Freshwater and Terrestrial Mollusca [1] of the Olympic Peninsula, Washington

BY

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(3 Text figures)

INTRODUCTION

THE OLYMPIC PENINSULA is one of the last frontiers for large-scale ecological research in the contiguous 48 states (FONDA & BLISS, 1969), yet there has not been a concerted study of the terrestrial and freshwater mollusks living on that remarkable thumb of land. The snail fauna of the peninsula is remarkable for several reasons. Not only is it depauperate in eastern species, but it also lacks several genera and species which are common in the nearby Cascade Mountains and on mainland Washington, Idaho and Oregon, such as the slug genus *Zacoleus* Pilsbry, 1903 and others (KOZLOFF & VANCE, 1958; HENDERSON, 1929b). This is also true of plants and higher animals. Eleven species of mainland mammals, for example (SHARP & SHARP, 1963) are lacking. The explanation for these faunal and floral absences has to be sought in the geologic history of the area (CRANDELL, 1963). During late Wisconsin times a massive piedmont glacier moved from the mountains of southwestern Canada, advancing into Washington, bifurcating into two separate tongues, the Puget Sound and the Juan de Fuca lobes. At its maximum development, the Puget Sound lobe spread out along the east side of the peninsula and the western slopes of the Cascades, completely isolating the area from the mainland. The Juan de Fuca lobe moved along the northern edge of the peninsula, breaching the northern extremity of the Olympic Mountains to spread southwesterly along a line just south of the Soleduck River. At the same time, many of the montane glaciers advanced down their valleys nearly to the sea. These glaciers left only the mountain slopes and a good share of the western peninsula as ice-free refugia, whereas mainland organisms were pushed steadily southward. Invasions of the peninsula apparently did not occur, and several groups of organisms still have not been able to reach the area because of its narrow, bottleneck-like connection with the mainland.

Several groups of organisms which were able to survive in the peninsular refugia seem to have evolved along lines that differed from the gens of the mainland. Such isolated evolutionary sequences, of course, resulted in the formation of endemic species. There are at least 19 endemic plant species present, 3 or more endemic slugs, and 2 or more endemic snails. Such endemics, however, are only one of 4 molluscan elements present on the Olympic Peninsula. The remaining 3 elements are comprised by preglacial relicts, by re-invaders from the south, and by exotic species introduced by the folly of humans.

DESCRIPTION OF AREA

The Olympic Peninsula is a thumb-like projection of land on the extreme northwestern corner of Washington, extending westward of the waterways formed by the Admiralty Inlet, Hood Canal and the upper Puget Sound, and southward from the Strait of Juan de Fuca to Gray's Harbor and the lower Chehalis River valley (Figure 1). The total area is relatively small – 10 400 km² (FONDA & BLISS, 1969) – with a Pacific Ocean front of more than 160 km. The Olympic Mountains, trending northwest to northeast with an average width of about 64 km, occupy the central portion of the peninsula. The Olympic National Park occupies nearly 364 000 ha of the highest (Mount Olympus: 2 425 m) and best-developed section of the mountains, and an 80.5 km strip along the Pacific Coast. Because the prevailing winds come from the southwest, the mountains intercept practically all moisture, creating an extensive rain shadow along the northeastern

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corner of the peninsula. Although the western slopes of the mountains may receive over 500 cm of annual moisture, the rain-shadow district gets less than 50 cm, a phenomenon which is strongly reflected in plant and animal distribution.

The western slope of the peninsula is marked by a series of relatively large river valleys, intervening mountain ridges and general hilly country (HEUSSER, 1964). In this sector, between Cape Flattery (extreme northwestern tip) and the mouth of the Hoh River, the country is rocky and irregular with a maximum elevation of about 365 m, most of the terrain, however, averaging less than 45 m above mean sea level. From the mouth of the Hoh southward, the peninsula rises from sea level up to over 350 m; this area can be typified as the "fog belt zone" (JONES, 1936).

Because of its relative far-northern position, juxtaposition to the sea, and the climate-directing role of the Olympic Mountains, all of the so-called life zones are depressed, and only 4 of them are present, the Arctic-Alpine, the Hudsonian, the Canadian, and the Transition (SHARP & SHARP, 1963, and others), and even these 4 occur at considerably lower altitudes than encountered at more southerly latitudes on the mainland, with some variability because of protection here and there, differences in slope factors, and other factors. The average elevations for these zones are: Arctic-Alpine, 1 524 - 2 134 m; Hudsonian, 762 - 1 524 m; Canadian, 417 - 914 m; Transition, under 457 m. There is, of course, a corresponding variation in plant growth and molluscan habitat conditions associated with this altitudinal effect.

The soil types of most of the Olympic Peninsula are principally lithosols, mainly under seral forests (FONDA & BLISS, 1969), and brown podzolics under the stable forests. Both types are extremely acid (pH 4.5 - 5.0). However, in many river valleys and lowlands, where good growths of broadleaf maple, vine maple, and red alder occur, the soils tend toward black organic, have considerably more available calcium, and exhibit pH values of 6.3 - 7.7.

Another phenomenon of considerable importance in the distribution of plants, and hence mollusks, is slope factor (FONDA & BLISS, 1969). Snow melt is much delayed on north-facing slopes, as in the upper Soleduck River basin, precluding the dense forests. Instead, wet subalpine meadows develop and persist for long periods of time. On the other hand, very dense forest conditions persist up to 1 500 m on the south-facing slopes.

In general, the vegetation of the Olympic Peninsula is classified as Pacific Coastal Forest, but there is much variation in community distribution. JONES' (1936) botanical survey of the peninsula is still highly useful. Also, FONDA & BLISS (1969) presented an excellent discussion of montane and subalpine forests, and KURAMOTO & BLISS (1970) studied the distribution of subalpine meadows. These papers served as the basis for plotting my collecting stations, *i. e.*, insuring as complete an ecological coverage as possible, including the spectacularly developed cryptogamic epiphyte area in the so-called Quinault Rain Forest (DAUBENMIRE, 1969) and the areas occupied continuously by local vegetation throughout the glacial epoch (HEUSSER, 1964), *i. e.*, from the Hoh River valley southward.

HISTORY OF RESEARCH

BINNEY & BLAND's (1869) records for *Prophysaon foliolatus* (Gould, 1851) at Discovery Bay and *Ariolimax columbianus* (Gould, 1851) constitute one of the earliest reports for any terrestrial or freshwater mollusk on the Olympic Peninsula. Practically all additional reports involve easily visited coastal regions or sites along main thoroughfares. PILSBRY & VANATTA (1898) recorded several sites for various slugs, and DALL (1910) reiterated some of those same records in his distributional interpretation for Alaskan snails. CRAIG's (1927) collections from mainland Washington provide data for comparative purposes. Probably the most important, and certainly the most extensive, papers on this fauna published during the first three decades of the twentieth century were those of HENDERSON (1929a, 1929b, 1935, 1936), which summarized existing collections and presented new data. HORACE B. BAKER (1930a) listed collecting sites from Clallam and Snokomish counties for *Haplotrema*. In his comprehensive treatment of North American land mollusks, PILSBRY (1939, 1940, 1946, 1948) summarized for the last time all published snail records for the Olympic Peninsula, adding, however, little new information.

During the remainder of this century few molluscan investigations have been conducted on the peninsular fauna. GOODRICH's (1942) work clarified some of the pleurocerid problems of the area, and MEAD's (1943) revision of *Ariolimax* eliminated some of the confusion in that genus, but practically none of his material was derived from extreme northwestern Washington. Recent investigation of the freshwater elements of the area are conspicuously lacking. HUBENDICK (1951) included several lymnaeids (by way of total range) in the fauna, and LAROCQUE (1953) did the same for several freshwater pelecypods and snails.

During my own preliminary studies of the area, several gastropod records were established (BRANSON, 1969; BRANSON, SISK & MCCOY, 1966), including the description of 2 new species (Branson, 1972, 1975), both putative endemics.

Localities and Habitats

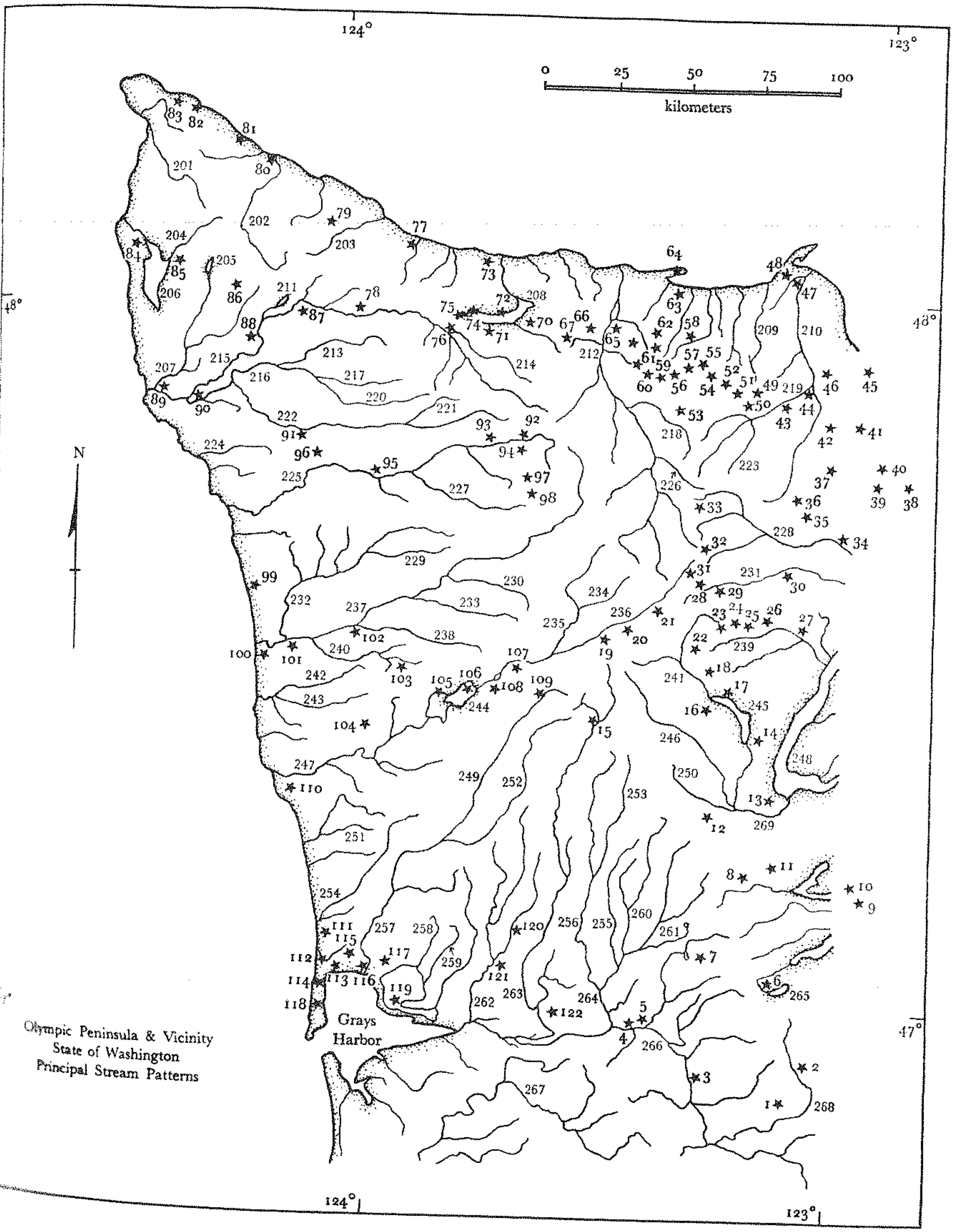
Descriptions of the collecting sites are presented below. The identifying numbers correspond to those on the locality map (Figure 1) and those presented in the annotated list.

