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Some Fossil Mollusks of Yakima County, Washington

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SOME FOSSIL MOLLUSKS
OF
YAKIMA COUNTY, WASHINGTON

A Thesis
Presented to
the Graduate Faculty
Central Washington State College

In Partial Fulfillment
of the Requirements for the Degree
Master of Education

by
Raymond Deane Foisy
July, 1967
APPROVED FOR THE GRADUATE FACULTY

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CHAPTER 1

INTRODUCTION

Discussion of the Problem

High on the slopes of Sedge Ridge, a 4,000 foot high ridge west of Yakima, is a sizeable assemblage of fresh-water mollusk fossils interbedded between basalt flows. Little or nothing has been published about these fossils.

This thesis is designed to locate and describe known fossil mollusk sites in Yakima County, Washington. As part of this thesis a detailed comparison of two sites will be given, including identification and a systematic description of the specimens, as well as the correlation and interpretation of the fossil mollusks. A discussion of the present geography, geology and ecology is given.

Though the study of paleontology has been carried on in the state of Washington for many years, there are still many areas like this one virtually untouched. Possible reasons for the apparent lack of interest in the fossils of Yakima County are their lack of economic importance and the inaccessibility of much of the county.

A large portion of Yakima County is underlain by basalt which has very little economic value because of the scarcity of mineral wealth.
Inaccessibility presents itself in diverse ways. Some regions are closed to public use because of ownership. Large areas are private land used for farming, cattle grazing, or private forest land. Another large section, the Yakima Firing Center, is closed because of its use as a military base. The Atomic Energy Commission has restricted a very sizeable region extending into eastern Yakima County for the Hanford Atomic Works. Still another extremely large portion of Yakima County that is closed to public use is that land covered by the Yakima Indian Reservation. In many of these cases it is nearly impossible to gain permission to do any type of geologic study unless one is directly associated with the group in control of the land. Some areas have been closed only in the past few years due to abuse of the privilege that had been extended by the land owners. This is true of the Yakima Indian Reservation where hundreds of acres of previously open land have been closed to public use because of the removal of tons of petrified wood and other rocks by rock hounds. The Cowiche Cattleman's Association has recently closed a large area of western Yakima County because of misuse by hunters and campers.

Natural barriers create inaccessibility in a great portion of Yakima County. Much of the Cascade mountains and the foothills leading up to the range, in the western part of the county, is highly timbered and only within the past
few years has it been opened to logging. There are still many miles of countryside that can be reached only by foot, and then the heavy forest cover does not allow a person to readily see the geology of the area. A person walking through the western part of the county is faced with high ridges and deep valleys which make travel and collecting difficult.

Procedures of Solving the Problem

In order to locate and collect from as many fossil mollusk sites in Yakima County as possible, many people were contacted . . . shepherders, rock hounds, professional and amateur geologists, loggers, and others. General directions were given in many instances to sites which had not been visited for years. At one site a portion of a highway had been relocated, completely removing the hillside containing the fossils. At this site one-half of one fossil snail was found. After field exploration two of the seven sites "known" to the persons contacted were located and studied. One site is on Sedge Ridge, some thirty miles west of Yakima. The second is found on Toppenish Ridge, about 45 miles southwest of Yakima.

Some very striking similarities were noted between the locations on Sedge Ridge and Toppenish Ridge. Both were on high, dry basaltic ridges with quite steep slopes.
Definite basalt outcrops were noted both above and below the fossil occurrences at each site. Massive pieces of fossiliferous material seemed to be cast upon the surface of the slope with no particular bedding pattern visible; smaller pieces being carried downhill from the larger ones, along with small fractured pieces of basalt in each case. The present vegetation of the surrounding region was very similar at both sites. The fossils looked as though they were the same species at each location.

The material collected at both sites contained great numbers of fossil mollusks. Snails were by far the most predominant with the remaining specimens being small clams.

Definitive characteristics like the number of whorls, the overall altitude of the shell, the overall width of the shell, diameter of the body whorl, the angle of rise of the whorls, and shell ornamentation were used to distinguish the various species of snails. Shell height, width, and general shape were used to distinguish the fossil clams. These characteristics led to the identification of three species of fossil snails and the one fossil clam at both the Sedge Ridge and Toppenish Ridge locations.
Previous Investigations

In Washington State there are fossil localities representing almost every geologic period. Vaughn E. Livingston tells of some of these sites but freely admits that it is only a beginning of a long list of locations. He suggests that his book gives a point of departure for those wishing to study fossils. This book does bring our state into focus, but it covers much more than mollusk fossils.

Mollusks of one form or another have been present on earth for some 1,500,000,000 years (17:228). For this reason there have been many studies of fossil mollusks through the years, but as Junius Henderson states:

The literature of this subject is vast and scattered, considerable of it practically unavailable to all but the specialists, because of the lack of a comprehensive, systematic review and index (11:vii).

This statement was part of the introduction of the book written by Mr. Henderson in 1935. Neither the Sedge Ridge site nor the Toppenish Ridge site was mentioned, nor were other sites in Eastern Washington discussed. In this book he discusses various fossil sites and species of mollusks that had been described up to that time. The species lists are extremely long and steeped in synonymy and would be help to a person working on a fossil site that had already been studied, or to one who was working with known species of mollusks.
In reply to a letter requesting materials to make proper identification of the specimens, Dr. Aurele LaRouque, Professor of Geology, Ohio State University, said: "The literature on non-marine Mollusca is widely scattered and is difficult to handle simply because comparative material is not available."

