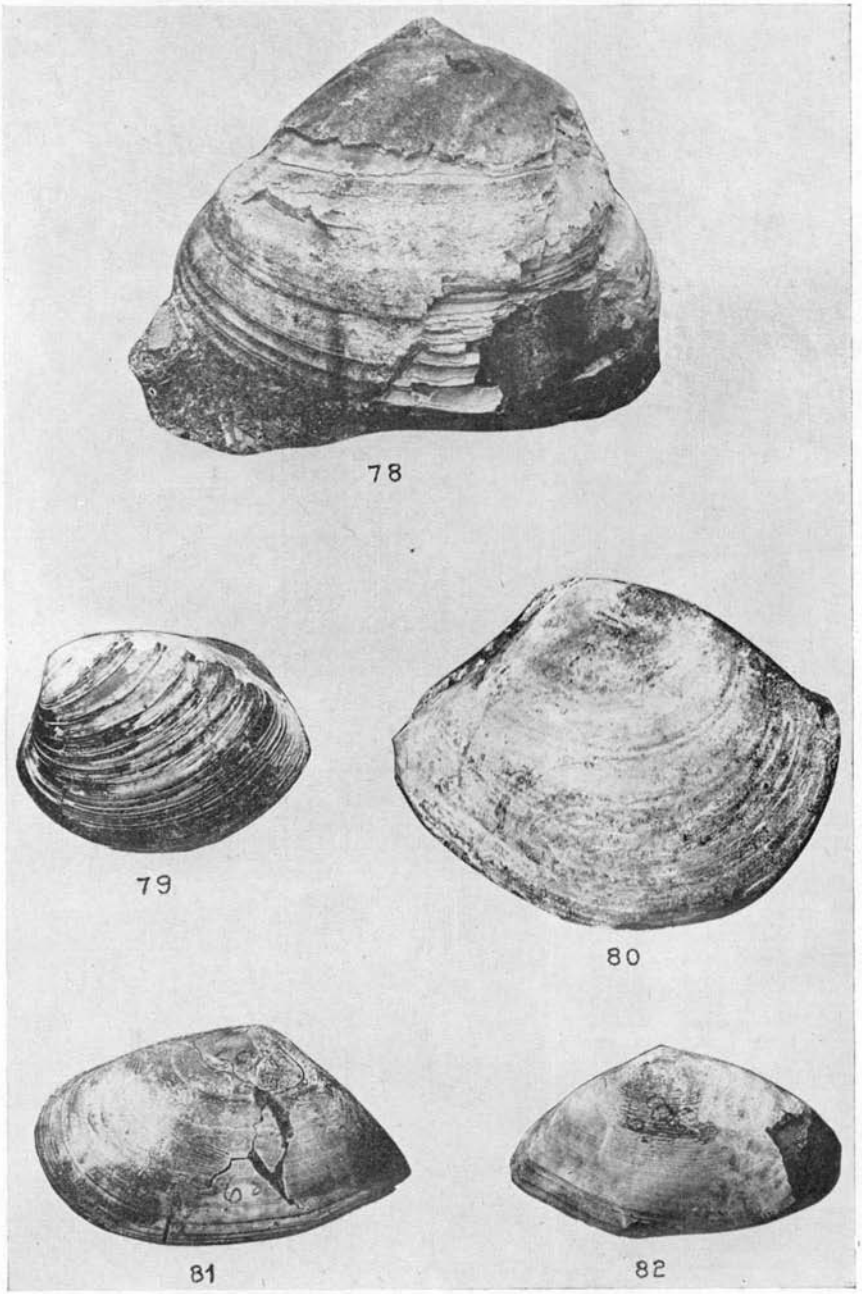


70. Pecten porterensis.
71. Chione chehalisensis.
72. Pecten porterensis.

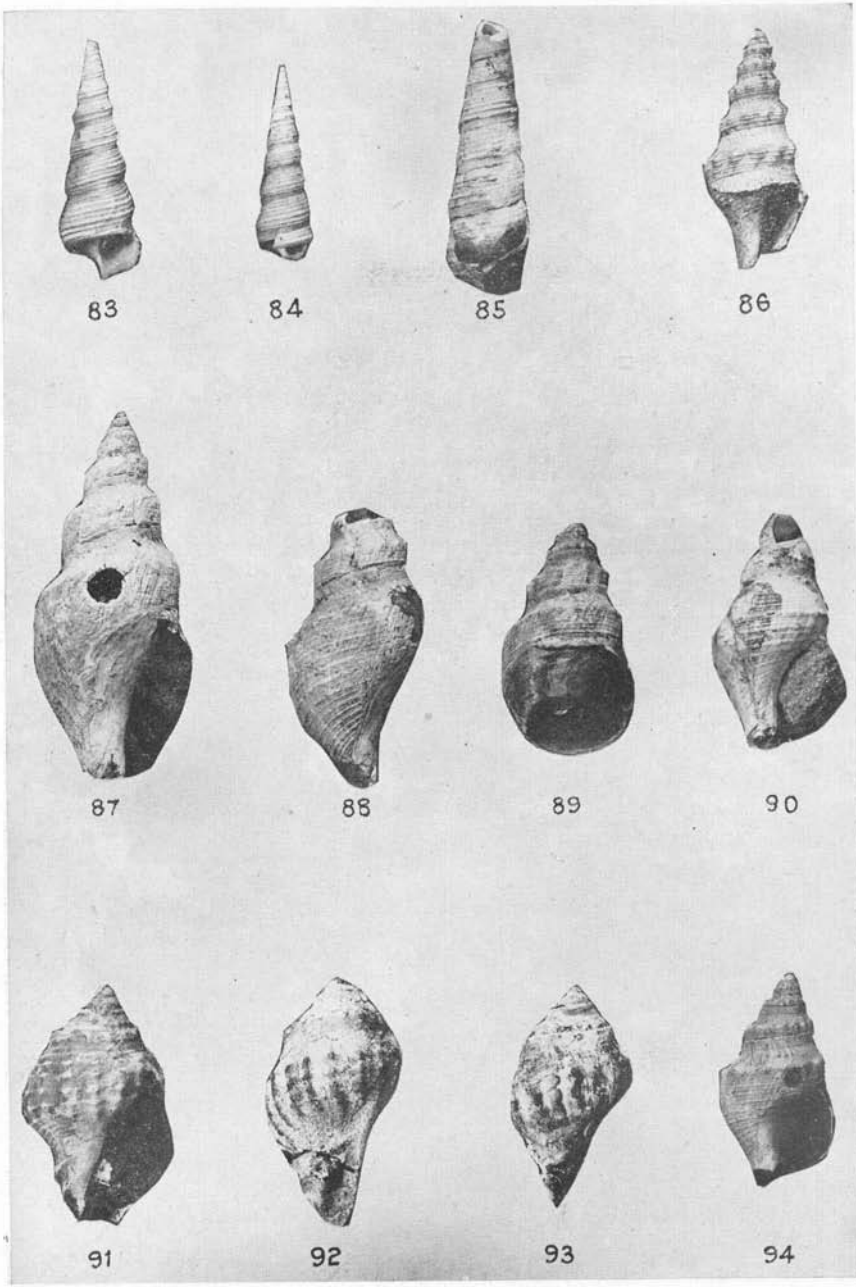
(All new species.)



73. Ficus clallamensis n. sp.
74. Tellina merriami n. sp.
75. Pseudocardium landesi n. sp.
76. Pseudocardium gabbi Remond var. undiliferum n. var.
77. Spisula albaria Conrad.