1. Chehalis Indian Reservation, Black River crossing of State Route 12, S 33, R 4 W, T 15 N, Rochester Quadrangle, 24.4 m elevation; 30 June 1969
2. Small spring, tributary to Black River, S 27, R 3 W, T 15 N, Rochester Quadrangle, 36.6 m elevation; gravel and small stones; 30 June 1969
3. Near Chehalis River, State Route 12, southwestern tip S 12, R 5 W, T 16 N, Malone Quadrangle, 73.2 m elevation; western red cedar, vine maple, bigleaf maple; 30 June 1969
4. Schafer State Park, Chehalis River, S 29, R 7 W, T 18 N, Elma Quadrangle, 76.3 m elevation; 30 June 1969
5. Chehalis River, S 31, R 7 W, T 18 N, Elma Quadrangle, 74.2 m elevation, 30 June 1969
6. Upper end of Case Inlet, State Route 3, 0.8 km due N of Allyn, Allyn Quadrangle, 35 m elevation, 29 June 1969
7. Grant Ferry Road, 0.2 km above its junction with State Route 3, near upper end of Lake Spencer, Allyn Quadrangle, 31.6 m elevation, 29 June 1969
8. Near New Kamilche, S 20, R 3 W, T 18 N, Shelton Quadrangle, 23.4 m elevation, mixed forest, 29 June 1969
9. Clear-cut area, 8 km E of Olympia, S 11, R 2 W, T 18 N, Olympia Quadrangle, 61 m elevation, 12 August 1970
10. Cut-over lowlands forest, 8.8 km N of Olympia, S 14, R 2 W, T 19 N, Olympia Quadrangle, 45.8 m elevation, 12 August 1970
11. Cozy Valley, 4 km E of Tenino, S 27, R 1 W, T 16 N, Tenino Quadrangle, evergreen forest, 152.5 m elevation, 8 August 1970
12. Matlock Road, SW corner S 16, R 4 W, T 20 N, Shelton Quadrangle, 85.4 m elevation, Douglas fir, red cedar, red alder; 30 June 1969
13. Skokomish Indian Reservation, Skokomish River, 0.8 km above mouth, State Route 106, S 12, R 3 W, T 21 N, Potlatch Quadrangle, 164.8 m elevation, 29 June 1969
14. Garbage dump near Finch Creek, S 10, R 4 W, T 22 N, Potlatch Quadrangle, 152 m elevation, 27 June 1969
15. Trail shelter, Upper Satsop Lake, S 1, R 7 W, T 22 N, Satsop Quadrangle, dense mountain forest, 732 m elevation, 14 August 1970
16. Near upper end of Lake Cushman, S 15, R 5 W, T 23 N, Mount Tebo Quadrangle, alder and maple duff, 305 m elevation, 19 July 1969
17. Near upper end of Lake Cushman, S 11, R 5 W, T 23 N, rotting cedar logs, 256.2 m elevation, 19 July 1969
18. Near Staircase Rapids, Skokomish River, Olympic National Park, Mount Steel Quadrangle, bigleaf and vine maples, hemlock, Douglas fir, red cedar, 205 m elevation, 28 June 1969
19. Quinault River, 1.6 km below Graves Creek Ranger Station, Olympic National Park, Mount Christie Quadrangle, dense rain forest, 151.5 m elevation, 4 July 1969
20. Abandoned farm in rain forest, Quinault River valley, S 31, R 8 W, T 24 N, Mount Christie Quadrangle, 152.5 m elevation, 4 July 1969
21. O'Neil Creek Shelter, Enchanted Valley Trail, Olympic National Park, rain forest, 250 m elevation, 3 July 1969
22. Flapjack Lakes Trail, 3.2 km above ranger station, Olympic National Park, 658.8 m elevation, mountain hemlock and shrubs, 20 July 1969
23. Flapjack Lakes Trail, 8.0 km above ranger station, Olympic National Park, 1 494.5 m elevation, above timberline, low annuals, 20 July 1969
24. Gladys Divide above glacial cirque, Mount Steel Quadrangle, Olympic National Park, bare rocks, ferns, low annuals, 1 [illegible] elevation, 20 July 1969
25. Near mouth of Tumbling Creek (tributary of Dosewallips River), 4 km E of Dose Forks Shelter, Olympic National Park, dense evergreen forest, 442.3 m elevation, 27 June 1969
26. Dosewallips Campground, Olympic National Park, massive red cedar, Douglas fir and alder along streams, 500 m elevation, 2[illegible] June 1969
27. Hillside above Dosewallips Campground, Olympic National Park, talus slides, ferns, red cedar, Douglas fir, 521 m elevation, 27 June 1969
28. Honeymoon Meadows, Olympic National Park, 25.3 km above Dosewallips Ranger Station, grasses, forbs, annuals, alder, decaying logs, 1 075.7 m elevation, 22 July 1969
29. Honeymoon Meadows Trail, 12.8 km above ranger station, Olympic National Park, dense evergreen forest, 915 m elevation, 2[illegible] July 1969
30. Honeymoon Meadows Trail, 8.8 km above ranger station, Olympic National Park, stream margin vegetation, 872.3 m elevation, 22 July 1969
31. Enchanted Valley Trail, 4.8 km above Graves Creek Ranger Station, Olympic National Park, dense forest, heavy growths of Pacific dogwood, 260 m elevation, 3 July 1969
32. Sentinel Peak at U. S. G. S. benchmark (2 010.6 m elevation), Olympic National Park, sedges, grasses, annuals, 16 August 1970
33. Dose Meadows Trail Shelter, Olympic National Park, 1 357.3 m elevation, sedges, forbs, grasses, annuals, 15 August 1970
34. Seal Rock State Park off U. S. 101, Point Misery Quadrangle, 10.7 m elevation, salal, Douglas fir, 20 June 1969
35. North Point Lookout, Mount Walker, ferns, pines, spruce, hemlock, 875 m elevation, 26 June 1969
36. Below Mount Walker, U. S. 101, S 27, R 2 W, T 27 N, Quilcene Quadrangle, rocky hillside, ferns, mosses, 140.3 m elevation, 25 June 1969

(on facing page →)

Figure 1

Distribution of Collecting Stations, Olympic Peninsula, Washington. Numbers under 200 correspond to those in the locality descriptions; numbers over 200 correspond to those in the list of creeks, rivers and lakes.



Olympic Peninsula & Vicinity
State of Washington
Principal Stream Patterns

37. Junction of West Leland Road with U. S. 101, S 14, R 2 W, T 28 N, Quilcene Qaudrangle, maples, ferns, moss, alder, red cedar, 54.9 m elevation, 25 June 1969
38. Forested slopes 2.4 km SE of Camp Discovery, S 26, R 1 W, T 27 N, near radio relay station, Discovery Quadrangle, 187.3 m elevation, 9 August 1970
39. Terminus of Lindsay Road, "Bolton Peninsula," S 32, R 1 W, T 27 N, salal, alder, 18.3 m elevation, 9 August 1970
40. Forested lowland slopes, 1.6 km SE of Quilcene, S 20, R 1 W, T 27 N, Quilcene Quadrangle, 91.5 m elevation, 9 August 1970
41. Swampy lowlands near South Fork of Dungeness River, S 22, R 1 W, T 28 N, 152.5 m elevation, 7 August 1970
42. Forested slopes at headwaters of Tarboo Creek (tributary to South Fork of Dungeness River), S 17, R 1 W, T 28 N, 183 m elevation, 7 August 1969
43. Palo Alto Road, 14.4 km SE of Sequim, S 30, R 3 W, T 29 N, Tyler Peak Quadrangle, bluffs of Dungeness River, maples, Douglas fir, red cedar, ferns, mosses, 381.3 m elevation, 16 July 1969
44. Palo Alto Road, 16 km SE of Sequim, S 30, R 3 W, T 29 N, Tyler Park Quadrangle, talus, 337.3 m elevation, 13 July 1969
45. Swampy swale, R 1 W, T 29 N, Port Townsend Quadrangle, 61 m elevation, 25 June 1969
46. Near Carr Point, U. S. 101, R 2 W, T 29 N, Port Townsend Quadrangle, 60 m elevation, mixed forest, 25 June 1969
47. The "Potholes," S 39, R 4 W, T 30 N, marsh vegetation, 31.5 m elevation, 10 August 1970
48. Base of Dungeness Spit, S 34, R 4 W, T 31 N, sandy lowlands, 30 m elevation, 10 August 1970
49. Deer Park, Blue Mountain, Olympic National Park, alpine region, creeping phlox and other annuals, 1 832 m elevation, 5 July 1969
50. Deer Park, Blue Mountain, Olympic National Park, subalpine fir region, 1 660 m elevation, 6 July 1969
51. Deer Park, Blue Mountain, Olympic National Park, Krummholtz (subalpine fir and dwarfed Douglas fir, annuals, rocks) 1 760 m elevation, 5 July 1969
52. Deer Park, Blue Mountain, Olympic National Park, lower subalpine, 1 500 m elevation, 6 July 1969
53. Obstruction Peak, Olympic National Park, subalpine area, 1 510 m elevation, 13 July 1969
54. Deer Park Road, 16.5 km above junction with U. S. 101, talus slopes, 820 m elevation, 7 July 1969
55. Cox Valley, transition zone, R 5 W, T 29 N, Mount Angeles Quadrangle, 1 145 m elevation, 13 July 1969
56. Steep, open slopes, Hurricane Ridge Road, Olympic National Park, 6.4 km below terminus, dwarf alder, 1 525 m elevation, 14 July 1969
57. Hurricane Ridge Road, 4.8 km below terminus, Olympic National Park, fallen logs, annuals, 1 145 m elevation, 14 July 1969
58. Decaying homestead, Blue Mountain Road, S 14, R 5 W, T 29 N, Port Angeles Quadrangle, ferns, maples, Douglas fir, red cedar, hemlock, 457 m elevation, 24 June 1969
59. Moist subalpine meadows, 0.5 km below junction of Obstruction Peak Road with Hurricane Ridge Road, Olympic National Park, sedges, subalpine buttercup, grasses, 1 540 m elevation, 14 July 1969
60. Sedge slopes at junction of Obstruction Road with Hurricane Ridge Road, Olympic National Park, 1 570 m elevation, 14 July 1969
61. Heart O'Hills Campground, Olympic National Park, S 3, R 6 W, T 29 N, Port Angeles Quadrangle, Douglas fir, hemlock, mosses, 762.5 m elevation, 24 June 1969
62. Mount Angeles Trail off Hurricane Ridge Road, Olympic National Park, S 3, R 6 W, T 29 N, Port Angeles Quadrangle, [illegible] m elevation, 24 June 1969
63. Headquarters, Olympic National Park, S 15, R 6 W, T 30 N, Port Angeles Quadrangle, maples, Douglas fir, ferns, 760 m elevation, 29 June 1969
64. Ediz Hook, Coast Guard Station, T 30 N, R 6 W, driftwood, 68 m elevation, 12 July 1969
65. Elwha River Campground, Olympic National Park, S [illegible], R [illegible] W, T 29 N, Joyce Quadrangle, maples, grand fir, hemlock, [illegible] mosses, annuals, 610 m elevation, 23 June 1969
66. Near Lake Mills Overlook, Olympic Hot Springs Road, Olympic National Park, maples, ferns, scattered evergreens, mosses, 1 372.5 m elevation, 23 June 1969
67. Olympic Hot Springs, Olympic National Park, red alder, [illegible] evergreens, 6286 m elevation, 23 June 1969
68. Hurricane Hill, Hurricane Ridge, Olympic National Park, 1 738.5 m elevation, 13 July 1969
69. Idaho Shelter, Hurricane Ridge, Olympic National Park, 1 5[illegible] m elevation, talus, 13 July 1969
70. Mount Storm King, R 8 N, T 29 N, Joyce Quadrangle, 1 [illegible] m elevation, buckthorne, hemlock, talus, 21 June 1969
71. LaPoel Point, S 32, R 9 W, T 30 N, Lake Crescent Quadrangle, salal, 176.9 m elevation, 12 July 1969
72. Neagle Point, Lake Crescent, S 28, R 9 W, T 30 N, Lake Crescent Quadrangle, abandoned railroad in dense lowland forest, Olympic National Park, 219.6 m elevation, 21 June 1969
73. Lyre River bottoms near Lake Crescent, State Route 112, S 2[illegible], R 9 W, T 31 N, Lake Crescent Quadrangle, alder, ferns, grasses, 80.2 m elevation, 22 June 1969
74. Upper end of Lake Crescent, S 20, R 9 W, T 30 N, Lake Crescent Quadrangle, dense lowland forest, 283.7 m elevation, [illegible] June 1969
75. In water, Fairholm arm of Lake Crescent, S 30, R 9 W, T 3[illegible] N, Olympic National Park, 276.4 m elevation, 21 June 1969
76. Soleduck River, S 13, R 10 W, T 29 N, Lake Crescent Quadrangle, dense forest, 22 June 1969
77. Near Pysht, S 19 and 20, R 10 W, T 31 N, Pysht Quadrangle, spruce, maples, alder, deep, black soil, 6.1 m elevation, 18 June 1969
78. Near Soleduck River, 1.6 km W of Snider Ranger Station, S 27, R 11 W, T 30 N, Pysht Quadrangle, hemlock, spruce, ferns, rocks, logs, 381.3 m elevation, 21 June 1969
79. Near Pysht River, S 14, R 12 W, T 31 N, Pysht Quadrangle, maples, red cedar, hemlock, ferns, 243 m elevation, 18 June 1969
80. On coast, S 15, R 14 W, T 33 N, Clallam Bay Quadrangle, red cedar, salmon berry, hemlock, spruce, 9.8 m elevation, 18 June 1969
81. On coast, S 36, R 14 W, T 33 N, Clallam Bay Quadrangle, red cedar, salmon berry, 10 m elevation, 18 June 1969
82. Bluffs overlooking sea, S 17, R 14 W, T 35 N, Cape Flattery Quadrangle, 7.6 m elevation, 19 July 1969
83. Makah Indian Reservation, Neah Bay, S 11, R 15 W, T 33 N, salmon berry, hemlock, black cottonwood, spruce, 8 m elevation, 19 June 1969