Likewise, Dr. Dwight W. Taylor, Director of Paleontology for the United States Geological Survey, Menlo Park, California, states: "There isn't any satisfactory introduction to the fauna, hence your study is handicapped," (by written communication, May 1966). Dr. Taylor did suggest a book for living forms by Robert W. Pennak. A fine description to the generic level as well as a highly detailed discussion of the ecology of mollusks is given. One statement made by Mr. Pennak cast some doubt on the species names of both living and fossil forms of mollusks. He feels that the only real way to determine species of most mollusks is through use of the soft body parts (22:587).

Junius Henderson used comparisons with other forms to identify to species. This complicates matters if one has only one of the species being discussed. This book deals with the studies made by Mr. Henderson and his students during their tours of Washington and Oregon. He suggests that there is a great deal of room for further study in the area of living fresh-water Mollusca in most of the western states (12:1-10).
Charles E. Weaver gives a comparison of fossil sites along the coastal regions of Washington and Oregon and shows the methods to be followed in such studies. Weaver discusses one of the greatest problems in identification, that of synonymy. He states:

Due to greater refinement in biological classification in recent years, many of the earliest descriptions and identifications of genera and species have undergone revision (33:vii).

Though the changes are made, the old names are carried on to clutter the books with an overpowering number of names.

To better understand the mechanics of the systematic description of fossils, a paper by T. C. Yen was selected. Mr. Yen begins his paper with a general discussion of the area in which the fossils had been found. He includes the location, type of matrix, thickness of sequence, and refers to a study on the stratigraphy of the site. Also included are general points of interest such as the number of species, genera, and families involved, the species that helped determine the age of the fossils, and in what museum the specimens are located.

The second section of the paper is involved with the listing of families, genera, and species, followed by the frequency of occurrence and justification for some of the identifications and dating.
The final section of Mr. Yen's paper is the systematic account. Each species of gastropods is treated separately, giving family and genus of each specimen, as well as the name of the person who first identified the species. A specific reference for each species is given showing the first known publication which gives a description of the species. This is followed by a description of a typical specimen, pointing out the quality of preservation, number of whorls, the overall altitude, overall width, and height of aperture. There is also a discussion of any synonyms that might be involved. The last item for each species is the specimen number. This paper shows the methods used in a scientific approach to a study very similar to this one (34:495).

The only mention of the Sedge Ridge site was found as a very short explanation of the geology of the Ahtanum Valley by Bruce L. Foxworthy. This book specifically dealt with the water supply of the Ahtanum valley and was not meant to be a geologic study in itself. Though the mollusks involved in the Sedge Ridge site were identified by T.C. Yen, no description of the fossils was given to associate names with specific specimens (8:19).

A question about the identification arose when it was found that two species named by Mr. Yen had been found only in Southern California (11:223; 11:200).
A review of the literature did not reveal any mention of the Toppenish Ridge site.

ACKNOWLEDGMENTS

The field work and preparation of this report was facilitated by many people. The many persons that made suggestions of locations provided much help. Mr. Ron Buder, Yakima Indian Agency, assisted greatly on the Yakima Indian Reservation. The Boise Cascade Corporation gave permission to work on the Sedge Ridge site. Appreciation is expressed to Joe Dobie and Jack Stapleton of Yakima for their assistance in location and collection. Thanks is given to William Pennell for the close-up photos. A special vote of appreciation to Dr. Edward Klucking, as committee chairman, and Dr. Richard Mould and Dr. Donald Baepler as members of the committee.
CHAPTER II

GEOLOGY OF THE REGION

Geography

Yakima County lies in the south central part of the state of Washington (plate 1). In the western portion of the county are the Cascade Mountains, an irregular and deeply eroded chain of mountains running north and south through the entire state. The highest in Yakima County is the volcanic mountain, Mt. Adams, which rises to 12,307 feet. Most of the ridge tops are about 4,000 to 5,000 feet with peaks to 8,000 feet (29:4). As the streams drain eastward toward the Columbia, on the east flank of the Cascades, they run through deep valleys until they reach the Naches and Yakima Rivers. At the junction of these two rivers the elevation drops to 1,100 feet. The elevation drops more slowly until it reaches 650 feet at the southeastern border of the county.

As the Yakima River flows south through the county it cuts through a series of five east-west trending, narrow, even-crested anticlinal ridges that rise about 1,000 feet above the valley floors. One of these is Toppenish Ridge which forms the southern flank of lower Yakima Valley or Toppenish syncline. The Toppenish anticline is about
fifteen miles wide by about sixty miles long and is nearly flat with an extremely steep north face, sloping more gradually to the south. It gradually builds from 1,600 feet elevation on the east end to over 4,000 feet on the west end where it joins the Cascade Mountains.

Sedge Ridge, on the other hand, is a wedge-shaped, northwest-southeast trending anticline rising very steeply out of the western flank of the Ahtanum Valley to the west of the city of Yakima. It rises from 2,100 feet at Tampico to 4,400 feet in about three miles and drops even more steeply on the northwest side. The northeast end of the ridge drops off in a nearly 1,500 feet sheer face to the floor of the North Fork of Ahtanum Creek. The ridge blends into the Cascade range to the southwest.

