

## ANOPHELES AND MALARIA IN THE NORTH-WESTERN STATES

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Malaria was an important disease in Oregon and Washington during the 19th century. In an analysis of historical data relating to *Anopheles* and malaria in the Pacific Northwest, Stage and Gjullin (5) found that malaria made its first appearance in the Oregon country in 1829 or 1830, that it was probably introduced by early settlers or by sailors and travelers from malarious belts in the United States, and that it was prevalent among both white and Indian populations during the following years. Indians were so severely affected that it was considered an important factor in the decimation of their tribes. The disease was prevalent in these States for many years, but gradually subsided so that by the end of the 19th century there were comparatively few cases.

Malaria is still endemic in the Willamette Valley in Oregon, but in eastern Oregon and in Washington and Idaho there have been few cases in recent years. With the presence of military training camps and the concentration of defense workers in some of these areas, the possibility that epidemics might again occur became an important consideration. Measures designed to deal with this situation were taken by Federal and State agencies. Furthermore, as indicated by Freeborn (2), military personnel returning to this country from malarious areas in other countries and war prisoners employed as agricultural laborers may start malaria epidemics in areas having sufficient *Anopheles* to distribute the disease. In discussing malaria in returning military personnel, Freeborn states, "It is known from experience that the examination of a single

blood smear will detect only from 20 to 50 percent of those infected. To hold all returning personnel over a period of 5 to 8 weeks in quarantine with weekly examinations of blood smears would probably result in the detection of perhaps 80 to 85 percent of those infected, but the cost would be terrific and the results problematical." Undetected cases of malaria in returning military personnel or prisoner-of-war laborers may cause an increase of this disease in some areas in the North-western States. Any increase will, of course, be dependent on the number of *Anopheles* in this area.

### *Distribution and Abundance of ANOPHELES*

Information on the distribution and abundance of *Anopheles* in the North-western States has been accumulated for a number of years in surveys and investigations of this and other genera of mosquitoes occurring in this area. The data have been obtained from larval collections, from hand collections of adults, and from material taken in light traps. In these collections *A. freeborni* Aitken, *A. occidentalis* Dyar and Knab, *A. punctipennis* Say, and *A. pseudopunctipennis franciscanus* McCracken have been taken in Oregon; and *A. freeborni*, *A. occidentalis*, and *A. punctipennis* in Idaho and Washington. The known distribution of these species in the Northwestern States, as determined from these collections, from records of various collectors as given by King and Bradley (3), and from specimens in the U. S. National Museum, is shown in figure 1.<sup>2</sup>

*Anopheles freeborni* is the most widely distributed of these species in the North-

<sup>1</sup>The writers wish to thank H. H. Stage and E. F. Nipling for data on *Anopheles* obtained by them during their consecutive periods in charge of the Portland, Oreg., laboratory of the Division of Insects Affecting Man and Animals.

<sup>2</sup>Several locality records for Washington were kindly contributed by M. P. Mondala, of the Washington State Health Department.

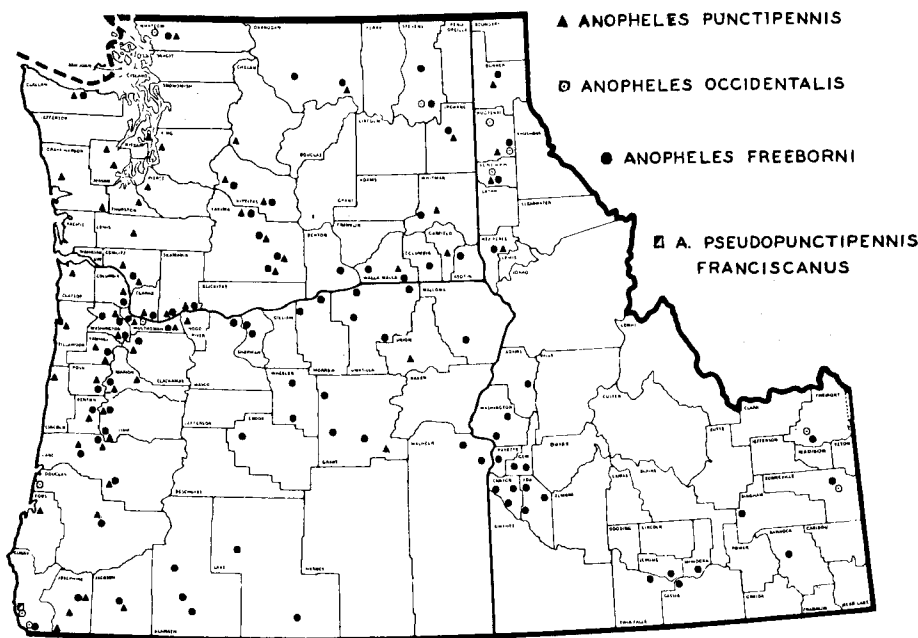


Fig. 1. Known distribution of *Anopheles* in the Northwestern States.