84. Indian Village Nature Trail, S 25, R 15 W, T 30 N, Olympic National Park, spruce, mosses, ferns, alder, hemlock, 24.4 m elevation, 19 June 1969
85. Ozette Lake bluffs, garbage dump, S 3, R 15 N, T 30 N, 48.8 m elevation, 19 June 1969
86. Near Hoko Falls, S 7, R 13 W, T 31 N, Lake Pleasant Quadrangle, shaded spring with decaying vegetation, 61 m elevation, 19 June 1969
87. Tumbling Rapids, S 30, R 12 W, T 29 N, Lake Pleasant Quadrangle, maples, spruce, ferns, mosses, 122 m elevation, 20 June 1969
88. Maxfield Prairie, S 16, R 13 W, T 29 N, Douglas fir, grasses, 76.3 m elevation, 20 June 1969
89. Mora Campground, near Dickey River mouth, Olympic National Park, spruce, maple, Douglas fir, S 22, R 15 W, T 28 N, at sea level, 20 June 1969
90. Above mouth of Soleduck River, S 20, R 14 W, T 28 N, La Push Quadrangle, 12.2 m elevation, 20 June 1969
91. Near mid-length of Bogachiel River, S 1, R 12 W, T 27 N, Forks Quadrangle, alder, hemlock, 238 m elevation, 7 July 1969
92. Mount Olympus Trail, 5.8 km above Hoh Ranger Station, Olympic National Park, rain forest conditions, S 4, R 9 W, T 27 N, 305 m elevation, 11 July 1969
93. Hoh Campground, Olympic National Park, rain forest conditions, S 2, R 10 W, T 27 N, 189 m elevation, 10 July 1969
94. Soleduck Shelter (48°53′07″ N; 125°45′45″ W), Olympic National Park, 1 464 m elevation, 21 August 1970
95. Rain forest, just below South Fork of Hoh River, S 28, R 10 W, T 27 N, Spruce Mountain Quadrangle, maple, ferns, rain forest conditions, 131.2 m elevation, 11 July 1969
96. Rain forest, S 30, R 12 W, T 27 N, Spruce Mountain Quadrangle, 122 m elevation, 12 July 1969
97. Elk Lake, Hoh River Trail, Olympic National Park, (48°53′01″ N; 123°04′47″ W), 762.5 m elevation, 19 August 1970
98. Glacier Meadows Shelter, Mount Olympus, Olympic National Park, glacial moraines, ferns, annuals (48°50′00″ N; 123°04′46″ W), 1 830 m elevation, 19 August 1970
99. Kalaloch Campground, Olympic National Park, S 4, R 13 W, T 29 N, Destruction Island Quadrangle, skunk cabbage, 23 m elevation, 7 July 1969
100. Near Queets River, 0.4 km SW of Queets, U. S. 101, Quinault Indian Reservation, trash dump, S 3, R 13 W, T 23 N, Destruction Island Quadrangle, 24.4 m elevation, 7 July 1969
101. Flood plains of Queets River, Olympic National Park, S 26, R 12 W, T 24 N, Salmon River Quadrangle, 55 m elevation, 7 July 1969
102. Old glacial valley below Sams River, S 34, R 10 W, T 24 N, maples, ferns, 122 m elevation, 7 July 1969
103. Queets Campground, Olympic National Park, S 32, R 10 W, T 25 N, Salmon River Quadrangle, spruce, hemlock, maples, ash, 86.7 m elevation, 8 July 1969
104. Northeastern corner of S 17, R 11 W, T 23 N, Macafee Quadrangle, U. S. 101, fallen logs, 166 m elevation, 5 July 1969
105. Near Big Creek, S 3, R 9 W, T 23 N, Kloochman Quadrangle, alder, logs, 121 m elevation, 4 July 1969
106. Abandoned farm near upper end of Lake Quinault, rain forest conditions, R 9 W, T 23 N, Kloochman Rock Quadrangle, 61 m elevation, 2 July 1969
107. Near Quinault River, Graves Creek Ranger Station, Olympic National Park, rain forest conditions, 152.5 m elevation, 4 July 1969
108. Base of Mount O'Neill, near mouth of Merriman Creek, alder, devil's club, leaf litter, 183 m elevation, 2 July 1969
109. West Fork Shelter, West Fork of Humptulips River, Olympic National Park (47°52′55″ N; 123°04′54″ W), 244 m elevation, 13 August 1970
110. Quinault Indian Reservation, 2.4 km SW of Taholah, State Route 109, S 1, R 13 W, T 21 N, Tahola Quadrangle, trash heap, 6.1 m elevation, 1 July 1969
111. Low hillside, 3.2 km N of Copalis, State Route 109, grasses and oyster shells, 1 July 1969
112. Near coast, S 16, R 11 W, T 15 N, Tenino Quadrangle, 122 m elevation, 7 August 1970
113. Sparse forest, 3.4 km E of Heather, S 28, R 11 W, T 15 N, 48.8 m elevation, 7 August 1970
114. State Route 109 crossing of Cranberry Creek, Ocosta Quadrangle, sea level, 1 July 1969
115. Near Humptulips River, S 8, R 10 W, T 20 N, Humptulips Quadrangle, 30.5 m elevation, 2 July 1969
116. Mouth of Fairchild Creek, SW corner of S 28, R 10 W, T 20 N, Humptulips Quadrangle, 33.5 m elevation, 2 July 1969
117. Near Hoquiam River, NW corner of S 26, R 10 W, T 19 N, Humptulips Quadrangle, 49 m elevation, 2 July 1969
118. Ocean City State Park, Ocosta Quadrangle, at sea level, 2 July 1969
119. Hillside 1.6 km W of Hoquiam, State Route 109, shale and clay, 9.2 m elevation, 1 July 1969
120. Wynoochee Valley, S 33, R 8 W, T 18 N, Wynoochee Quadrangle, mixed forest, 1 July 1969
121. Wynoochee Grange, near Caldwell Creek, Wynoochee Valley, S 28, R 8 W, T 18 N, 58 m elevation, 1 July 1969
122. Sylvia Lake State Park, S 32, R 7 W, T 18 N, Montesano Quadrangle, 76.3 m elevation, 1 July 1969

[illegible] – Sooes River
[illegible] – Hoko River
[illegible] – Pysht River
[illegible] – Big River
[illegible] – Lake Dickey
[illegible] – Lake Ozette
[illegible] – Dickey River
[illegible] – Lake Cresent
[illegible] – McDonnel Creek
[illegible] – Dungeness River
[illegible] – Lake Pleasant
[illegible] – Elwha River

224 – Goodman Creek
225 – Hoh River
226 – Lost River
227 – South Fork of Hoh River
228 – Dosewallips River
229 – Solleks River
230 – Tshletshy Creek
231 – Duckabush River
232 – Clearwater River
233 – Sams Creek
234 – Rustler Creek
235 – North Fork of Quinault River

247 – Quinault River
248 – Hood Canal
249 – West Fork of Humptulips River
250 – Vance Creek
251 – Moclips River
252 – East Fork of Humptulips River
253 – Canyon River
254 – Copalis River
255 – Middle Fork of Satsop River
256 – West Fork of Satsop River
257 – Humptulips River
258 – West Fork

213 – North Fork of Calawan River
214 – North Fork of Soleduck River
215 – Soleduck River
216 – Calawan River
217 – Sikum River
218 – Lillian River
219 – Wolf River
220 – South Fork of Sikum River
221 – North Fork of Bogachial River
222 – Bogachial River
223 – Crazy River
236 – East Fork of Quinault River
237 – Queets River
238 – Matheny Creek
239 – Hama Hama River
240 – Salmon River
241 – North Fork of Skokomish River
242 – North Fork of Raft River
243 – Raft River
244 – Lake Quinault
245 – Lake Gushman
246 – South Fork of Skokomish River
259 – East Fork
260 – Decker Creek
261 – East Fork of Satsop River
262 – Wishkah River
263 – Wynoochee River
264 – Satsop River
265 – Lake Summit
266 – Chehalis River
267 – North River
268 – Black River
269 – Skokomish River

ANNOTATED LIST

In the discussion which follows, collecting sites are referred to by number, and the number of specimens collected is presented in parentheses.

PELECYPODA

Schizodonta

Unionidae

Margaritifera margaritifera falcata (Gould, 1850)

This species, according to Simpson (1914), has a very wide distribution, *i. e.*, throughout Europe, northern Asia, Japan, and western North America south to the 40th degree latitude, and east of the Rockies in the upper Missouri River and in eastern Canada, New York, Pennsylvania and New England. On the Olympic Peninsula, the species has been previously reported from Lake Crescent (1:1 ratio of purple and white nacred specimens), the Chehalis River and Mill Creek south of Shelton (Henderson, 1929a, 1936) and implied by distribution in LaRocque (1953). The 6 adult specimens reported here were secured from Lake Crescent at the Mount Storm King Ranger Station, Olympic National Park on 14 August 1970. All have purple nacre. With the exception of rather poorly developed laterals, the hinge teeth are well-developed and the ventral margins of the shells are arcuate, the periostracum black. These shells measure 66.0 to 73.0 mm in length and 33.5 to 35.1 mm in depth.

Anodonta kennerlyi Lea, 1860

Although the type locality for this species is Chiloweyuck Depot, Puget Sound (Simpson, 1914), the only published records for any peninsular locality is Lake Quinault at Gray's Harbor (Henderson, 1929a). I was unable to locate populations at that lake.

Heterodonta

Sphaeriidae

Although Craig (1927) and others have reported various species of sphaeriid clams from mainland Washington, most of these forms either have been unable to invade peninsular waters or they have remained undetected by later investigators.

Sphaerium patella (Gould, 1850)

In the Pacific Northwest, this species enjoys wide distribution in Washington, Oregon, Idaho and northern California (Herrington, 1962). Specimens in my collections came from stations 15, 47, 65, 92, and from Tarbuck Lake, 9.12 km north of Quilcene, Jefferson County (collected in August, 1963 by Mr. Tom Rice); Henderson (1929a) also reported specimens from Lake Whatcom, 8 km NW of Quilcene as *Sphaerium nobile* (Gould, 1855). The shell teeth of the right valve are very short and strongly curved, and the external sculpturing is very fine. A selected series of shells (10) averages 10.5 mm (6.0 - 12.5) in length and 8.0 mm (4.9 - 9.5) in height.

Sphaerium lacustre (Müller, 1774)

An extremely widely distributed sphaeriid in North America, Europe and Asia. The specimens reported here were secured by Tom Rice from Lake Leland, 4.8 km NW of Quilcene, Jefferson County, in August of 1963. Four specimens measure 6.4 mm (6.0 - 7.0) in length and 5.8 mm (5.5 - 6.0) in height.