Climate

Precipitation and other weather conditions in Yakima County vary substantially with elevation and with proximity to the Cascade Mountains. Due to the lack of year round weather stations in the Cascade Mountains, it is impossible to give accurate data of this area of the county. Snowfall is great enough in the winter months to afford year round irrigation for vast amounts of land in the valleys below.

The weather station at Rimrock Lake, about thirty miles west of Yakima, shows the definite increase in
precipitation in relation to the nearness to the Cascades as well as the increase in elevation. Rimrock, at an altitude of 2,730 feet, has a mean annual precipitation of 26.2 inches contrasted to Yakima City, at an altitude of 1,061 feet, with 7.21 inches mean annual precipitation.

Although no comparative data is available for either Toppenish Ridge or Sedge Ridge, it is assumed that, due to increase in altitude and greater distance from the Cascades, the annual precipitation would be about the same as the Rimrock station.

A general picture of the county weather pattern can be drawn from the conditions that exist in the city of Yakima. The local relief is complex, with minor valleys and ridges giving local relief of up to 500 feet. This results in marked differences within a short distance in air drainage, winds, and temperatures. The climate of Yakima is relatively mild and dry, having characteristics of both maritime and continental climates modified by the Cascade and Rocky Mountains, respectively. Summers are hot and dry and winters cool with little snowfall. On some occasions cold arctic air will pass west of the Rocky Mountains bringing sub zero temperatures to Yakima. It is average to have only five days per winter of 0 degrees or below and to have an average of twenty days of minimum temperatures above freezing during the winter. However, in January and February
of 1950 there were four consecutive days colder than -20°, including a -25° on February 1.

The modifying influence of the Pacific Ocean is much less in the summer. Afternoons are hot, but dry air results in rapid cooling after sunset. July is the hottest month with a mean maximum 88.9° and a mean minimum of 53.1°. The annual mean maximum is 63.7°, mean minimum 35.8°, and average mean of 49.8°. Spells of four or five days of 100° or over have occurred, and in July 1928 there were seven such days, reaching 111° on the 26th.

Precipitation follows a pattern of a West Coast Marine Climate with typical late fall and early winter maximum fall. Because Yakima is in the rain shadow of the Cascade Mountains, the total amount is small. The months, November to January, each average about an inch, totaling nearly half the annual fall. June usually shows an increase in precipitation, receiving an average of .61 inch. The least falls in July and August with a mean of .19 inch each. The mean since 1910 is 7.40 inches per year.

Snowfall is light, the average being 20-25 inches per season. The range is from two inches in 1957-58 to 74 inches in 1955-56. The most snow to fall in 24 hours was 14 inches on December 20 and 21, 1964. Maximum snow depth was 22 inches on December 22, 1964.
The relative humidity ranges from quite high in the winter, mean of 81 per cent in December, to very low in summer, mean of 41 per cent. July afternoon relative humidity mean goes as low as 25 per cent. The annual mean relative humidity is 61 per cent.

The average growing season is 193 days. The average date for the last killing frost in the spring is April 13 and the first in the fall is October 23 (30:1-4).

**Vegetation**

The vegetation of Yakima County ranges from sagebrush to alpine tundra in nature, depending on the elevation, climatic conditions, and nearness to the Cascade Mountains. The eastern portion of the county is dominated by sagebrush (*Artenisia tridentata* and *Artenisia rigida*), grasses, and rabbit brush (*Chrysothannus* sp.). Along the stream beds in this area coyote willow (*Salix exigua*) and black cottonwood (*Populus tricocarpus*) are most common.

To the west of Yakima, at the base and on the shoulder of the first ridges of the Cascade foothills, a change of vegetation takes place. Groves of oak (*Quercus garryana*) appear in the valleys and part way up the ridges. Some yellow pine (*Pinus ponderosa*), aspen (*Populus tremuloides*), black cottonwood (*Populus tricocarpus*), and interior rose
(Rosa ultramontana) are found near the streams. The southern and eastern slopes still retain the sagebrush (Artenisia rigida) to the 3,000 to 4,000 feet level. On some of the more exposed areas on the south and east ridges the vegetation is reduced to little more than thyme-leafed Eriogonum (Eriogonum thymoides).

On the north and west slopes at the lower elevations widely separated yellow pine are mixed with sagebrush. As the elevation increases the yellow pine thicken and the sagebrush decrease where the wind drainage is favorable. At about 2,500 feet elevation Douglas fir (Pseudotsuga menziesii), grand fir (Abies grandis), and western larch (Larix occidentalis) begin to mix with the yellow pine. Though this mixture continues to occur for some distance to the west, the yellow pine slowly loses its dominance to the Douglas fir and the timber becomes more dense.

In some local areas western larch, lodge pole pine (Pinus contorta), western white pine (Pinus monticola), Englemann spruce (Picea englemanii), or western hemlock (Tsuga heterophylla) may become the dominate tree.