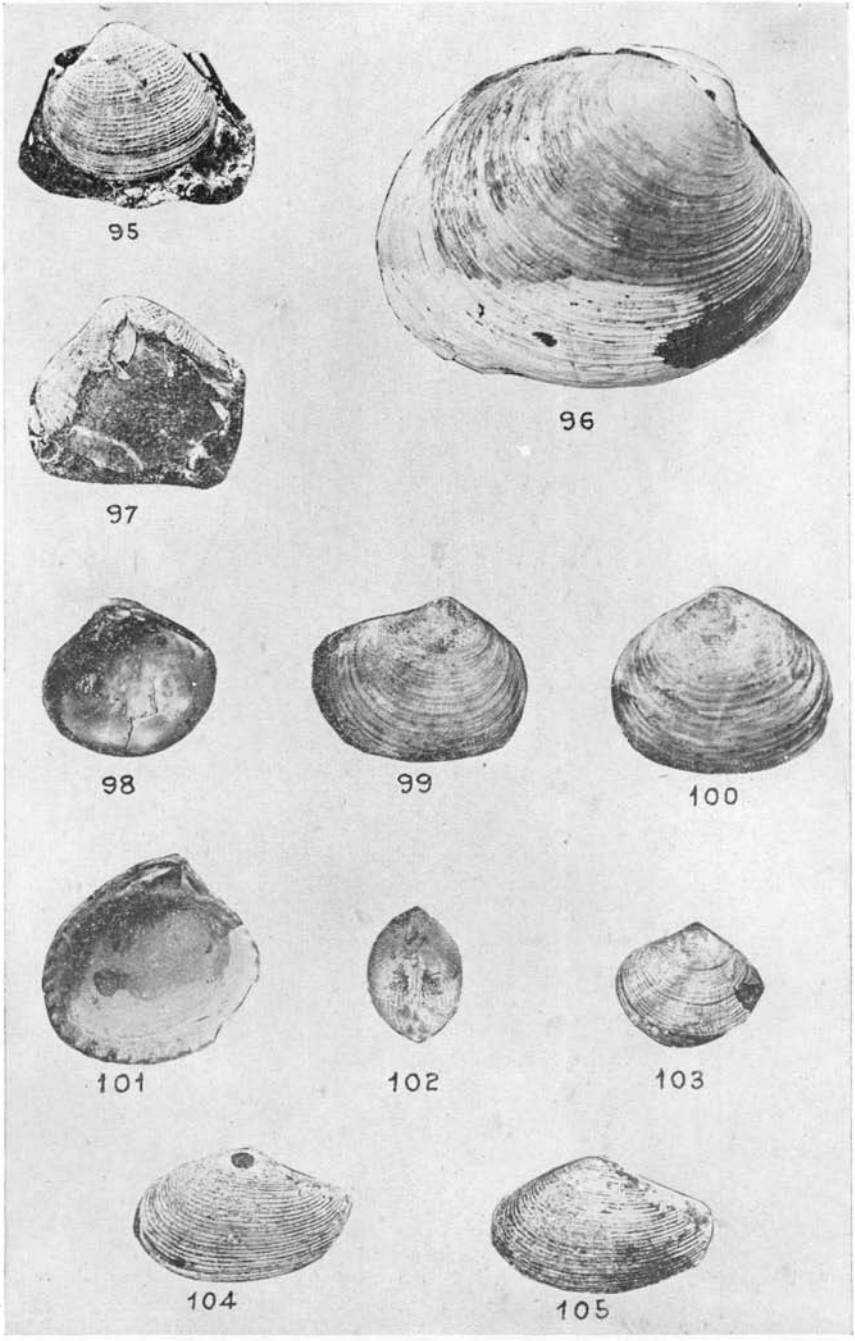


78. Pseudocardium gabbi Remond var. elongatus n. var.
79. Chione cathcartensis n. sp.
80. Macoma montesanoensis n. sp.
81. Tellina merriami n. sp.
82. Tellina kincaidi n. sp.