western States. It occurs throughout the entire nonmountainous area wherever suitable breeding places are found. *A. punctipennis* has not been taken in southeastern Oregon or in southern Idaho. In surveys made in 1944 *A. occidentalis* was taken near Reedsport and near the mouth of the Pistol and Windchuck Rivers in Oregon. Specimens were also taken near Cataldo, St. Maries, St. Anthony, Swan Valley, and Coeur d'Alene, Idaho, and near Valley, Wash. There are previous records of this species from Portland, Oreg., Coeur d'Alene, Idaho, and Whatcom Lake, Wash. *A. pseudopunctipennis franciscanus* larvae were taken near the mouth of the Pistol River by the junior author in the summer of 1944. This is the first authentic record of this species in Oregon.

In areas where favorable breeding places are present throughout the summer, *Anopheles freeborni* and *A. punctipennis* are most abundant in August and September. Their abundance from season to season varies considerably with spring and summer weather conditions.

Collections obtained with New Jersey light traps show that *Anopheles punctipennis* is the predominating species in the Willamette Valley in Oregon, and that *A. freeborni* is the predominating species in Yakima Valley, Wash. The traps were operated for an average of from 2 to 3 months a year. In Oregon they were operated near Portland, Tualatin, Peoria, Junction City, Harrisburg, Elmira, and Cottage Grove Dam, and on Grand Island. In some of these places traps were operated for more than a year, so that records from 21 traps are available for the Willamette Valley during the period 1932-1944. Of the *Anopheles* females taken in these traps 80 percent were *A. punctipennis* and 20 percent were *A. freeborni*. In 16 of these trap collections *A. punctipennis* predominated.

In the Yakima Valley, traps were operated near Moxee City, Buena, Union Gap, Yakima, Selah, Wiley, and Naches in 1941, and near Buena, Yakima, Naches, Moxee City, and Sunnyside in 1942. In the 2-year period 90 percent of the females

taken in these traps were *Anopheles freeborni*, and 10 percent were *A. punctipennis*. In all these localities *A. freeborni* was the predominating species.

The average weekly catch of females for the Yakima Valley area was 3.93 *Anopheles freeborni* and 0.42 *A. punctipennis*, as compared with 0.45 *A. freeborni* and 1.9 *A. punctipennis* in the Willamette Valley.

Records obtained from traps operated between the Willamette River and Scappoose, Oreg., in 1941 and 1942 show that the average weekly catch of females for the 2-year period, 29.6 for *Anopheles freeborni* and 11.7 for *A. punctipennis*, is higher than for any other area in which traps have been operated in the Northwestern States. In the first 10 days of August 1941, a trap collected an average of 52 *Anopheles* females per night. The large number collected may have been due to favorable weather conditions and to the excellent breeding conditions which have been created here by diking to keep out the waters of the Willamette River. In the drainage ditches, and in the spring- and seepage-fed sloughs behind this dike, larvae of the two species develop in large numbers.

*Anopheles* mosquitoes are present in comparatively large numbers in several other areas in the Northwestern States. Higher than average populations have been found in Prineville and Klamath Agency, Oreg. Collections made in Idaho indicate that larger than average numbers may also occur in some irrigated sections in the lower Boise and Payette River Valleys.

In Prineville *Anopheles freeborni* were found to breed in large numbers in pools and sloughs formed by the waters of Ochoco Creek. They were also found along the margins of this creek, and in favorable places along the margin of Crooked River where it borders Prineville. On an average six *A. freeborni* females were taken in six 10-minute collections in the city park about dusk on July 25, 1936. The females were taken with a chloroform tube, while they were attempt-

ing to bite the collector. This species apparently attacks outdoors only on warm still nights, for no adults have been seen on slightly cooler evenings in subsequent years.

In a 10-minute collection made in Klamath Agency at dusk in June 1941, nine *Anopheles freeborni* females were also collected while attempting to bite. Larger numbers might be expected to develop here later in the season, since *Anopheles* do not usually reach a population peak until late summer. A large marsh and irrigated pastures provide breeding places in this area.

Many favorable breeding places exist in the Willamette Valley, where the largest number of malaria cases occur. Here the larvae develop in ponds and sloughs, which are filled by overflow or seepage from the Willamette River, and occasionally along the river itself where there are sloping banks and vegetation. They also develop in such situations along the creeks and rivers in the Valley, which empty into the Willamette River. A few are found in other miscellaneous places. In the Yakima Valley all breeding places, with the exception of those along a few creeks, are caused by irrigation water.