Pisidium casertanum (Poli, 1791)

Reported by Henderson (1929a) from the Skokomish River, 12.8 km N of Shelton, Mason County. The synonymy of this species is so complicated (Herrington,

1962) that it is difficult to make sensible deductions from published records.

Pisidium variabile Prime, 1865

Reported from Lake Cushman, Mason County (HENDERSON, 1929a).

GASTROPODA

MESOGASTROPODA

PLEUROCERIDAE

The most recent review of Pacific Northwestern pleurocerid snails is that of GOODRICH (1942), who synonymized many of HENDERSON's (1935) species; species which were based upon shell size, color, and strength or weakness of sculpture, all characteristics which vary greatly from stream to stream and from headwaters to mouth. The relationships of western pleurocerids have always posed theoretical problems. In a previous paper (BRANSON, 1969), I relegated specimens from the Satsop River, 1.6km N of Satsop, Washington, to *Oxytrema* Rafinesque, 1819, principally because they deposited their eggs in single rows of close, irregular spirals as described by MORRISON (1954). However, specimens at the California Academy of Sciences (Allyn G. Smith, personal communication) are catalogued as *Juga*, mostly because of the influence of TAYLOR (1966) and H. B. BAKER (1963, 1967). All of this, of course, is mostly legalistic argumentation, which does very little to clarify the relationships of this highly interesting group of aquatic snails.

GOODRICH (1937, 1942), based upon collections of *Oxytrema (Juga) columbiensis* Whiteaves, 1905 from the Columbia River near Kootenay, British Columbia, thought the group was more or less closely related to *O. livescens* (Menke, 1830). Cytological evidence can be marshalled to support this contention, *i. e.*, both snails mentioned above have 36 (2 n) chromosomes (BURCH, 1967), although this is not particularly compelling evidence since many other American pleurocerids also have an equal number (WOODWARD, 1935; DAVIS, 1969; BURCH, 1967). On the other hand, the shell sculpturing and opercular characteristics of the Northwestern forms seem more similar to various species of the Asian genus *Semisulcospira* (BRANSON, 1969; BURCH, 1967). It may be significant that *S. cancellata* (Benson, 1833) has been found as a Miocene fossil in western Siberia (ZHADIN, 1952).

Oxytrema silicula (Gould, 1847)

Confined to streams and springs of central and western Washington and adjacent Oregon (GOODRICH, 1942; HENDERSON, 1935). Specimens reported by HENDERSON (1929a) came from a small pond on Aberdeen Road, 8km E of Elma; the Wynootche River, 1.6km W of Montesano; the Cloquallam River, E of Elma; and Mill Creek at Shelton. My specimens came from the following stations: 1 (57), 2 (81), 4 (9), 13 (24), 114 (20), *115* (10), *116* (30), and 121 (17). Also, 22 specimens were secured from a small unnamed creek, 2.9km W of Maytown, Millersylvania State Park, 30 June 1969; and 15 were taken from a brook 11.2km N of Vancouver, Washington on 22 August 1970; and 7 from Scatter Creek at Tenino, Washington on the same day.

This pleurocerid is restricted to portions of streams below the falls line, and most specimens are more or less typical for the species. However, the population at Millersylvania State Park – on the southern extremity of the peninsula – have some characteristics which make them similar to *Oxytrema plicifera* (discussed below), *i. e.*, straight rather than curved rib-sculpturing and larger, heavier shells. In the other populations discussed above, the ribs vary from very heavy to moderate, being crossed by spiral lines. These ribs usually stop short of the last 2 to 2½ whorls, but at stations 13 and 1 they are present on all whorls. The apex is eroded in most specimens, 4 to 10 whorls remaining. As far as color is concerned, most shells are horn-yellow to yellowish brown, although they appear dark because of a dense black deposit. Most shells possess a revolving reddish-brown band near the suture and one within the aperture.

Oxytrema (Juga) plicifera (Lea, 1838)

Found in many of the larger streams of western Oregon and Washington; there are no records from the Olympic Peninsula. However, I have 55 specimens (5 August 1969) from the South Nemah River at Nemah, Washington, and 26 (5 August 1973) from the Sutton Creek crossing of U. S. 101, 9.6km N of Florence, Oregon. Although these shells resemble those of *O. silicula*, the aperture is more attenuate below, the ribs are strongly curved and scattered rather than being regularly arranged on the lower whorls, and the spiral threads are "beaded" where they cross the ribs. The two taxa are possibly conspecific, and if so, *O. plicifera* has priority.

Viviparidae

Viviparus malleatus (Reeve, 1864)

The native range of this introduced species probably includes the Kuril Islands and Japan (Zhadin, 1952). Not previously recorded from the peninsula, the 6 specimens listed here were secured by Tom Rice from Lake Leland, 4.8km NW of Quilcene, Jefferson County, Washington.

Hydrobiidae

Although the most recent summary of this family is that of Wenz (1938-1944), Taylor (1966) presented some important taxonomic revisions, one of which applies to the fauna considered here. In erecting the new subfamily Lithoglyphinae, Taylor (*op. cit.*) indicated that the putative genus *Fluminicola* Stimpson, 1865 should be included in the genus *Lithoglyphus* Hartmann, 1821, and I follow his reasoning.

Lithoglyphus virens (Lea, 1839)

Reported from streams near Montesana (Henderson, 1936).

Lithoglyphus nuttalliana (Lea, 1838)

Scatter Creek at Tenio; Cloquallum River, 35km E of Aberdeen; Mile Creek S of Shelton; a stream 8km E of Elma (Henderson, 1929a); Tumwater Falls at Olympia (Henderson, 1936). The following specimens were collected from 8 of my stations: 1 (14), 2 (6), 4 (3), 5 (3), 114 (10), 115 (1), 116 (5), and 121 (13). In addition, 13 specimens were collected from a small stream at Millersylvania State Park (30 June 1970), 1 from Scatter Creek at Tenino (19 August 1970), and 6 from the South Nemah River at Nemah (5 August 1969).

BASOMMATOPHORA

Lymnaeidae

Lymnaea humilis Say, 1822

The principal literature sources are Baker (1911) and Hubendick (1951). Henderson (1936) recorded *Lymnaea caperata* Say, 1829 from "Olympia," a species relegated to the synonymy of *L. humilis* by Hubendick (*op. cit.*). My collections contain 6 specimens from site 96.

Lymnaea emarginata Say, 1821

Intimated by range (Hubendick, 1951). I collected [illegible] specimens from a small pond 800m E of Maytown, Washington on 30 June 1969. The shells are very glossy, light horn-color and nearly transparent; marked by cross-hatched sculpturing. Measurements: 10.5 - 14.5mm in length, 7.0 - 9.0mm in diameter, with $4\frac{3}{4}$ - 5 whorls. The aperture measures 7.0 to 9.0mm in length and 4.5 - 5.[illegible] mm in greatest width.

Lymnaea stagnalis (Linnaeus, 1758)

Intimated by range (Hubendick, 1951).

Lymnaea bulimoides Lea, 1841

Intimated by range (Hubendick, 1951).

Ancylidae

The most recent review of this family in North America is that of Basch (1963), and I follow his work in assigning the following epithets.

Ferrissia rivularis (Say, 1817)

The following living specimens were collected from 3 stations: 2 (3), 89 (7), 121 (4). Measurements: 3.3-5.0 mm in length, 2.0 - 3.1mm in width.

Ferrissia fragilis (Tryon, 1863)

Basch (1963) reported this species from Lake Isabella, Mason County, Washington, and Mr. Tom Rice sent me 3 specimens secured on 13 June 1963 from Lake Leland, 4.8km NW of Quilcene, Jefferson County. Measurements of the latter specimens are: 3.0 - 4.0mm in length, 2.0 - 2.5 mm in width.

Ferrissia parallela (Haldeman, 1841)

Very common in Lake Crescent, and 6 specimens were secured for the record at site 75. Measurements: 6.2 - 7.0 mm in length, 4.0 - 4.4mm in width.

Planorbidae

The principal reference for this family is Baker (1945).

Helisoma occidentale (Cooper, 1870)

Intimated by range (Baker, 1945), and reported from Lake Leland S of Sequim (Henderson, 1936).

Helisoma binneyi (Tryon, 1867)

Henderson (1929a), reporting specimens from Lake Leland, 8 km NW of Quilcene, indicated that the species probably occurred in most of the lowland lakes on the peninsula. However, I was unable to find it in any of the upland ponds and lakes visited. Mr. Rice sent me 2 well-preserved shells (14.0 - 17.5 mm in diameter, 8.5 - 10.0 mm in height, 3½ and 4 whorls) from Rice Lake near Quilcene.

Menetus cooperi F. C. Baker, 1945

Although Henderson (1929a, 1936) reported *Menetus opercularis* (Gould, 1847) from a Skykomish River slough 12.8 km S of Quilcene, Lake Leland SE of Sequim, and from the Chehalis, Quilleute and Tumwater rivers, Baker (1945) indicated that this species is restricted to California. The only species occurring in coastal regions from northern California to southern British Columbia is *M. cooperi*. The following specimens were collected: 44 (4), 65 (19), and 92 (13).

Gyraulus vermicularis (Gould, 1847)

The specimens reported here are typical in sculpturing and shell shape of the Pacific Northwestern form: 26 (3), 86 (13), 118 (1). Measurements: 6.3 - 6.5 mm in diameter, 2.5 - 2.6 mm in height, with 3⅘ to 4⅓ whorls. Branson (1969) also reported this tiny snail from the mouth of the Lilliwaup River.

PHYSIDAE

This is, perhaps, one of the most perplexing groups of snails in America, since nearly all species have been based upon shell characteristics alone, characteristics which are in the main highly variable and unreliable. Despite this, however, I am able to recognize 2 categories or kinds of *Physa* in the Olympic Peninsular fauna. One type exhibits a relatively short spire, a gibbously inflated and shouldered body whorl – *P. lordi* – and the second form with a small size, longer spire, and a shallower suture line – *P. ampullacea*.

Physa ampullacea Gould, 1865

Specimens were collected from the following stations: [illegible], 13 (3), 70 (3). Tom Rice also sent 4 specimens from Rice Lake, near Quilcene, Jefferson County (18 June 1963). Branson (1969) reported the species from the mouth of the Lilliwaup River, and Henderson ([illegible]) (as *P. gabbi* Tryon, 1863) from a small slough [illegible] km NW of Quilcene, and from Lake Leland. Measurements: 13.0 - 18.7 mm in length, 8.5 - 11.0 mm in diameter, 9.0 - 14.3 mm in apertural length, 4.5 - 6.5 mm in apertural width, with 3½ - 5¼ whorls.

Physa lordi Baird, 1863

Thirteen living specimens were collected at station 4 and Tom Rice sent 3 additional ones from Lake Leland, 4.8 km NW of Quilcene, Jefferson County. All of the shells have a twisted columella, and most of them are heavily infested with strigeid larvae. Measurements: 12.5 - 15.3 mm in length, 8.0 - 10.9 mm in diameter, 10.0 - 12.5 mm in apertural length, 4.5 - 6.0 mm in apertural width, with 3½ - 4⅓ whorls.

CARYCHIIDAE

Carychium occidentalis Pilsbry, 1891

The following living specimens were collected: 10 (31), 21 (6), 38 (23), 96 (26). In addition, 27 dead shells were secured from the lowlands near the mouth of the Duckabush River (18 July 1969), and 5 from Second Beach near La Push, Olympic National Park, same date. Pilsbry reported the species from Rialto Beach, Port Angeles, Lake Crescent and Piedmont in Clallam County, and Brook Valley and Esperance, Snohomish County.

STYLOMMATOPHORA

HELMINTHOGLYPTIDAE

Monadenia fidelis (Gray, 1834)

Living specimens were secured from the following sites: 6 (3), 8 (2), 9 (4), 10 (1), 11 (6), 12 (1), 18 (3), 27 (3), 31 (1), 32 (1), 35 (2), 36 (3), 37 (1), 38 (2), 39 (1), 44 (2), 47 (2), 52 (3), 55 (3), 58 (1), 65 (11), 66 (5), 70 (1), 92 (2), 95 (1), 96 (2), 102 (2), 103 (1), 105 (1), 108 (1), 109 (1), and 1 from Sequim State Park (26 June 1969). Literature reports include sites from near Olympia and 13 km NW of Kelso (Henderson, 1929a), Port Angeles and Chehalis (Pilsbry, 1939), and Hoh River Ranger Station (Branson, Sisk & McCoy, 1966).