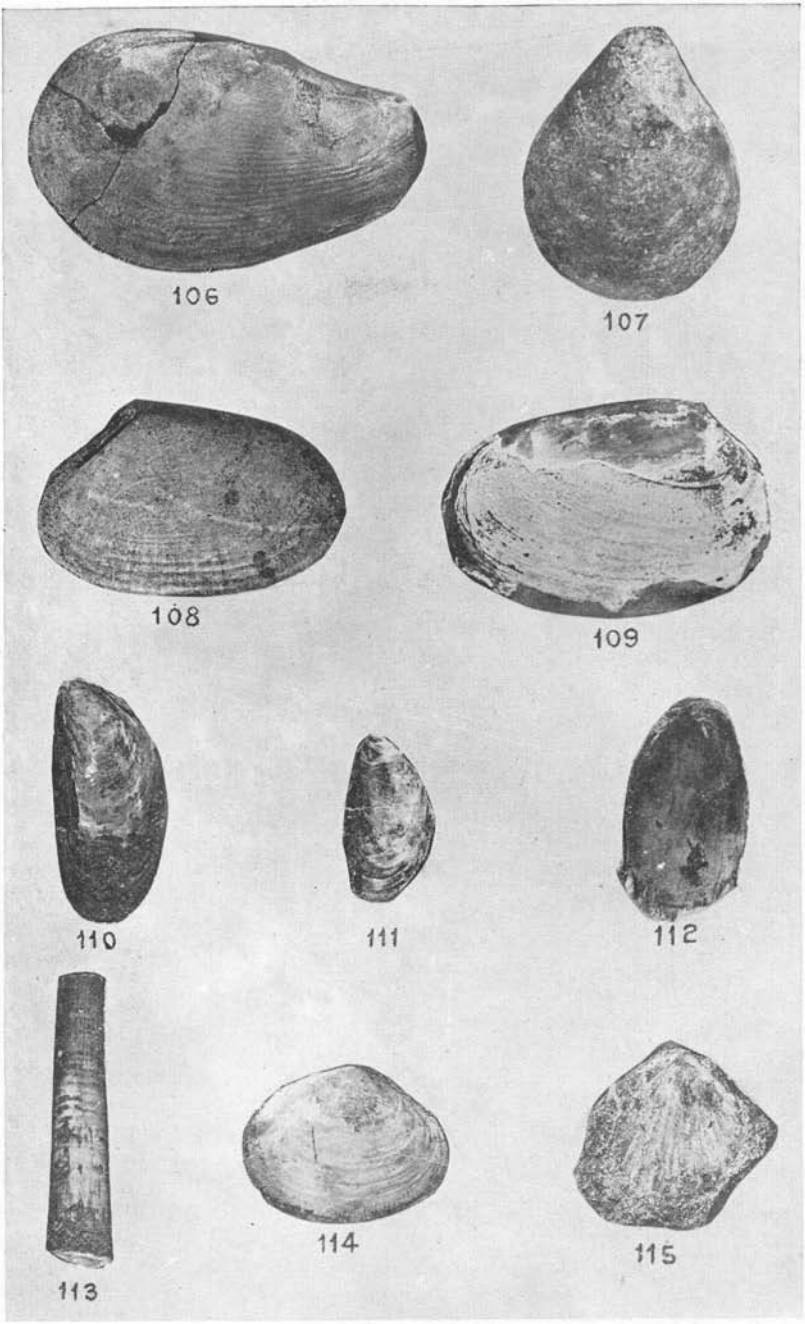
83. Turritella porterensis.
84. Turritella porterensis.
85. Turritella blakeleyensis.
86. Surcula cowlitzensis.
87. Turris wynootcheensis.
88. Turris wynootcheensis.
89. Turris wynootcheensis.
90. Pleurotoma chehalisensis.
91. Cuma biplicata var. quadranodosum.
92. Cuma biplicata var. quadranodosum.
93. Cuma biplicata var. quadranodosum.
94. Turris wynootcheensis.

(All new species.)