In sections of the Northwestern States where *Anopheles freeborni* and *A. punctipennis* are both present, the larvae are often found together. They have been taken along the margins of rivers, creeks, and irrigation ditches, and in ponds, sloughs, gravel pits, and roadside ditches. *A. pseudopunctipennis franciscanus* larvae have been taken with *A. occidentalis*. The latter species has also been found with *A. freeborni*.

Near Sherwood, Oreg., about 100 second and third instars of *Anopheles punctipennis* were taken in two 50-gallon wooden barrels two-thirds full of water, which were standing next to a building. Larvae of this species were also taken by Reeves (personal communication, 1944) in a barrel near Buena, Wash. While the selection of this type of breeding place may represent a tendency of the species to adapt itself to breeding in artificial containers,

the tendency is probably not sufficiently developed to be of importance at the present time.

In Yakima Valley, large numbers of *Anopheles freeborni* and *A. punctipennis* have been found in daylight resting places in semi-open buildings. In the fall most of the mosquitoes move to root cellars, which are present throughout the Valley. In the warmer winter climate in the Willamette Valley they are usually found hibernating in barns and in other partly open buildings.

#### *Status of malaria in Northwestern States*

Washington.—Thirty-four cases of malaria were reported to the Washington State Department of Health during the period 1935-44. Most of these cases occurred in the western half of the State. Information was not available on all cases, but in only one instance did the history indicate that the individual contracted the infection in the State. In this case the infection was acquired near Kettle Falls in August 1942.

Idaho.—In Idaho, where malaria has been reported to the State health officer on a voluntary basis since 1936, 20 cases have been reported. Ada, Valley, Twin Falls, Kootenai, Boundary, and Canyon Counties have each reported one case during this period, whereas Nez Perce and Boise Counties have reported seven cases each. The reports do not state whether the patient contracted the disease in the State or elsewhere.

Oregon.—Malaria is still endemic in the Willamette Valley and, although there have been comparatively few cases during the present century, the possibility that it can again become prevalent was shown by the occurrence of 41 cases among 24 families in a school district in Benton and Lane Counties in 1931 (Stage and Gjullin 5). This outbreak was thought to be due to the migration of more than 100 Oklahomans into this area. Malaria has also been prevalent on Grand Island in Yamhill County during the last few years. In 1941 the people of the Island requested assistance from Federal and State agencies in dealing with the problem. Seasonal work-

ers who came in to harvest the crops were apparently responsible for dissemination of the disease among the residents. *Anopheles freeborni* and *A. punctipennis* are present in these areas, and favorable breeding places are comparatively numerous.

*Anopheles freeborni* is known to be an important vector of malaria, whereas *A. punctipennis*, which was found to be more than twice as numerous as *A. freeborni* in light-trap collections made in the Willamette Valley, is believed to carry very little malaria in nature. Experimental transmission of *Plasmodium vivax*, *P. falciparum*, and *P. malariae* by *A. punctipennis* has been demonstrated by several investigators. There is only one doubtful record of an infected *A. punctipennis* being taken in nature, but present data cannot be considered conclusive. Simmons and Aitken (4), who have summarized available information on the ability of *Anopheles* to transmit malaria, state that further studies of *A. punctipennis* "will be required to determine more exactly its relative importance in the different regions where it exists."

A total of 578 cases of malaria, exclusive of those having histories of recurrence or infection from outside the State, has been reported to the State health officer since 1918, the first year that reports on the disease were required. Although Stage and Gjullin found 41 authentic cases of malaria in a school district in Lane and Benton Counties in 1931, only 9 cases were reported to the State health officer from these 2 counties during that year. This discrepancy between the actual numbers and the numbers reported is probably typical of other areas in the State, and is due to the fact that a considerable number of these people do not have a physician, and that physicians are sometimes lax in reporting cases. Boyd (1, p. 132) states that in southeastern Missouri a doctor had been consulted in less than 40 percent of the cases studied. Since irregularities of this nature might vary in different years, and since no cases occurred in some counties in Oregon in some years, the number and distribution of cases in this State can be