The base varies from uniform chestnut brown through dark mahogany to black with a light yellowish band below or exactly on the periphery and a dark band above it. The growth striae are rough and widely spaced, and the lip reflection covers approximately ⅙ of the umbilicus. The mantle is marked with a bold, rust-colored band and there are some sparse black reticulations behind the head. Adult shell measurements are: 20.8 mm (16.5 - 23.8) in height, 31.9 mm (25.8 - 35.5) in diameter, 4.2 mm (3.5 - 5.3) in umbilicus diameter, with $6\frac{2}{5}$ ($6 - 6\frac{3}{4}$) whorls.

CAMAENIDAE

Megomphix hemphilli (W. G. Binney, 1879)

This snail has often been confused with *Haplotrema*, although there are many conchological and soft anatomical differences. The following specimens were collected: 3 (1), 26 (1), 40 (2), 42 (1), 44 (2), 48 (1), 52 (1), 54 (6), 67 (2), 94 (1), 105 (1), 113 (2). Also, 2 shells were secured from a site near the mouth of the Duckabush River (18 July 1969) and 1 from near the Quilcene River dam. HENDERSON (1929a, 1936) and PILSBRY (1946) recorded the species from Olympia. Measurements: 10.1 mm (8.5 - 12.5) in height, 20.1 mm (16.0 to 28.6) in diameter, 4.1 mm (2.7 - 6.0) in umbilical diameter, with 5 ($4\frac{1}{2} - 6$) whorls.

POLYGYRIDAE

The principal authority for this family was PILSBRY (1928, 1940).

Triodopsis germana (Gould, 1851)

PILSBRY (1940) distinguished between forms occurring north and south of the Columbia River as *Triodopsis germana vancouverinsulae* (Pilsbry & Cooke, 1922) and *T. germana germana* (Gould, 1851), respectively, indicating that the differential characteristics did not intergrade in his materials. However, specimens from the southern, seaward portions of the peninsular area are sometimes imperforate and are as densely hirsute as ones from Oregon. Specimens were collected from the following sites: 8 (1), 12 (2), 13 (1), 16 (2), 18 (1), 19 (1), 36 (1), 37 (2), 41 (2), 46 (1), 48 (2), 65 (1), 66 (2), 72 (1), 79 (1), 82 (1), 87 (1), 88 (5), 99 (5), 100 (1), 102 (6), 104 (1), 106 (1), 112 (2), 120 (1). Also, single living specimens were collected from Grays Harbor (27 July 1969) and Camp Collins 13 km above the mouth of the Duckabush River (18 July 1969), and from Second Beach near La Push (27 July 1969). Two live specimens were secured from Cannon Beach, Oregon, just off U. S. highway 101 (5 August 1968). Measurements for the peninsular specimens: 4.98 mm (4.3 - 5.5) in height, 7.8 mm (6.8 - 8.5) in diameter, with $4\frac{1}{4} - 5\frac{1}{3}$ whorls. The Oregon shells measured: 6.0 mm in height, 8.5 mm in diameter, with $5\frac{1}{2}$ whorls, were paler in color, had dense periostracal hairs, and sparse melanin deposits in the soft parts.

Allogona townsendiana (Lea, 1838)

This species is nearly entirely restricted to extreme northwestern Oregon near the mouth of the Columbia River and to the moister western portion of Washington and adjacent British Columbia (PILSBRY, 1940). The distribution of *Allogona ptychophora* (Brown, 1870) lies to the north (British Columbia) and east in Alberta, eastern Washington, Montana, Idaho and adjacent Oregon, although the species does extend westward along the Columbia River (PILSBRY, 1940; HENDERSON, 1936). *Allogona townsendiana brunnea* Vanatta, 1924 is here considered as a synonym of *A. townsendiana*, since very dark individuals are found throughout the range of the species. Also, in my estimation, *A. townsendiana* is a more or less recent invader of the Olympic Peninsula, since it is restricted to peripheral areas, and is probably a derivative of *A. ptychophora*. My specimens were collected from 4 stations: 3 (1), 6 (5), 12 (2), 37 (23). These specimens exhibited the following measurements: 18.4 mm (16.5 - 20.5) in height, 28.2 mm (26.5 - 31.5) in diameter, with $5\frac{1}{2} - 6$ whorls.

Vespericola columbiana (Lea, 1838)

The literature on this species is rather confusing, particularly where 2 or more so-called subspecies are reported from single localities. Hence, I have not attempted to diagnose races. However, I do believe that *Vespericola columbiana pilosa* (Henderson, 1928) – the most prevalent form on the Olympic Peninsula – is probably a distinct species.

Records from the literature include: Olympia, Carnation, Centralia, La Push (HENDERSON, 1929a); near Satsop, Castle Rock, Stella, Olympia, Chehalis (HENDERSON, 1936); La Push, Rialto Beach, Port Angeles, and the "Olympic Mountains" (PILSBRY, 1940). New records: 1 (2), 8 (5), 9 (2), 10 (3), 11 (1), 12 (1), 15 (2), 17 (1), 18 (10), 19 (1), 21 (2), 26 (3), 27 (4), 31 (5), 32 (2), 33 (1), 35 (1), 37 (4), 38 (2), 40 (1), 41 (4), 42 (2), 44 (1), 45 (6), 46 (4), 47 (2), 48 (6), 55 (2), 58 (1), 61 (1), 63 (2), 66 (1), 70 (2), 72 (3), 73 (2), 74 (1), 76 (2), 78 (8), 84 (1), 86 (1), 88 (6), 90 (2), 91 (2), 92 (4), 94 (1), 96 (1), 99 (2), 100 (8), 102 (4), 103 (2), 105 (2), 106 (4), 107 (1), 109 (2), 111 (2), 112 (3), 117 (1), 118 (5), 119 (2); 2 from near Forks (25 July 1969), 1 from 0.5 km E of Maytown (30 June 1969), 1 from banks of South Nehah River, U. S. highway 101 (5 August 1969), and 1 from Del Norte Redwoods State Park, 14.4 km S of Crescent City, California. Measurements: 9.1 mm (7.3 - 11.1) in height, 13.1 mm (11.1 - 16.0) in diameter, with $5\frac{1}{5} - 6\frac{1}{5}$ whorls.

HAPLOTREMATIDAE

Another taxonomically complicated family, mostly because of inadequate anatomical investigation of western species. Detailed dissections shall doubtless reveal undescribed species in western Washington, particularly in the *Haplotrema sportella* complex.

Haplotrema vancouverensis (Lea, 1839)

Widely distributed from northern California to Alaska, this is a highly variable snail, particularly in coloration and shell sculpturing. Previous records from the peninsula include: Surprise Valley, Jefferson County (BRANSON, SISK & McCOY, 1966), Clallam, Jefferson and Gray's Harbor (PILSBRY, 1946), Tillamook, Clallam and Olympia (HENDERSON, 1929a), and Clallam (H. B. BAKER, 1930a). New records: 3 (1), 11 (2), 17 (1), 18 (6), 19 (2), 20 (1), 22 (1), 26 (6), 27 (1), 30 (1), 31 (4), 32 (3), 35 (2), 37 (7), 39 (2), 41 (3), 44 (2), 45 (2), 47 (3), 55 (1), 59 (1), 65 (5), 69 (1), 70 (1), 72 (1), 74 (1), 76 (4), 77 (1), 79 (4), 89 (5), 94 (1), 96 (1), 99 (2), 102 (4), 103 (1), 105 (1), 106 (2), 107 (4), 109 (1), 110 (1), 113 (3), 114 (1), 119 (1), and the following: 2 from Olympic National Forest Camp Collins, 8km above mouth of the Duckabush River (18 July 1969), 3 from Sequim Bay State Park (25 June 1969), 3 from Second Beach near La Push (27 July 1969), and 3 from Del Norte Redwood State Park, 14.4km S of Crescent City, California (6 August 1969).

The sides of the body bear diagonal rows of large, coarse granules, and the mantle behind the head is light tan, grading to a darker brown with lines and blotches; in *Haplotrema sportella*, the mantle is dead white and immaculate. Measurements: 11.4mm (7.0 - 13.5) in height, 22.8mm (13.6 - 28.5) in diameter, 5.6 (3.0 - 7.0) in diameter of umbilicus, 10.7 (6.3 - 13.9) in width of spire, with 4½ to 6¼ whorls.

Haplotrema sportella (Gould, 1846)

Haplotrema sportella hybrida (Ancey, 1888) reported from Olympia, Pacific Beach and Clallam Bay by HENDERSON (1929a), should be investigated in order to determine its status, for, as indicated by PILSBRY (1946), *H. sportella* is quite a variable species. Additional peninsular records are: Spencer Forest Camp (BRANSON, 1969), Moro Beach, Port Angeles, Olympia (PILSBRY, 1946), "eastern slopes of the Olympic Mountains," Chehalis, Olympia, Satsop, Porter, Port Townsend (HENDERSON, 1936), Snohomish and Clallam counties (H. B. BAKER, 1930a), and along Hoh River and Olympia (HENDERSON, 1929a). New records: 2 (1), 6 (7), 8 (19), 10 (1), 15 (2), 16 (2), 18 (12), 19 (4), 19 (2), 21 (2), 24 (1), 26 (3), 27 (5), 31 (3), 34 (4), 35 (2), 36 (1), 37 (3), 38 (2), 40 (3), 42 (2), 44 (10), 45 (3), 46 (4), 48 (4), 58 (3), 62 (1), 63 (4), 65 (3), 66 (1), 70 (7), 72 (7), 73 (4), 74 (1), 76 (1), 78 (6), 81 (3), 82 (2), 87 (3), 88 (8), 89 (2), 90 (2), 91 (3), 92 (4), 95 (2), 96 (5), 99 (1), 100 (1), 101 (1), 102 (2), 104 (1), 105 (6), 108 (1), 109 (3), 113 (1), 114 (2), 122 (1), and the following: 8 from Sequim Bay State Park (25 June 1969), 5 from 8km SW of Forks via U. S. highway 101 (25 July 1969), 1 from Second Beach near La Push (27 July 1969).

There is some very light tan stippling on the head, but bold, dark markings are lacking on the mantle. Measurements: 7.4mm (4.5 - 10.5) in height, 15.3mm (8.0 - 21.5) in diameter, 4.1mm (2.5 - 6.0) in umbilical diameter, 8.0 mm (4.2 - 11.5) in spire width, with 4+ - 6⅛ whorls.

ZONITIDAE

Euconulus fulvus (Müller, 1774)

Not common on the Olympic Peninsula, even in the mountains. Records: 97 (2), 98 (1), 103 (4). Measurements: 2.15 - 2.68mm in diameter, with 4⅓ - 5⅜ whorls.

Oxychilus draparnaldi (Beck, 1902)

This and the next species, both exotic to North America, have achieved a relatively wide distribution (DUNDEE, 1969, 1974; HANNA, 1966). Although not previously reported from the Olympic Peninsula, *Oxychilus draparnaldi* (native to Europe and adjacent Africa) has been recorded from Seattle (PILSBRY, 1946). Eight immature specimens, measuring 4.0 - 6.8mm in diameter and possessing 3½ to 4⅓ whorls, were collected at station 85. The shells are very pale amber and nearly transparent; the aperture is very oblique, the last whorl being much wider than the preceding one.

Oxychilus alliarius (Miller, 1822)

A single specimen of this European exotic species was collected on 18 July 1969 from the lid of a garbage can, 8 km above the mouth of the Duckabush River, in a National Forest campground. The shell measures 5.3mm in diameter, 2.7mm in height, 1.1mm in umbilical diameter, and has 4½ whorls. Not previously reported from the peninsula.

Retinella electrina (Gould, 1841)

Two specimens from station 70 at 1200m elevation. A poorly understood species in the Pacific Northwest.