At the higher elevations the trees begin to thin out into alpine meadows with subalpine fir (Abies lasiocarpa) or noble fir (Abies procera) with dwarf juniper (Juniperus communis) or in the extremely high areas the whitebark pine (Pinus albicaulis).
Though each of these zones have a variety of shrubs, grasses, and flowers, the list would be far too long and detailed for this paper.

**Present Mollusca**

Nearly every permanent body of water has its mollusks (17:667). During a study of the streams of the Ahtanum Valley the author found six species of gastropods representing six genera and three families, as well as one species of pelecypod. These gastropods were Family Physidae, Genus *Physa*, Genus *Aplexa*; Family Lymnaeidae, Genus *Lymnaea* of which there were Subgenus *Radix*, Subgenus *Pseudosuccinea* and Subgenus *Stagnicola*; Family Planorbidae, Genus *Promentus*; and the pelecypod was Family Sphaeriidae, Genus *Pisidium*.

Though the study was carried out over a period of one year it was not broad enough in area to feel that all species within Yakima County were represented. But until further study can be carried out, these species show a fair picture of the living forms.

During the hot part of the summer large numbers of the subgenus *Radix* were observed floating freely in the stream. These free-floating snails were caught in settling basins and accumulated to a depth of over two feet. The streams are mainly snow fed, which creates a great deal of
seasonal fluctuation. Also during the hottest part of the year water is drawn from the streams to irrigate the adjacent fields. The reduction of water level and the increase in temperature causes the oxygen level to drop to the critical level. Thus the snails move to find a more suitable location.

Geology

The oldest and most extensive rock unit exposed in Yakima County is the Yakima Basalt, a division of the Columbia River Basalt (15:4). It is composed of numerous basaltic lava flows several thousand feet thick, interbedded with minor sedimentary layers. It is the bedrock unit for Yakima County, but in some areas it may be hundreds of feet below the surface because of the younger sediments covering it. The basalt is a dense rock that is quite resistant to erosion and weathering.

Individual flow layers of this basalt range from less than 20 to over 200 feet in thickness. Enough time elapsed between extrusions to allow for erosion and soil accumulation adequate to support the growth of trees. Some of these trees were encased by later flows and petrified, leaving near perfect cell structure in many cases (16:24).

The name Yakima Basalt was applied by Smith (1901) to that part of the Columbia River Basalt that poured out in
the Yakima region during the Miocene Epoch. The age assignment was made on the basis of fossil plants in the Manashtash formation (Eocene) which underlies the Yakima Basalt in the vicinity of Cle Elum, Washington, and of fossil plants in the overlying Ellensburg formation (late Miocene). Later workers have assigned early to middle Pliocene to the Ellensburg formation (8:16).

The Yakima Basalt is overlain by the Ellensburg formation, which consists of a few to over a thousand feet of clay, silt, sand, and gravel. For the most part this formation is easily eroded, and in many areas it has been stripped away, leaving the basalt on the surface. About 85 to 95 per cent of the Ellensburg formation consists of semi-consolidated clay, silt, and sand and only five to fifteen per cent gravel and conglomerate. Generally the colors are gray, tan, and buff, but there are a few rusty-brown sand and gravel strata.

The silts and sand are mainly composed of pumice, volcanic ash, and smaller amounts of quartz, feldspar, and hornblende particles. The clay is mainly finely divided pumice and ash. The gravel contains a great percentage of tuff and purple or gray tuffaceous andesite. Minor amounts of diorite, quartzite, and smaller amounts of granite and metamorphic rock types are found locally in the gravels, but basalt fragments are rare (8:17).
Another rock unit of importance is the cemented basalt gravels. These are found overlying the Ellensburg formation, mainly in the valley. About 75 per cent of these gravels are pebble-size cobbles with few boulders. Sand or finer material make up less than 25 per cent of the total amount and are generally found in lenses. The larger the materials, the more well-rounded they are.

Most of the cemented gravels are pieces of Yakima Basalt. Locally the percentage of other types vary greatly. Tuff and andesite are quite common; less common are diorite, quartzite, granitic types, and metamorphic varieties.

These gravels were probably deposited during the Pleistocene or glacial epoch, probably caused by glacial outwash from the local glaciers to the west of the Yakima Valley (8:21).

More recent materials have been deposited in local flood-plain alluvium. Much of the more protected areas have mounds of wind-blown silt or loess.

A general picture of the geology of Yakima County has been given to show the major features. There are many local features that have not been mentioned, for the variety and number of these non-typical features would be too much for this paper.
**Structure**

The Yakima Basalts and Ellensburg formation have been warped very greatly to form anticlines and synclines. Toppenish Ridge and Sedge Ridge are both fine examples of anticlines found in Yakima County. Both show steep slopes and relatively flat tops which are typical. Toppenish Ridge is probably more typical, displaying a very steep north face with a more gradual south slope (15:8).

The Ahtanum-Moxee syncline, in which the city of Yakima is located, is typical of the synclines. The same basalt layer that can be seen at over 2,000 feet elevation on Ahtanum ridge, to the south of the city, has been found through test drilling, at under 500 feet below sea level at the base of the syncline. Over 1,500 feet of this syncline is filled with Ellensburg formation, cemented basalt gravels, and alluvium above the bedrock, Yakima Basalt (8:22).