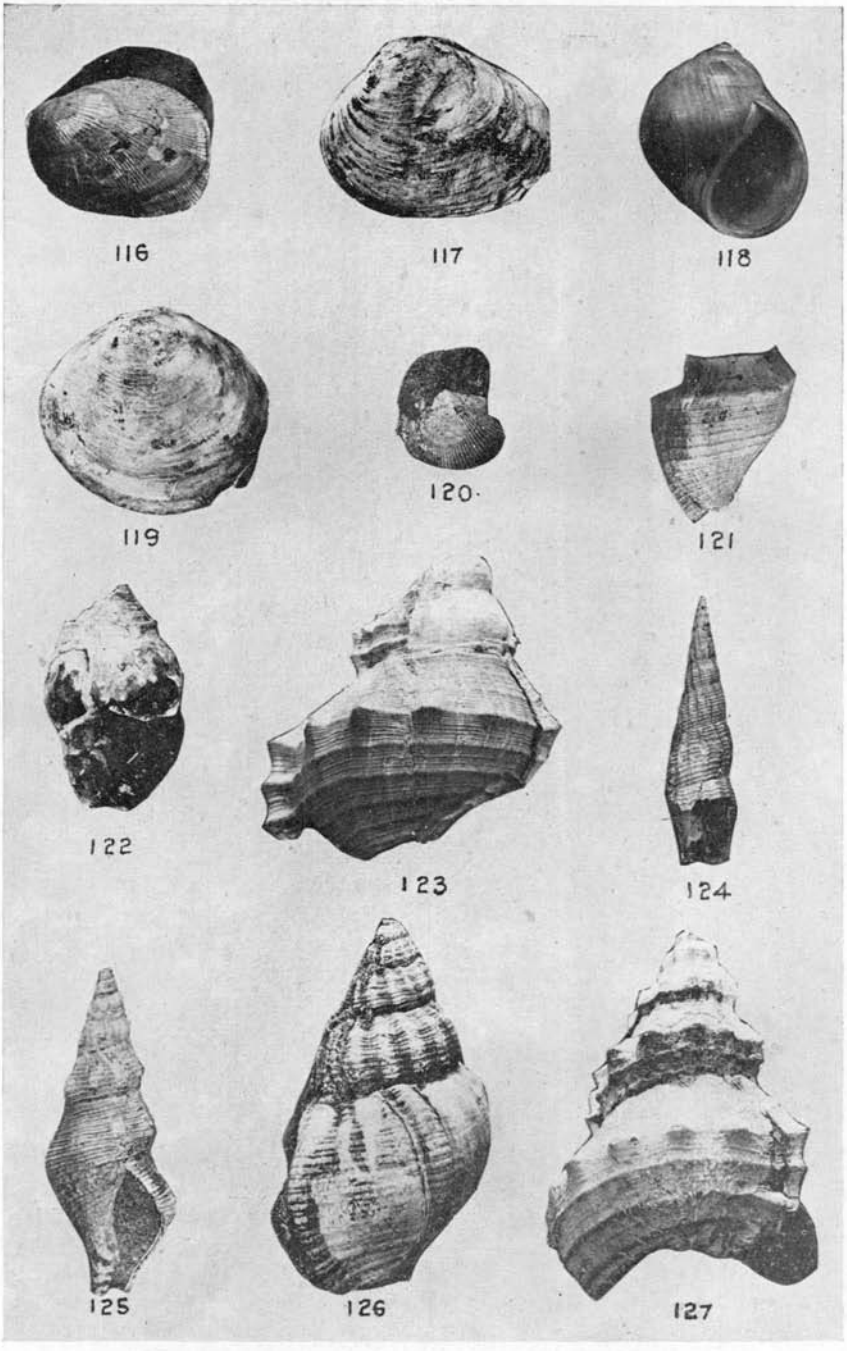
95. Chione montesanoensis.
96. Marcia oregonensis.
97. Chione montesanoensis.
98. Semele montesanoensis.
99. Semele montesanoensis.
100. Semele sylviaensis.
101. Venericardia chehalisensis.
102. Venericardia chehalisensis.
103. Chione montesanoensis.
104. Leda chehalisensis.
105. Leda chehalisensis.

(All new species.)