Retinella binneyana occidentalis H. B. Baker, 1930

There may be a complex of species included under this designation, since some of the animals are much paler than others. However, this may also be an edaphic or ground-temperature effect, or both. The species was reported previously from Clallam and Snohomish counties (Pilsbry, 1946), and I have it from the following localities: 16 (1), 102 (4), 103 (3), 105 (2). Measurements: 3.6mm (2.3 - 6.0) in diameter; 3 - 4 whorls.

Pristiloma Ancey, 1886

This genus is strictly western in distribution, in the Pacific Coastal region from southern Alaska to California, Montana and Utah; one species apparently lives in Japan (Pilsbry, 1946). The principal reference is H. B. Baker (1931).

Pristiloma stearnsi (Bland, 1875)

Previously reported from Olympia (Dall, 1910; Henderson, 1929a) and Clallam and Lake Quinault and Olympia (Pilsbry, 1946). Four of my collecting stations yielded the following: 27 (1), 54 (3), 59 (1), 105 (1).

Pristiloma arcticum (Lehnert, 1884)

Distributed from Alaska to northern Oregon, this is mostly a high-country snail. It is a relatively common species near the timberline on mounts Rainier, Baker and Adams on mainland Washington. Records: 24 (1), 26 (4), 56 (3), 57 (1), 69 (1), 71 (1), 96 (4), 97 (2), 98 (1), 103 (1), and from Second Beach near La Push (27 July 1969), 5 from near the mouth of the Duckabush River at U. S. highway 101 (18 July 1969). Measurements: 1.4mm (1.1 - 2.1) in height, 2.3mm (1.8 - 3.5) in diameter, with $3\frac{2}{3}$ to $5\frac{1}{2}$ whorls.

Pristiloma lansingi (Bland, 1875)

Apparently the most common *Pristiloma* on the peninsula. Previously recorded from Clallam County (Henderson, 1936) and Snohomish County (Pilsbry, 1946). New records: 17 (1), 44 (12), 89 (4), 92 (3), 96 (11), 102 (5), 108 (1), and 1 from Forks (25 July 1969).

Pristiloma johnsoni (Dall, 1895)

The only peninsular record for this species is that of Henderson (1936), repeated by Pilsbry (1946), from Clallam County. New Records: 19 (2), 54 (6), 103 (2).

Pristiloma wascoense (Hemphill, 1911)

Not previously reported from Washington. A single living specimen from station 59 at 1540m elevation seems closer to this species than any other. It measures 1.3mm in height, 2.2mm in diameter, 0.24mm in umbilical diameter, and has $3\frac{2}{3}$ whorls.

Hawaiia minuscula (Binney, 1840)

Although not previously reported from Washington, principally because of inadequate collecting, this species is not uncommon in adjacent British Columbia (Pilsbry, 1946, and others). A single dead shell collected from station 44.

Zonitoides arboreus (Say, 1816)

Although this species reaches relatively high altitudes in many western latitudes (Raymond, 1892; Cooper, 1892), it is not particularly common on the englaciated slopes of the Olympic Mountains, although it is one of the few species found at and above the timberline. Specimens were collected from these sites: 26 (4), 27 (3), 51 (8), 52 (1), 68 (3), 69 (2), 88 (2), 97 (1), 99 (2), 102 (2), 103 (1), and 11 from a low-lying swale 3.2km NE of La Push (28 July 1969).

Striatura pugetensis (Dall, 1895)

"Many places in Clallam, King, Pacific, Pierce and Snohomish counties" (Pilsbry, 1946). Also see discussion under *Radiodiscus* below.

Vitrina alaskana Dall, 1905

Found only at a few localities at high elevations: 50 (1), 51 (19), 59 (3), 60 (9), 97 (4), 98 (6).

Endodontidae

Discus cronkhitei (Newcomb, 1865)

There is a great paucity of records for this species in Washington (Pilsbry, 1946), and there are apparently no previous reports from the Olympic Peninsula. My specimens were collected from 2 stations only: 26 (5) and 29 (3).

Punctum randolphi (Dall, 1895)

Previously reported from Lake Crescent, Port Angeles and Esperance (Pilsbry, 1948). New records: 29 (1), 44 (1), 96 (2). Measurements: 0.87mm (0.8 - 0.92) in height, 1.31mm (1.2 - 1.44) in diameter, 0.24mm (0.21 - 0.28) in umbilical diameter, with $3\frac{3}{4}$ to 4 whorls.

Punctum conspectum (Bland, 1865)

Reported previously only from Snohomish County (Pilsbry, 1948). New record: dead shell from station 78.

Radiodiscus hubrichti Branson, 1975

Drs. Wayne Grim and Alan Solem believe this to be a species of *Striatura* rather than *Radiodiscus*. However, until the soft parts are examined more fully, because of the shell size and sculpture characteristics (Branson, 1975), it seems best to leave its status quo for the time being. The following sites are reported here: 16 (1), 44 (1), 64 (5), 70 (1), 71 (2), 92 (1), 96 (7), 102 (2), 103 (2), and 1 from Second Beach near La Push (27 July 1969) and 2 from near the mouth of the Duckabush River (18 July 1969).

Pupillidae

Pupilla hebes (Ancey, 1881)

Probably the most abundant snail at and above the timberline, where it utilizes creeping phlox colonies as the principal habitat. Heretofore unrecorded from the peninsula. Records: 49 (45), 96 (1), 97 (13), 98 (11).

Vertigo columbiana Sterki, 1892

Probably a synonym of *Vertigo ventricosa* (Morse, 1865), this form was previously reported from Lake Quinault and Olympia (Henderson, 1929a; Pilsbry, 1948). New records: 54 (3), 95 (1), 96 (1), 102 (2), and 2 from Second Beach near La Push (27 July 1969).

Vertigo andrusiana Pilsbry, 1899

Not seen by me. Reported from Lake Quinault, Chehalis County (Henderson, 1929a; Pilsbry, 1948).

Vertigo modesta (Say, 1824)

Vertigo modesta is probably a complex of species. In fact, the genus is badly in need of thorough revision. Records: 92 (2), 96 (3), 103 (6).

Columella alticola (Ingersoll, 1875)

Not heretofore reported from Washington. Three specimens from station 56. Measurements: 2.6 mm (2.5 - 2.8) in height, 1.5 mm in diameter, with $5\frac{5}{8}$ to $6\frac{1}{3}$ whorls.

Vallonidae

Vallonia cyclophorella Sterki, 1892

Not previously reported from the peninsula, although it is a relatively common species around Walla Walla (Pilsbry, 1948). Five specimens collected near the mouth of the Duckabush River (18 July 1969).

Planogyra clappi (Pilsbry, 1898)

Previously reported from Brook Valley and Esperance, near the mouth of the Quillaute River, Boundry Creek, Crescent Lake and Piedmont (Pilsbry, 1948). New records: 44 (7), 96 (3), 102 (1). Measurements: 1.2 mm (1.06 - 1.46) in height, 1.9 mm (1.7 - 2.2) in diameter, with $3\frac{1}{8}$ to $3\frac{3}{4}$ whorls.

THE SLUGS

I have purposely saved the discussion of the slugs until last because of several interesting distributional and biological problems. For one thing, the exotic slug element is practically as large as the known native fauna, not only on the Olympic Peninsula, but in coastal Washington in general. Thus far, 8 species of European origin have been catalogued, a massive number when one considers the nation as a whole. The principal mechanism of slug importation is through the distribution of plant materials. But regardless of how they got there, the ecology of exotic slugs on the peninsula is intimately associated with the distribution of refuse dumps. As many as 50 specimens of 6 different species were observed at a single site. Furthermore, because of the Mediterranean-like environment of much of the peninsula, these introductions are truly unfortunate, and for several reasons.

Native American slugs seldom produce huge aggregations, being more or less solitary in their habits. Usually, such species are integrated parts of well-established communities, being held in check by predators, parasites, food distribution, etc, and there are few reports of these species producing extensive damage to the human environment. The exotic species, in contrast, their natural control agents being left behind in the country of origin, very often produce superpopulations which upset natural balances in communities. Every organism in such communities may be directly or indirectly affected: the native and more or less well-regulated slugs may be out-competed, and vegetation essential to the well-being of many other animals may be adversely affected; food chains may be interrupted. Moreover, although slugs have not been shown to harbor human parasites, these creatures may act as intermediate hosts for the parasites of important wildlife and domestic animals. Any time massive populations of slugs develop, such as those described for *Arion ater* (Hanna, 1966), wildlife experts and agriculturists should be alarmed. It is difficult to imagine, however, what measures can be taken to really control these pests. Being nocturnal and burrowing or otherwise secretive by day, many of the exotic slugs are nearly impossible to eliminate once they become established. Compounding the problem is the fact that we have only meagre information with regard to their overall distribution in North America (CHICHESTER & GETZ, 1969).

Although many of the exotic species have been impugned for their destructiveness to agricultural and horticultural products, *Arion ater* is one of the worst molluscan pests in North America (HANNA, 1966). A native of central and northern Europe, this species apparently first entered western North America in the region of Puget Sound. As an index to how destructive the slug can become, it has been estimated that during some years it damages over 75% of the Washington strawberry crop (HANNA, *op. cit.*).

Arion ater is a highly polymorphic species, varying from deep black to bright orange, with many intermediates between the extremes. Since these color patterns are genetically determined, CHICHESTER & GETZ (1969) explained homogenous color populations of *A. subfuscus*, a related species, in eastern North America as being derived from single initial introductions. Conversely, the presence of various color patterns in a single population would indicate repeated introductions. In the case of the Olympic Peninsular populations, the high incidence of color pattern variation seems to indicate many introductions. A variation of this hypothesis is utilized to explain a similar pattern of variation in two native species. However, in order to properly interpret the origin of the native slug fauna, particularly the relicts and re-invaders, one must first understand that these species have a very ancient lineage. In general, the distribution of snails is very closely tied to plant geography, both in time and in space.

There is, for example, clear evidence for the existence of a nearly continuous and more or less homogenous forest during the warmer and moister portions of Mesozoic times in America. During this period, molluscan elements were able to invade North America from Asia via the Bering land bridge, and northern forms penetrated southward into Mexico. Likewise, southern elements moved northward. This resulted in a mixing of northern and southern floras and faunas along the western margin of the American continent. Near the end of the Cretaceous and the beginning of the Eocene, a drying trend developed, allowing an expansion of dry-adapted organisms northward, but these were again deflected toward the south during early Pliocene times as moister conditions resumed. During late Pliocene times, with the progressive loss of summer rainfall, the southern and northern floras became segmented and, in the main, they have remained separated to the present.

The distribution of several groups of western American animals makes sense only when viewed against known botanical information. For example, the isolation, divergence and development of 2 distinct although related plethodontid salamander faunas – one in coastal Washington, Oregon and northern California, the other in Mexico, Central America and northern South America – is explained by the presence of a continuous forest and its later partitioning by the intervention of a broad tract of arid land between them.

Under the primal conditions of the Miocene forest, the terrestrial gastropod fauna was probably a widespread one. That Asian elements were actually able to penetrate into North America is attested by the fact that the nearest relative of the western American slug genus *Prophysaon* is found in east and central Asia (PILSBRY, 1948). The movement of southern forest northward during dry periods stimulated the expansion of southern slugs. During one such period, members of the very primitive slug genus *Binneya* migrated northward as far as Washington, Idaho and southern Canada. The 2 living species of *Binneya* are primitive in retaining a relatively large external and slightly spiral shell, hinting, of course, at their normally coiled ancestral stock. Following partitioning of the forest in northern and southern components, *Binneya* became isolated in the south, the range now being restricted to Santa Barbara Island off California, and a small segment of southern Baja California. The northern form, the cold-adapted derivative genus *Hemphillia*, underwent divergent evolution in Montana, southern Canada, Oregon and Washington. Five species of this odd slug are known, 2 of them being characteristic of the Olympic Peninsula. In these species, the shell is no longer spiraled; it has, instead, been reduced to an external flat plate.

In conjunction with forest movements, knowledge of Pleistocene glaciation is useful in accounting for the development of several of the molluscan specialties of the

Explanation of Figures 2 and 3

Figure 2: Color Variation in *Ariolimax columbianus* (Gould, 1851). Specimens from a single locality on the Olympic Peninsula.