**Location**

The Sedge Ridge site (CWSC I 018) is located on the west flank of the ridge (NE1/4 SW1/4 Sec.16, T.12N., R.15E.) at about 3,800 feet elevation, 4 1/2 miles west of Tampico. It is accessible only by foot from either Carpenter Gulch, to the northwest, or Bear Canyon, to the north, or from the jeep road on top of the ridge to the east.
The matrix encasing the fossils is a tan or rusty-brown, highly resistant chert that can be traced for more than a half a mile in a band roughly parallel to the strike of the basalt flows above and below the fossil site. Contact of fossiliferous material and basalt cannot be seen because of the slope wash, but the material is quite certainly an inter bed between upper basalt flows.

The Toppenish Ridge site (CWSC I 019) is located some 30 miles southeast of the Sedge Ridge site. It is possible to drive to this site by leaving the Satus Pass Highway eight miles south of Toppenish and driving 22 miles west on the Oak Springs Road. At a point four and two-tenths miles past the summit of Toppenish peak, a small spur road leaves the main road, leading directly into the fossil site (SE1/4 SW1/4 Sec.21, T.9N., R.17E). The slope is slightly less steep on Toppenish Ridge and the elevation is 3,150 feet.

The relationship to the geology is the same as described at Sedge Ridge. The only exception is that the matrix is more varied in color, ranging from nearly white to pure black.
CHAPTER III

COMPOSITION OF FAUNA

Specimens and their Condition

This collection includes three species of fresh-water gastropods representing three genera from three families as well as one species of fresh-water pelecypod. Each of these fossil forms is found at both the Sedge Ridge site and the Toppenish Ridge location.

The loose specimens found on Sedge Ridge are agatized steinkerns lacking much of the original shell or ornamentation so necessary for identification. The specimens found on Sedge Ridge and Toppenish Ridge still in the matrix are so firmly imbedded in a very hard quartzite that it is impossible to remove them intact. Some of the solid material has been badly misshapen because of pressure. In some cases these have been reduced to nothing more than fragments.

One author states:

In many groups of non-marine mollusks, such as Sphariidae, Lymnaeidae, Physidae, and others, the shells lack very pronounced sculpture or other characters useful in the description and identification of species, so that it is often difficult to identify them even with perfect live material at hand. This difficulty is greatly enhanced when the material consists of fossils of various localities in different states of preservation, all more or less imperfect and without anatomy. . . The division of mollusks into families and genera is based largely upon the soft anatomy. This not being available in case of fossils, their classification must
depend solely upon shell analogies, which is often insufficient to enable one to determine satisfactorily to what genus and sometime even what family a given species may belong (11:5).

Keeping these statements in mind and following the International Code of Zoological Nomenclature (26:33), it seems somewhat improper to name new species in view of the lack of highly distinctive features and supportive reference. But to allow for correlation between sites and any future findings, it becomes necessary to be more specific than is allowed by the use of only the genus description. Therefore new names will be established for each of the species.

Systematic Account

Phylum MOLLUSCA

Class GASTROPODA

Order Ctenobranchiata

Family Viviparidae

Genus Viviparus Martini, 1767


The genus Viviparus has a spiraled shell that is dextral. The aperture is fairly large with an enlarged body whorl reducing to a much smaller protoconch diminishing to a fairly sharp apex.
Though no native species of this genus is now found living in the states west of the Rocky Mountains, the bulk of the fossil North American species are found there (11:165). This genus is usually found in sandy lakes and rivers.

Type species: *Viviparus sedgenus*, sp. nov.

Figure 10, 12 and 13

Numerous specimens of this species were collected, ranging from the young of less than 3mm in altitude to the adult of over 20mm in altitude. The holotype is 22mm in altitude, 20mm in diameter, and has four whorls. The body whorl flares slightly at the lip, and the upper surfaces of the first two whorls show a definite square-shouldering effect. The aperture is rough and shows no distinctive feature. The most distinctive feature displayed by this specie is the very uniform reduction in size of the protoconch. The angle of ascent to the apex from the body whorl is 75° on the aperture side and 80° on the opposite.

The size of the apical whorl remains large enough to produce a flattened apex. This species has a medium spiral.

On only one specimen from the type location could any shell feature be found. The growth lines are quite distinct and run slightly diagonal to the vertical axis. This same shell pattern is found on two specimens from the Toppenish Ridge site.

Holotype: Central Washington State College
Other type material is also to be found at Central Washington State College. Over 500 specimens were collected and examined, 100 of which are part of the museum collection.

The type locality number is: CWSC I 018

Family Amnicolidae

Genus *Pluminicola* (Stimpson)

The adult of this genus is generally less than 10 mm in altitude and diameter. In some species the diameter exceeds the altitude slightly. The body whorl is generally greatly expanded. The additional two or three whorls diminish rather slowly to give a short flattened appearance. This genus is generally found in slow moving fresh-water streams (22:691).

Type species: *Pluminicola yakimana* sp. nov.

Many specimens were collected that measured nearly 9 mm in altitude but the bulk were about 8 mm. The holotype is 8.5 mm in altitude, 8 mm in diameter, and had 3 whorls. The body whorl is much expanded and is centered more under the spire than other species that have been observed. The apex has a rather blunt or flattened appearance. The reduced size and height gives this specie the marked appearance of being nearly as wide as it is high with a low spiral. The apical whorl is much reduced giving a pointed effect. The ascent of the protoconch is 65° on either side of the axial line. No distinctive features of the shell remain.
Holotype: Central Washington State College

Other type material is located in the Central Washington State College Collection. Over 150 specimens were collected, or which 75 were selected for the collection.