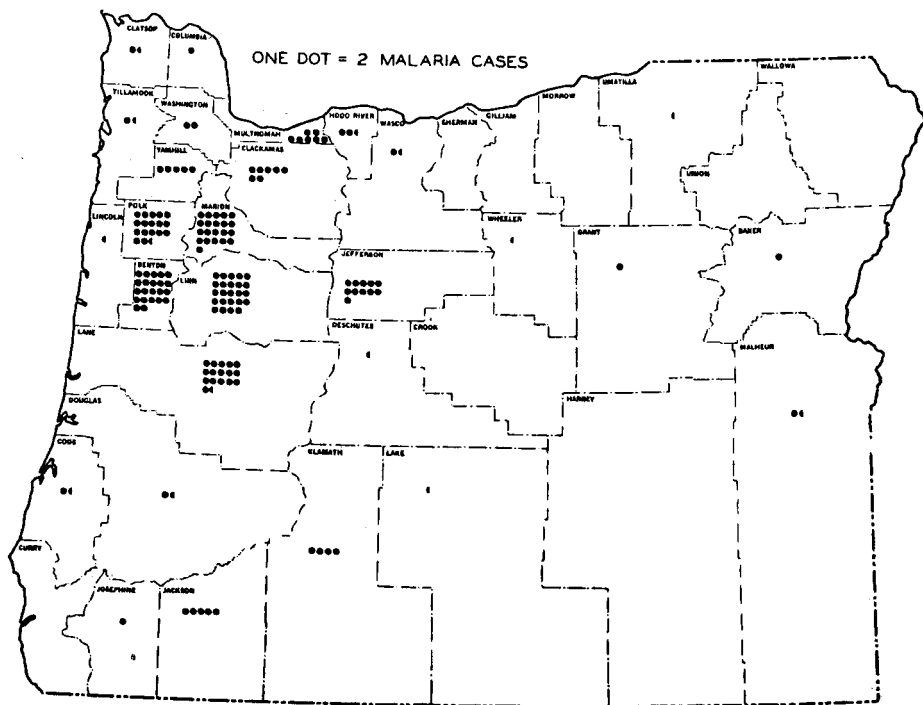


Fig. 2. Distribution of malaria cases in Oregon by counties as reported to the State health officer for the period 1935-44, exclusive of cases having histories of recurrence or infection from outside the State. Distribution within counties is not shown.

more clearly shown from reports for a series of years. The distribution of cases for the period 1935-44 is shown in figure 2. Cases for which no histories of infection are available have been included in this figure. A number of them may have contracted the infection outside of the State.

Only a limited amount of control work against *Anopheles* has been done in the Northwestern States. This work was done by the Oregon State Health Department and the U. S. Public Health Service on Grand Island in 1942, by the Malaria in War Areas branch of the U. S. Public Health Service and military personnel in the vicinity of Camp Adair in 1943-44 and in the vicinity of Camp White in 1944, and by personnel of the U. S. Veterans Hospital on the hospital grounds near Walla Walla, Wash., in 1943-44. The Portland City-County Control District also continued their pest-control program dur-

ing August 1944 to control *Anopheles* in that area.

Irrigation of a million acres of land in western Washington from the waters impounded by the Grand Coulee Dam is planned, and will undoubtedly create mosquito breeding places throughout this area. How large the *Anopheles* population might become, and how much malaria might develop in the area, it is difficult to estimate, but breeding places would probably not be more numerous or extensive than in the Yakima Valley, which has been irrigated for many years. In this Valley *A. freeborni*, which is considered to be an excellent vector of malaria, is present in larger numbers than the combined populations of *A. punctipennis* and *A. freeborni* in the Willamette Valley, where malaria is prevalent. Many transients come to the Yakima Valley each year to harvest crops, and no doubt a num-