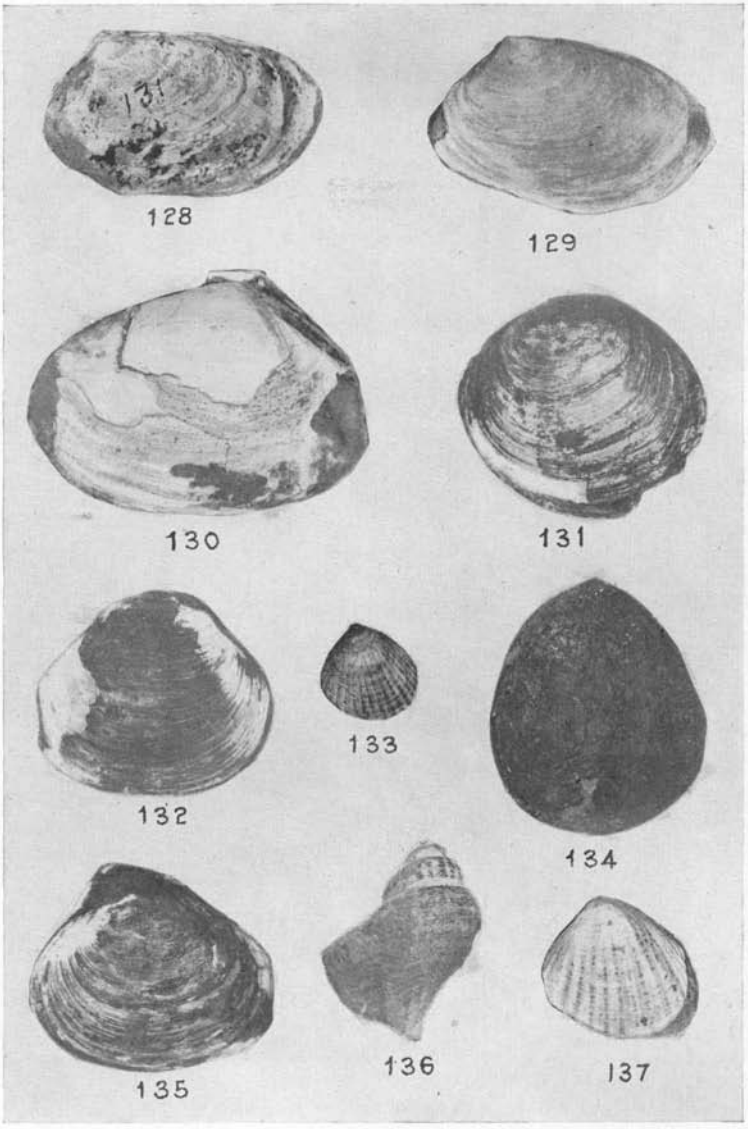


106. Yoldia sammamishensis.
107. Terebratula oakvilleensis.
108. Tellina n. sp.
109. Macoma snohomishensis. (Enlarged twice.)
110. Mytilus snohomishensis.
111. Mytilus sammamishensis.
112. Sharks tooth.
113. Dentallium porterensis.
114. Cryptomya washingtoniana.
115. Pecten alockamanensis.

(All new species.)



116. Crenella porterensis n. sp.
117. Corbicula cowlitzensis n. sp.
118. Lunatia hornii Gabb.
119. Corbicula eufaulaensis n. sp.
120. Cardium sp.
121. Turris wynootcheensis n. sp.
122. Cuma biplicata Gabb var. quadranodosum n. var.
123. Tritonium n. sp.
124. Fusus dickersoni n. sp.
125. Drillia chehalisensis n. sp.
126. Gyrineum sylviaensis n. sp.
127. Tritonium n. sp.



128. Macoma wynootcheensis.
129. Macoma wynootcheensis.
130. Macoma wynootcheensis.
131. Corbicula eufaulaensis.
132. Corbicula cowlitzensis.
133. Venericardia chehalisensis.
134. Pectunculus tejonensis. (Natural size.)
135. Corbicula cowlitzensis.
136. Chrysodomus clallamensis.
137. Venericardia chehalisensis.

(All new species.)

INDEX.

	Page
Acknowledgments	9
Ancillaria Lamarck	53
bretzi n. sp.	53
Arthropoda	80
Blakeley Formation	17
Bonsor, T. A., work of	9
Brachiopoda	55, 79
Brachysphingus Gabb	48
clarki n. sp.	48
Caliostoma Swains	72
delazinensis n. sp.	72
Cardium Linnaeus	34
olequahensis n. sp.	34
Cassidaria Lamarck	38
washingtoniana n. sp.	38
Chehalis Formation	19
Chione Megerle	60
chehalisensis n. sp.	60
montesanoensis n. sp.	61
cathcartensis n. sp.	62
Chlorostoma Swains	71
arnoldi n. sp.	71
Chrysodomus Swains	43
clallamensis n. sp.	43
Cryptomya Conrad	70
washingtoniana n. sp.	70
Conus Linnaeus	54
cowlitzensis n. sp.	54
Corbicula Megerle	32
eufaulaensis n. sp.	32
cowlitzensis n. sp.	33
Cowlitz Formation	14
Crassatellites Kruger	31
cowlitzensis n. sp.	31
washingtoniana n. sp.	32
Crustacea	80
Cuma Humph	75
biplicata var. quadranodosum n. var.	75
Dentalium Linnaeus	79
porterensis n. sp.	79
Description of Species	28
Drillia Gray	78
chehalisensis n. sp.	78
Eocene	12
Fasciolaria Lamarck	52
washingtoniana n. sp.	52
Fettke, Charles R., work of	9
Ficus Conrad	74
clallamensis n. sp.	74