The type locality: CWSC I 018

Family Pleuroceridae

Genus *Goniobasis* Lea

This genus is abundant and represented by many species in Eastern United States and most common in the rivers of Tennessee and Alabama (22:689). Many fossil species have been assigned to it in the west (11:215). The shell is ovate-conic to elongated with most of the adults over 15mm long but much less than 15mm in diameter. This genus varies greatly in amounts of ornamentation, from none at all to quite elaborate patterning (22:689).

Type species: *Goniobasis cascadenensis*, sp. nov.

Figure 11 and 14

Very few of these specimens were found and all were broken. They have from three to six whorls that could be seen. All are over twice the altitude of the diameter. The holotype, which is also broken, is 8.5mm in altitude, 3mm in diameter with four whorls. The body whorl is only slightly expanded, giving a long slender appearance. In some of the specimens where more of the apical region is displayed, there is a definite tapering effect.
One specimen from each site was found with shell features still intact. These features have a quite distinctive netting effect caused by definite ridges of shell running both vertically and horizontally. The vertical lines appear to run as an unbroken ridge from the base to the apex.

The most distinctive feature by far is the fact that the length is much greater than the width making a long narrow shell with a high spiral.

Holotype: Central Washington State College

There are sixteen other fragmentary specimens included in the type material at Central Washington State College.

Locality: CWSC I 018

Order PELECYPoda

Family Sphaeriidae

Genus *Sphaerium* Scopoli

This genus contains many species of pelecypods that are quite small with little outward means of identification. The major means of identification in living species is the shape and position of the teeth of the hinge. Most members of this genus are bilaterally symmetrical (11:114).

Type species: *Sphaerium bearium*, sp. nov.

Many specimens were found ranging from under 2mm in width to over 9mm. The holotype is 7mm in width and 6mm in height. The outer margin is reduced to a very thin edge,
tapering up to a fairly heavy shoulder. The beaks are nearly centered between the anterior and posterior ends with a very faint enlargement of the anterior end. In the better preserved specimens the beaks are comparatively large. Both are of uniform size and shape. The valves meet evenly with no favor given either side. There is no shell ornamentation visible.

Holotype: Central Washington State College

There are 58 specimens included in the type material at Central Washington State College.

Type locality: CWSC I 018

T. C. Yen identified these species as: Sphaerium sp., Viviparus cf. V. leiostracta Brusinia; Fluminocola cf. F. williamsi (Mannibal); and Goniobasis cf. G. kettlemanensis, although no systematic description accompanied the identification to allow for positive correlation.
CHAPTER IV

ENVIRONMENT OF THE FOSSIL FAUNA

Relative Abundance of the Species

At both the Sedge Ridge site and the Toppenish Ridge site fossiliferous material has been cast over a large area by the movement of float. On Toppenish Ridge the float can easily be traced for more than 1,700 feet in a swath some 150 feet wide. On Sedge Ridge the fossiliferous float can be traced for nearly three-quarters of a mile in length and nearly one-half mile in width.

The four species cited from Sedge Ridge are also found on Toppenish Ridge. One broken specimen was found at Indian Flat in the Naches River drainage (Fig. 1, site 3). From the general appearance it would seem to fit the genus Viviparus.

During the early investigations the same type of fossils were said to be found on Yakima Ridge (Fig. 1, site 4), Elephant Mountain (Fig. 1, site 5), Ahtanum Ridge (Fig. 1, site 6), Priest Rapids (Fig. 1, site 7), Dry Creek Ridge (Fig. 1, site 8), and in wells drilled in north Yakima (Fig. 1, site 9), though no traces were found during field studies.
The genus *Viviparus* is by far the most abundant, numbering nearly five to one that of the genus *Fuminicola* and genus *Sphaerium* and nearly twenty to one of genus *Goniobasis* at Sedge Ridge. Because of the hardness of the matrix on Toppenish Ridge, it is difficult to tell the numbers involved, but by examination of the cut sections of both sites, it appears that the distribution is nearly the same in both areas.

**Ecological Indication**

From the observation of living species in the local streams of today, it can be assumed that the fossil forms were collected in settling basins within a stream or at the mouth of a stream or lake. The gastropods were seen to be floating freely in the stream during the summer and collecting in large numbers in the settling basins.

The general area of the central Mississippi Basin as a region of comparison can be borne out by the fact that each genus of the fossil gastropods has living representatives there today. Some of these forms can be found in rapidly moving water as well as in slow water. Because of the fineness of the matrix, it can be assumed that the fossil forms were present in still or very slowly moving water.
The majority of present day Viviparidae are found in sandy, slow moving streams of four feet or less in depth (17:681). It can, therefore, be assumed that the streams or shallow lake in which the fossils lived would have been of comparable type. The current had to have been extremely slow because of the matrix in which the fossils are found. The very fine silt-like material has no sign of gradation or interbedding that is common to moving water.