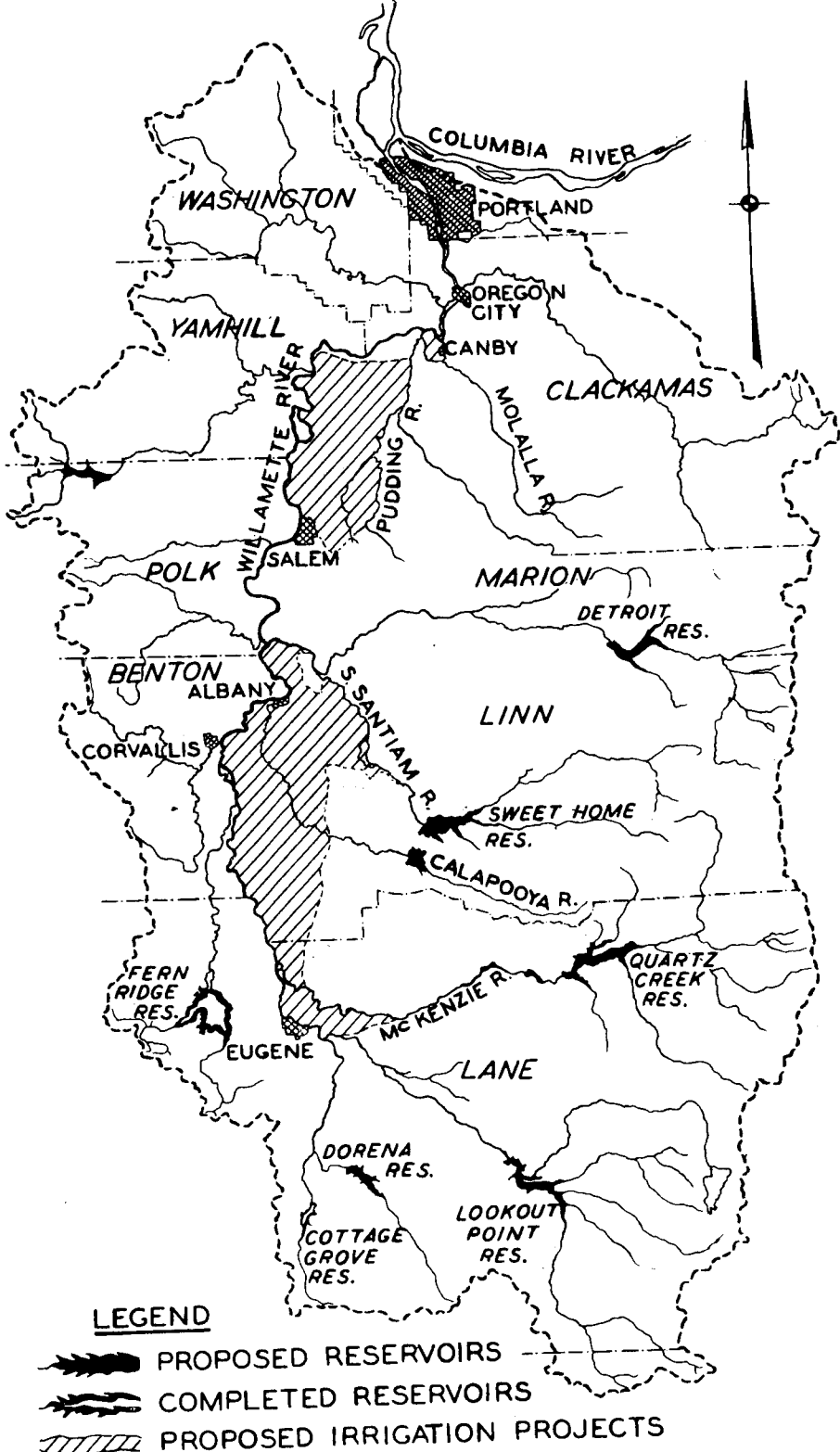


Fig. 3. Locations of proposed irrigation projects in Willamette Valley, Oreg.

ber of them come from other malarious sections of the country. The relatively few cases of malaria that occur in the Yakima Valley under these conditions would indicate that it probably would not become a serious problem in the new area that is to be irrigated.

A number of irrigation projects are also planned for the Willamette Valley. The locations of these projects, which would include a maximum of 355,000 acres, are shown in figure 3. In this area, where malaria is endemic and where warmer winter temperatures probably permit overwintering of the malaria parasite in the hibernating mosquito in most instances, the creation of additional breeding places might be expected to cause more malaria.

#### Summary

Undetected cases of malaria among military personnel returning to the North-western States, and prisoner-of-war agricultural laborers employed there may cause an increase of malaria in areas where sufficient *Anopheles* mosquitoes are present to spread the disease.

The distribution of *Anopheles freeborni*, *A. occidentalis*, and *A. punctipennis* in Washington and Idaho, and also of these species and *A. pseudopunctipennis franciscanus* in Oregon, is given from material obtained in collections and from locality records of other collectors.

Trap collections show that *Anopheles* species are more numerous in the Yakima Valley in Washington than in the Willamette Valley in Oregon. *A. freeborni* is the predominating species in the former, and *A. punctipennis* in the latter.

Larger populations of *Anopheles* have been found in Prineville and Klamath Agency and near Scappoose, Oreg., than have been found in other parts of the State.

The relatively few cases of malaria that occur in the irrigated Yakima Valley, in spite of a fairly large *Anopheles* population and a yearly influx of harvesters, some of whom may be malaria carriers, indicate that the disease may not be a serious problem in western Washington where a million acres of land are to be irrigated from the waters impounded by the Grand Coulee Dam.

Malaria is still endemic in the Willamette Valley, and may be expected to become more prevalent when proposed irrigation projects totaling 355,000 acres are completed in that area.

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