Figure 3: *Prophysaon obscurum* Cockerell, 1890, a species of the high slopes of the Olympic Mountains.

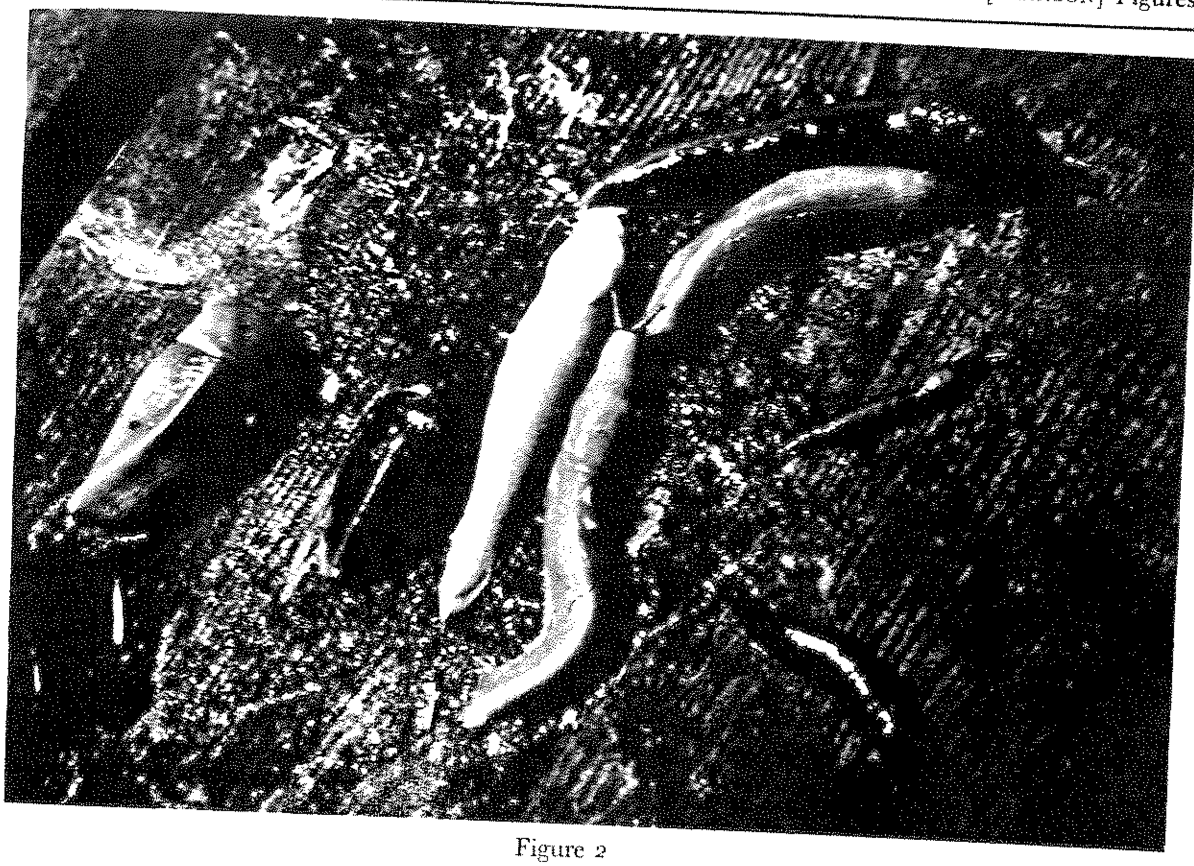


Figure 2

Figure *3*

Washington landscape. The build-up and movement of the continental icemass into Washington deflected large segments of the slug fauna southward and left other segments isolated on the slopes of the Olympic Mountains. As the ice retreated, reinvasion from the south occurred, and the 2 segments of the fauna were able to re-establish contact.

Several of the slugs isolated on the Olympic Peninsula from the main body of the fauna, as mentioned above, underwent evolutionary divergence, becoming distinct from their congeners on the mainland. *Hemphillia dromedarius*, *H. burringtoni* and *Prophysaon obscurum* are examples of slugs which, although closely related to mainland forms, are sufficiently different to be regarded as distinct. Two of these species show, in their behavior and ecology, the indelible results of long-continued association with cold climates and ice. *Prophysaon obscurum* (Figure 3) lives only on the high slopes of the mountains, usually near the timberline where snow does not melt until late summer, and where it comes early in the fall. *Hemphillia dromedarius* is a very-cold adapted slug. Most of the glaciers on the peninsula are retreating up the mountains, and this peculiar little animal invades liberated slopes and valleys as fast as plants become established.

Re-invasion of the Olympic Peninsula lowlands following removal of glacial ice allowed contact between 2 previously isolated segments of the slug fauna. Peninsular populations of *Prophysaon foliolatum* and *Ariolimax columbianus* are at least as variable in color pattern as their distant European relatives in the genus *Arion*.

Ariolimax columbianus (Figure 2), one of the largest slugs in the world, varies from dead white through lemon-yellow to light tan, dark brown, and nearly entirely black (Cockerell, 1891b; Mead, 1943; Pilsbry, 1948; Pilsbry & Vanatta, 1896). The body is most often maculated or spotted with black, but in the very pale specimens such spots are often lacking. Such color variations as these prompted early taxonomists to describe each variation as a new species and, to a large degree, this type of thinking has carried over into relatively recent times. In the southern range of *Ariolimax*, several color patterns exist here and there as more or less isolated colonies. Some of these forms have been referred to as "species." However, in view of the fact that the variation extremes of *A. columbianus* on the Olympic Peninsula include practically all of these southern types raises the suspicion that some of those forms bear unnecessary names. The southern colonies possibly represent the extremes to which *Ariolimax* fled during the glacial epochs; some are relicts. In this regard, it must be remembered that Pleistocene glaciation did not occur as a single impulse. Instead, there were several incidents of ice buildup, each impulse being separated from the next by a warm interglacial period during which the ice masses retreated. These ideas mesh very nicely with the observations of Chichester & Getz (1969) in *Arion*. The extreme southern populations, *i. e.*, the uniformly colored ones, probably indicate derivation from single initial invasions, whereas the highly variable populations indicate the effects of repeated isolation and re-establishment of contact correlated with glacial and interglacial epochs.

A very similar pattern of variation is seen in the beautiful slug, *Prophysaon foliolatum* (Pilsbry, 1948; Pilsbry & Vanatta, 1898; Binney & Bland, 1869). The usual color pattern is a yellowish or golden wash over black or brown with a light stripe down the back and several dark brown streaks and spots. However, collections from a single leaf of skunk cabbage, a very important food item in this species' diet, at Calaloch Beach demonstrates variation from very pale yellow without markings to dark rust or brown.

Peninsular slugs are not only interesting because of their importance to theoretical distribution problems and ecological associations, but they also offer a great deal of basic study because of their biology and behavior. Many of the most interesting aspects of slug behavior involve survival in the face of adversity. *Ariolimax*, for example, insures continuity of the species by having developed a rather long reproductive period, ranging from late fall through early summer, a period which is coincidental with the wet months. During this time, several clutches of eggs are deposited in small depressions in the ground, each clutch consisting of 15 to 35 eggs (Mead, 1943). Thus, freshly hatched slugs may be observed during all seasons of the year except during the relatively dry months of late July, August and early September. During these months, *Ariolimax* seeks shelter in rock crevices or beneath stones and logs. The slug can survive in a torpid state for over 3 months, a very definite advantage.

Prophysaon, on the other hand, avoids desiccation, or freezing in the highlands, by aestivating or hibernating inside decaying logs. Above 1200 m, this slug may remain secluded for as long as 6 or 7 months.

Another interesting phenomenon in *Prophysaon* is the practice of self-amputation of the posterior one-third or so of the body following rough handling (Pilsbry, 1948; Pilsbry & Vanatta, 1898; and others). In life, the tail bears an oblique constriction which indicates the position where amputation occurs. During manipulation, the constriction gradually deepens until the tail simply drops off. The tissues surrounding the excised area roll inward to close off the body. Specimens kept in the laboratory in terraria completely regenerate the tail during approximately 5 weeks. This trait is not shared with any other

American slug nor, in fact, with many slugs in the rest of the world. Although the physical and chemical reactions underlying the process have not been studied in order to determine the exact mechanism of the excisive act, it seems highly likely that such self-amputation is a predator escape mechanism.

A third and even more striking example of a predator avoidance mechanism is demonstrated by the species of *Hemphillia*. At rest, the slug wraps its long slender tail forward around the body, usually in a counterclockwise fashion. When molested, the animal violently swings the tail back and writhes and twists. Specialized muscles along the sides of the body are used to accomplish the movement, a motion so strong that the slug often "jumps" an 'inch' or so during its performance. This activity is quite obviously an important startle reaction used to avoid predators such as the omnipresent shrews, predaceous beetles and *Haplotrema*. Similar processes are unknown in any other arionid slug and are lacking in all American snails. However, Karl Semper observed a similar behavior in some Philippine slugs, and Pilsbry mentioned a "leaping" behavior in a snail from the Marquesas Islands (PILSBRY, 1948).

The slug fauna of the Olympic Peninsula, then, reflects in a very vivid way interesting moments in time and space. The peninsula is really an ecological island which, because of an abundance of moisture, the protection of rugged mountains, and the ameliorating influence of the warm Japanese current, has retained much of its original molluscan fauna. The large number of slugs, contrasted with a relatively depauperate fauna of shell-bearing snails, is in part a reflection of coniferous forest dynamics. The forest floor is normally considerably acid, which means that it is a poor habitat for many testaceous species. Such forms are mostly restricted to bottomlands along streams where hardwoods abound, and to mountain slopes above the timberline. Thus, competition for niches in the forest is mostly between slugs. This has, perhaps, stimulated adaptive radiation on the Olympic Peninsula, which would partly account for the large fauna.

Deroceras reticulatum (Müller, 1774)

Dissection of the genitalia verifies the diagnosis (ELLIS, 1967) of this European exotic species. Records: 1 (2), 4 (2), 14 (6), 20 (3), 34 (2), 58 (1), 83 (16), 85 (2), 88 (1), 100 (2), 110 (3), and 3 from a trash heap 3.2km NE of La Push (28 July 1969). Measurements: 17.7mm (12.0 - 23.5) in length, 2.7mm (1.8 - 3.0) in foot width.

Deroceras caruanae (Pollonera, 1891)

Not known from Washington. However, since ROLLO & WELLINGTON (1975) recently collected specimens from nearby British Columbia, collectors should be aware of its possible presence.

Deroceras laeve (Müller, 1774)

Generally considered as native (ROLLO & WELLINGTON, 1975), this small slug is widely distributed in North America (PILSBRY, 1948). Records: 1 (2), 4 (1), 14 (1), 20 (2), 34 (1), 58 (6), 73 (1), 83 (2), 85 (1), 88 (1), 99 (1), 100 (2), 110 (1), and 2 from a trash heap 3.2km NE of La Push (28 July 1969).

Deroceras monentolophus Pilsbry, 1944

Reported from Seattle (PILSBRY, 1948)

Deroceras hesperium Pilsbry, 1944

The 3 specimens from stations 65 (2) and 83 (1) seem closer to this species than to any other. In all 3, the color is light brownish with scattered light spots, and the pneumostome is surrounded by a pigmentless halo. Measurements: 18.7mm (17.5 - 20.0) in length, 3.3mm (2.8 - 3.8) in foot width, and 5.8mm (5.0 - 6.5) from anterior tip of mantle to anterior edge of breathing pore.

Limax (Lehmannia) marginatus Müller, 1774

Not previously recorded from the peninsula. I follow BURCH (1960) in using this epithet. Records: 14 (10), 102 (1). In all specimens, the dark brown bands are boldly developed on the mantle but weakly so on the body. The pneumostome is located in the posterior quarter of the mantle, and the foot is definitely tripartite.

Limax maximus Linnaeus, 1758

No previous records from the peninsula. Records: 87 (1), 88 (3), 100 (4), 110 (2), and 3 from a trash heap 3.2km NE of La Push (28 July 1969). Young specimens (30 - 40 mm) are often marked by 3 bold bands, but these break up into longitudinal series of large black spots with an increase in length.