Though all life was destroyed when basalt poured out over the land during the successive flows of the Yakima Basalt, it is evident that great amounts of time passed between some of the flows. Soil was able to accumulate and complete forests were reestablished. Likewise, the mollusk population was reestablished. This could have occurred in many ways. As the basalt flows cut across the water courses, vast amounts of water was backed up. As the water was released to flow back across the cooling basalt, flooding probably occurred and with the water some of the mollusk population could have been returned. Conditions would have been rather poor for reintroduction at this point, though some may have lived.

Later, as ponds and streams were reestablished, the plants needed for a mollusk population would have returned. Migrating birds and animals probably transported the larval
mollusks in mud on their fur or feathers. At this time a population could easily have been reestablished. Other floods at this time could have brought more larva as well as adults or larva could have been carried by fish.

A much simpler explanation is that the mollusk population in the streams and ponds adjacent to the margin of the basalt flows was maintained. Thus, as the conditions improved on the basalt flow, those mollusks being carried downstream, as they normally are, were able to live and develop a new local population.

The area involved must have been basically of sandy bottom, for very little other organic remains were found. In fact, only one small piece of petrified wood, with a rather disfigured specimen of what appears to be genus Fluminicola, was collected (Fig. 15).

By using the fossil flora from other sites involved with the Columbia Basalt, as well as the petrified wood that has been interbedded between the basalts, a good picture of the vegetation and climatic conditions can be established.

The Squaw Creek Petrified Forest, centered some twenty-five miles northeast of Yakima (centered in sec. 31, T.16N., R.21E.), has given a great number of petrified logs and stumps that are so well preserved that most were readily identified. This forest consisted of about 15% sycamore,
15% Douglas fir, 15% redwood, 15% red (sweet) gum, 15% oak (red, white, and black), 10% hickory, 5% elm, 1% ginkgo, 1% buckeye (horse chestnut), and the remaining 8% contained assorted hardwoods; alder, pine (pinon), walnut, maple, cottonwood, ash, fir, birch, sour gum, beech, and yew (2:3). All of the species identified in the Squaw Creek forest had previously been identified in the Mascall formation in the John Day Basin. Additional trees in the Mascall formation are: swamp cypress, hop hornbeam, and chestnut oak. Most of these have equivalents in either eastern North America or eastern Asia. Only 14% of the total flora are confined to present day western North America. Several genera are today restricted to eastern Asia; such as gingko, meta-sequoia, etc., and many are restricted to eastern North America (5:38-41).

The wet land or swamp conditions of Central Washington during the days of the Squaw Creek forest are seen in the United States today in the swamps of Arkansas and the dry land area in the Cumberland Mountains of Kentucky. These two regions seem to show the greatest number of living equivalents of the Mascall flora in North America (5:41).

In general terms, to have the type of forests that have been described as living in the time of the Mascall formation and the Squaw Creek Petrified Forest, some definite
climatic changes have occurred to allow for the present day climate. The major difference seems to be in precipitation and its distribution throughout the year. Rather than the present day six to twenty inches of precipitation, with most of this in the winter, it must have had from 30-60 inches of precipitation distributed quite evenly through all months of the year. This would have tended to moderate the extremes in daily temperature, but distinct summer and winter seasons would have been seen (19:280-1).

**Age of Fauna**

In view of the evidence given, it is assumed that the fossil mollusks found at Sedge Ridge and Toppenish Ridge are late Miocene to early Pliocene in age, for they appear to be interbedded between the same layers of the Yakima Basalt. The matrix in which the fossils are found is of the same very fine, sandy consistency. Further evidence is given by the identical shell pattern of *Viviparus sedgenus* at both sites. The specimens have the same size distribution and both sites were found to have smaller mollusks within the larger ones.

Though there seems to be some difference of opinion as to the age of the Yakima Basalts, most of the newer studies indicate that the upper flows can be considered as late Miocene or early Pliocene in age (15:4). The Mascall
formation and Squaw Creek formation are said to be Miocene in age, but were studied many years ago (5:34, 2:3).

The age of the basalts was determined through the identification of fossil material above, below, and inter-bedded within the basalts themselves. While tunneling through Yakima Ridge, about three miles north of Yakima, in 1936, the bones of a camel were found. These were said to be no younger than late Pliocene and no older than middle Miocene (8:19). Near Cle Elum, Washington, the Manashtash formation, which underlies the Columbia Basalts, is exposed. Within these sediments, plants from the Eocene have been found (8:16). The Ellensburg formation, overlying the Yakima Basalt, has been dated as early Pliocene on the basis of plant fossils (15:41).
CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Though the study of fossils has been carried on for many years throughout the world and particularly in the State of Washington, there are many areas still virtually unexplored. Yakima County displays this well with the earliest studies by Knowlton in the early 1890's and new sites still being found today.

Economics and inaccessibility are the leading reasons for the lack of interest in Yakima County geology. There is little wealth to be obtained from the geology of this county. Private, military, and Indian reservation lands are often closed to the public. Much of the region is too rugged or covered with dense timber; thus, making study difficult.

A fossil mollusk site found by the author in one of the more rugged areas brought questions to mind which led to this study. Finding little or nothing published about the site, it was decided to collect, identify, and interpret these fossils and search for other mollusk fossil locations in Yakima County. Positive location was made of a second site and tentative location of some six others. A detailed comparison of the stratigraphy, vegetation, and fossils of
the two positive sites was made. Yakima County is an area of wide variation as was found through study of the present day geography, climate, vegetation, geology, and rock structure.