Page
Fusus montesanoensis n. sp. 76
Fusus horni Gabb 46
washingtoniana n. sp. 50
dickersoni n. sp. 50
Gasteropoda 36, 70
Geologic History 22
Gyrineum Link 73
sylviaensis n. sp. 73
Hemifusus Swainson 44
cowlitzensis n. sp. 45
lewisiana n. sp. 46
sopenahensis n. sp. 44
tejonensis n. sp. 47
washingtoniana n. sp. 46
Introduction 9
Leda Schumacher 56
chehalisensis n. sp. 56
Lincoln Formation 16
Lower Miocene 17
Macoma Leach 65
montesanoensis n. sp. 65
snohomishensis n. sp. 66
wynootcheensis n. sp. 66
Marcia Adams 63
oregonensis Conrad 63
Meretrix Lamarck 34
landesi n. sp. 34
olequahensis n. sp. 35
Miocene Species 56
Mitra Lamarck 52
washingtoniana 52
Montesano Formation 20
Morio Montf. 39
tuberculatus, Gabb, var. tri-tuberculatus n. var. 39
Murex Linnaeus 48
sopenahensis n. sp. 48
cowlitzensis n. sp. 49
Mytilus Linnaeus 58
sammamishensis n. sp. 58
stillaguamishensis n. sp. 59
snohomishensis n. sp. 59
Nassa Martini 42
eocenica n. sp. 42
packardi n. sp. 43
andersoni n. sp. 75
Oligocene Formation 15
Ostrea Linnaeus 29
olequahensis n. sp. 29
fettkei n. sp. 30
Pecten Muller 30, 57
cowlitzensis n. sp. 30
porterensis n. sp. 57
alockamanensis n. sp. 58
Pectunculus Lamarck 28
eocenica n. sp. 28
eocenica n. sp. var. landesi n. var. 28
tejonensis n. sp. 29
Pelecypoda 28, 56

	Page
Pleurotoma Lamarck	77
chehalisensis n. sp.	77
washingtoniana n. sp.	78
Post Eocene	17
Potamides Brogni	36
fettkei n. sp.	36
lewisiana n. sp.	37
Pre-Tertiary bed rock complex	10
Pseudocardium Gabb	68
gabbi Remond var. altus n. var.	68
gabbi Remond var. elongatus n. var.	68
gabbi Remond var. robustum n. var.	69
gabbi Remond var. undiliferum n. var.	69
Puget Group	12
Ranella Lamarck	41
washingtoniana n. sp.	41
cowlitzensis n. sp.	41
Rhynconella Fischer	55
washingtoniana n. sp.	55
Rimella Agassiz	37
canalifera Gabb, var. elongata n. var.	37
Ross, Donald, work of	9
Semele Schumarck	67
montesanoensis n. sp.	67
sylviaensis n. sp.	67
Stratigraphy	10
Stromme, Olaf, work of	9
Surcula H. and A. Adams	53
cowlitzensis n. sp.	53
Tapes Megerle	35
washingtoniana n. sp.	35
Tejon Formations	14
Tellina Linnaeus	63
merriami n. sp.	63
kincaidi n. sp.	64
Terebratula Klein	79
oakvilleensis n. sp.	79
Tertiary Formations	11
Tritonium Link	40
sopenahensis n. sp.	40
Turris Bolten	70
wynootcheensis n. sp.	70
Turritella Lamarck	72
blakeleyensis n. sp.	72
porterensis n. sp.	73
Upper Eocene Species	28
Upper Miocene	20
Venericardia Lamarck	59
chehalisensis n. sp.	59
Wahkiakum Formation	19
Yoldia Moller	56
sammamishensis n. sp.	56

PUBLICATIONS

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