Limax flavus Linnaeus, 1758

Not previously recorded from most of Washington. However, this is a relatively common slug in coastal Washington and, although ROLLO & WELLINGTON (1975) did not find specimens in Vancouver, I have observed it in portions of British Columbia, including Vancouver Island.

Records: 1 (2), 4 (1), 14 (6), 20 (2), 34 (1), 58 (2), 83 (2), 85 (1), 88 (3), 100 (2), 110 (3).

Milax gagates (Draparnaud, 1801)

Not reported from the peninsula, but should be expected there since PILSBRY (1948) recorded it from Seattle.

ARIONIDAE

Some important references in this family of destructive slugs include BARNES & WEIL, 1945, GETZ & CHICHESTER (1971), CHICHESTER & GETZ (1973), HANNA (1966), MEAD (1943), PILSBRY (1948) and QUICK (1949).

Arion ater (Linnaeus, 1758)

Approximately a 1:1 ratio between black and orange or yellow forms on the Olympic Peninsula. PILSBRY (1948) and BARNES & WEIL (1945) present good discussions of color variation in the species, and PECK (1920) reported a nearly pure white color form. This is an extremely destructive slug and, although there are few published records from Washington, an exceptionally abundant population occurs along the coast on the mainland (unpublished data) and in coastal British Columbia (ROLLO & WELLINGTON, 1975). A European exotic species. Records: 6 (5), 25 (1), 36 (3), 83 (16), 85 (28), 100 (2), 102 (2), 106 (2), 110 (13), 111 (1), 115 (4), and 18 from a trash heap 3.2 km NE of La Push (28 July 1969), 2 from Bush Pacific State Park (5 August 1969). The last 2 specimens were extruding eggs when captured. Measurements: 38.7 mm (20.5 - 61.0) in length.

Arion hortensis Férussac, 1819

Reported from greenhouses in Seattle (PILSBRY, 1948) and from British Columbia (ROLLO & WELLINGTON, 1975), where it is potentially an agricultural pest. Collections: 6 (5), 14 (1), 83 (1), 85 (4), 105 (3), and 5 from a trash heap 3.2 km NE of La Push (28 July 1969).

Arion circumscriptus Johnston, 1828

The specimens reported here are of the dark variety discussed by CHICHESTER & GETZ (1973). The foot is not separate, and the bands on the mantle produce a lyre-shaped configuration. The entire slug, except the deadwhite sole, is dark gray. Collections: 14 (2), 85 (5), [illegible].

Prophysaon Bland & Binney, 1873

This relatively complicated genus of slugs is still poorly understood, biologically as well as taxonomically. The Pacific Northwest is obviously a speciation center for several endemic groups of mollusks, one of which is this genus. Although the nearest relative of this genus is in East Asia (WALDÉN, 1963), WEBB (1961), on the basis of weak mating evidence, suggests that *Prophysaon* is related to the polygyrid genus *Ashmunella*.

Prophysaon andersoni (J. G. Cooper, 1872)
(including "*Phenacarion hemphilli*" of Binney, 1890)

A relatively common slug from California to Alaska (HAND & INGRAM, 1950). The pneumostome lies in the anterior one-half of the rather granular mantle on the right side. The body granules of the tail portion are not elongated but more or less oblongly rounded. The tail pit is closed, and the amputation groove is often poorly developed. Previously reported from Chehalis, Port Townsend, Olympia and Gray's Harbor (HENDERSON, 1929a; PILSBRY, 1948) and Kalama (PILSBRY & VANATTA, 1898). New records: 14 (4), 44 (1), 82 (1), 83 (1), 88 (3), 100 (1), 106 (2). Measurements: 17.3 mm (12.5 to 28.0) in length, 2.9 mm (2.3 - 4.8) in foot width, 9.1 mm (7.1 - 11.0) in length of mantle, 3.96 mm (3.5 to 4.6) from anterior tip of mantle to pneumostome.

Prophysaon foliolatum (Gould, 1851)

One of the most interesting slugs in North America, growing to over 100 mm while in motion. As indicated by various authors, the tail is sharply demarked from the rest of the body by an oblique groove, indicating the region where self-amputation occurs. Records: 16 (1), 18 (1), 19 (1), 28 (4), 53 (4), 59 (1), 82 (2), 85 (1), 99 (58), 101 (1), 103 (1), 110 (1), 120 (1), 6 at Second Beach near La Push, and 8 at South Nehah River at Nemah. Literature records: Olympia, Gray's Harbor, Discovery Bay (HENDERSON, 1929a); Spencer Forest Camp (BRANSON, 1969); Lake Quinault, 8 km SW of Port Townsend (PILSBRY, 1948); and Chehalis (PILSBRY & VANATTA, 1898). Proportional measurements are presented in Table 1.

Prophysaon coeruleum Cockerell, 1890

Although reported from Olympia (type locality) by HENDERSON (1929a) and DALL (1910), I did not secure slugs with the characters of this species.

Prophysaon dubium Cockerell, 1890

Reported from Olympia (type locality) by PILSBRY (1948). Probably only a variant of ***Prophysaon andersoni.***

Table 1

Proportional Measurements in *Prophysaon foliolatum*. 1, foot width/total length; 2, Anterior tip of Mantle to Pneumostome/Tail Length; 3, Tail Length/Total Length. Tail Length Measured from Posterior Tip to Diagonal Groove.

Collecting Station	1		2		3	
99	0.09	0.15	0.37	0.80	0.36	0.35
99	0.13	0.12	0.48	0.54	0.43	0.30
99	0.13	0.13	0.54	0.67	0.36	0.31
99	0.11	0.12	0.51	0.56	0.31	0.15
99	0.12	0.13	0.50	0.92	0.35	0.34
99	0.13	0.12	0.58	0.44	0.33	0.37
99	0.10	0.13	0.41	0.46	0.36	0.30
99	0.13	0.11	0.68	0.64	0.31	0.32
99	0.11	0.12	0.41	0.49	0.37	0.32
99	0.11	0.14	0.44	0.50	0.34	0.36
99	0.12	0.13	0.56	0.51	0.33	0.33
99	0.14	0.14	0.48	0.48	0.36	0.36
99	0.13	0.13	0.48	0.51	0.39	0.30
99	0.13	0.12	0.53	0.62	0.32	0.41
99	0.14	0.12	0.50	0.42	0.33	0.31
99	0.13	0.15	0.60	0.50	0.27	0.33
99	0.11	0.12	0.48	0.50	0.35	0.44
99	0.14	0.12	0.38	0.59	0.29	0.35
99	0.10	0.12	0.77	0.48	0.32	0.31
99	0.16	0.12	0.61	0.65	0.38	0.28
99	0.12	0.12	0.35	0.62	0.37	0.34
99	0.12	0.12	0.45	0.50	0.30	0.39
99	0.14	0.14	0.63	0.38	0.24	
53	0.14	0.17	0.63	0.60	0.18	0.19
53	0.16	0.16	0.53	0.52	0.17	0.16
Second Beach	0.09	0.10	0.43	0.45	0.31	0.45
Second Beach	0.12	0.12	0.39	0.44	0.37	0.32
Second Beach	0.11	0.15	0.40	0.44	0.34	0.24

Prophysaon obscurum Cockerell, 1890
(Figure 3)

Originally described as a variety of *Prophysaon fasciatum* Cockerell, 1890 from California, this form is here considered as a full species. Reported from Chehalis by Pilsbry & Vanatta (1898). Mostly with a rather narrow penis and thin vagina. The sole varies from sooty gray to dark gray with white flecks, its edges being glistening black; tail tapering, black; mantle profusely mottled, black over yellowish, or finely reticulated; pneumostome round and in the anterior one-third of the mantle on the right. An indistinct, submarginal longitudinal band on each lateral margin of the mantle which curves around to the posterior but does not meet the band from the opposite side; tentacles dark gray to black; sides of head and face gray to yellowish-gray; back with large granules that vary from rusty to yellowish-gray. A longitudinal black band on each dorsolateral side of the body, and a more or less obscure median bar or wedge. Slime pale yellowish when disturbed, clear when in motion. Possibly only a variation of the next species, although the genitalia seem sufficiently different to consider the species distinct. For proportional measurements see Table 2.

Table 2

Proportional Measurements in *Prophysaon obscurum* from Blue Mountain at 1660 m elevation. 1=foot width/total length; 2=anterior tip of mantle to pneumostome/tail length; 3=tail length/total length

1	2	3
0.12	0.61	0.27
0.13	0.83	0.25
0.15	0.67	0.27
0.13	0.61	0.32
0.13	0.56	0.27
0.12	0.90	0.20
0.13	0.84	0.23
0.14	0.73	0.25
0.14	0.73	0.25
0.15	—	—
0.18	—	—

Prophysaon vanattae Pilsbry, 1948

Although relatively common on mainland Washington, *Prophysaon vanattae* is not abundant on the Olympic Peninsula, nor is it as variable in color pattern as elsewhere, being mostly dark gray. Previously reported from Chehalis and Gray's Harbor (Pilsbry, 1948). Spencer Forest Camp and Sol Duc Falls (Branson, 1969). The foot is very dark gray, and the mantle, with a curving very dark band on either side, is heavily mottled with dark gray and black, and the central area bears a median dark bar or wedge which is often obscure. The body tapers strongly posteriad, and the oblique grooves are most often poorly defined. Records: 17 (2), 22 (1), 53 (3). Proportional measurements: foot width/total length = 0.12, 0.15, 0.13, 0.16, 0.16; anterior tip of mantle to pneumostome/tail length = 0.64, 0.75, 0.92. 0.73, 0.71; tail length/total length = 0.28, 0.25, 0.17, 0.25, 0.28.

Prophysaon humile Cockerell, 1890

The head and tentacles are smoky-blue and the back is grayish-blue to brownish; the bands of the mantle curve posteriorly, enclosing an indistinct blotch; the body behind the mantle also bears an indistinct band on each dorsolateral field, and a central one between them, the laterals being confluent around the tail; pneumostome in the anterior one-half of the mantle; sole not tripartite; jaws with 16 plates. Previously reported from Chehalis and Olympia (DALL, 1910; HENDERSON, 1929a). New records: 54 (1), 100 (2).

Ariolimax columbianus (Gould, 1851)
(including *Ariolimax columbianus maculatus* Cockerell, 1891, and *Ariolimax steindachneri* Barbor, 1900)

Previous records: Cape Flattery (BINNEY & BLAND, 1869; HENDERSON, 1929a), Nisqually and Discovery Bay (MEAD, 1943), Hoh Forest Camp and Surprise Valley (BRANSON, SISK & McCOY, 1966) and Sol Duc Falls (BRANSON, 1969). New records: 9 (2), 10 (1), 11 (3), 16 (1), 26 (1), 30 (1), 32 (2), 37 (1), 38 (1), 39 (2), 40 (3), 41 (1), 42 (2), 44 (5), 45 (3), 47 (1), 48 (2), 61 (4), 77 (10), 81 (3), 82 (15), 83 (1), 85 (1), 90 (1), 92 (1), 94 (2), 95 (1), 100 (2), 103 (1), 105 (1), 106 (1), 109 (2), 110 (1), 112 (4), 117 (1), and 2 from Sequim Bay State Park (25 June 1969), 1 from 800 m above mouth of Skokomish River (20 June 1969), 3 from Elk Lake on Hoh River Trail (14 August 1970). At the following stations, I simply marked "abundant" in my field notes without taking specimens: 6, 18, 31, 35, 46, 54, 58, 65, 66, 67, 73, 84, 87, 91, 108, 119, 120, 122.

Hemphillia burringtoni Pilsbry, 1948

Originally described as a subspecies of *Hemphillia glandulosa* (PILSBRY, 1948) and later elevated to full species ranking (BRANSON, 1972). For a key to the species of the genus, see BRANSON (1975). New records: 19 (1), 31 (1), 53 (1), 54 (2), 55 (1), 92 (2), 104 (1), and 1 from Bush Pacific State Park, 37 km SW of Southbend, Washington, via U. S. highway 101.

Hemphillia dromedarius Branson, 1972

Records: 18 (1), 23 (1), 31 (2), 59 (2), 60 (1), 97 (2), 98 (1), 102 (1), 106 (1), and those presented in BRANSON (1972).

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