Positive species identification of previously named fossil mollusks was found to be impossible due to the lack of accessible published material. Though the general characteristics of the fossils were sufficient to name the genera involved, the fine shell patterns and ornamentations are no longer there in most cases. The fossils are found in the form of a steinkern or stone core from within the shell rather than having the shell itself. But for correlation purposes between the two sites as well as any that may be found in the future, it became necessary to name new species.

Three species of fresh-water gastropods and one species of fresh-water pelecypod fossils were found at both the Sedge Ridge and Toppenish Ridge sites. Though these gastropods lived in the west in the past, they are now found only east of the Rocky Mountains.

By using the characteristics of the fossil mollusks as well as the age of the fossils found above and below the Yakima Basalt, in which the fossil mollusks are assumed to be interbedded, as well as the other fossils interbedded
between the basalt, the age of the fossil mollusks is determined to be late Miocene to early Pliocene. Such fossils as leaves and fruit from the Mascall formation of Oregon, petrified wood from the Squaw Creek Petrified Forest, fossil camel bones from Yakima Ridge, and fossil plants in sediments above and below the basalt were used as indicators.

These fossils and the present day locations of their equivalents helped determine the ecology of the fossils during their life. Trees from the forests of their time now live mainly in eastern Asia and eastern North America. Therefore, the climate would have been much different than at present to support those forests.

Conclusions

Both the Sedge Ridge and Toppenish Ridge locations are of the same geological age because they are interbedded between the same flows of basalt. They contain the same species and about the same number distribution within the species.

These organisms lived in a very slow-moving stream in about three to four feet of water. The great accumulation of mollusks is due to either a change in water temperature or chemical makeup in the water or both. It can be assumed that due to the temperature change and for lack of
oxygen, they began to float freely, as they do under those conditions today, and were trapped in great numbers in a settling basin. Because of the vast numbers of organisms, linked with the increase in temperature, the oxygen content became critical. They then died. With a very slight shifting of the organisms by the current, the smaller organisms were moved into the body whorls of the larger snails where they later fossilized.

The Sedge Ridge and Toppenish Ridge locations should be considered death assemblages of fossil mollusks, due to the number of gastropod specimens found with smaller gastropods or pelecypods inside the body whorl. If the gastropods were alive at the time of deposition the body cavity would be filled with the body of the organism, thus not allowing the entry of others.

In view of the study of living mollusks in the Yakima Valley, made by the author, it can be concluded that the fossil species are no longer living in Yakima County. No representative of any of the fossil families could be found.

The climate of Yakima County has changed since the time these fossils were alive. Because the trees mentioned in the Mascall flora and Squaw Creek Petrified Forest needed more moisture and a more even distribution of this moisture throughout the year, they could not exist here today. Today
we have little moisture, which is received mainly during the winter, and an extremely high evaporation ratio during the summer which would not allow the past forests to live here today.

These fossil mollusks lived in the late Miocene or early Pliocene.

There is yet much study needed to give a complete picture of the geology of Yakima County. Many regions have not yet been well examined; such as the forested areas, the more mountainous regions, and well drilling cores.
BIBLIOGRAPHY


APPENDIX
Figure 1
Map of Yakima County Mollusk Fossil Sites

1. Sedge Ridge
2. Toppenish Ridge
3. Indian Flats
4. Yakima Ridge
5. Rattlesnake Ridge
6. Ahtanum Ridge
7. Priest Rapids
8. Dry Creek
9. North Yakima
Figure 2

Sedge Ridge Location (CWSC I 018)
Sec.16, T.12N., R.15E.

Grid = Fossil Bed
/// = Fossil Float
---- = By Foot
-- = Jeep trail
[][] = Basalt
Figure 3
Toppenish Ridge Location (CWSC I 019)
Sec. 21, T. 9N., R. 17E.

= Fossil Bed
/// = Fossil Float
--- = Deep trail
--- = Dry stream
Figure 4

A View of the Southern Section of the Sedge Ridge Fossil Location
Figure 5

A View of the Northern Section of the Sedge Ridge Site
Figure 6

A View of Fossiliferous Material in the Slope Wash On Sedge Ridge and Basalt Cliffs in the Background
Figure 7

Fossils Found in the Slope Wash on Sedge Ridge
Figure 8
Toppenish Ridge Fossil Site
Figure 9
Fossils Found in Slope Wash on Toppenish Ridge
Figure 10

Specimens of *Viviparus* sedgenus
Right: holotype from Sedge Ridge
Left: Specimen from Indian Flats
Figure 11

Holotype Specimens
Right: *Flumniocola yakimana*
Center: *Goniabasis cascadenensis*
Left: *Sphadeium bearium*
Figure 12

Shell Features of Type Specimen
*Viviparus sedgenus*, Sedge Ridge
Figure 13

Shell Features of *Viviparus sedgenus*,
Toppenish Ridge
Figure 14

Shell Features of *Goniobasis cascadenensis*
Figure 15

Fluminiocola yakimana attached to Petrified Wood,
Sedge Ridge