

*Suggestions for*  
**Mosquito Control**  
*in Oregon*

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## Foreword

The object of this bulletin is to provide means for making mosquito control programs in Oregon more effective. It summarizes information regarding the distribution, life history and habitat preferences of the 35 species of mosquitoes that occur in Oregon. A control program, to be thorough and effective, must be based on an accurate identification of the species involved and a knowledge of its life history. This information, as well as control recommendations, was developed through cooperation of federal and state research agencies. Consult your County Agricultural Extension Agent or write the Department of Entomology, Oregon State College, or the Bureau of Entomology and Plant Quarantine, Corvallis, if you wish additional information.



Dean and Director

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*Cover photo*—Poorly drained pastures breed enormous numbers of mosquitoes, causing financial losses as well as discomfort to humans.

# *Suggestions for* **Mosquito Control** *in Oregon*

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THE new insecticides developed during the past few years have stimulated mosquito control to a greater extent than ever before. DDT was widely used by our armed forces during the war. Immediately thereafter mosquito-control districts in various parts of the country began to use this insecticide with much success. Several new chemicals have appeared since and are being used in mosquito-control operations. Control measures vary with the kind of mosquitoes and the region in which they breed.

## **Oregon Problem Largely Rural**

The mosquito problem in Oregon is largely rural and agricultural in character. Mosquitoes affect the farmer, his family, his employees, and his livestock. They cause important financial loss to the stockman, dairyman, and general farmer. Mosquitoes are blood suckers and cause loss of weight and reduce the milk flow of livestock. They often drive livestock from lush pastures to barren hillsides and thus further reduce flesh gains. Mosquito annoyance to agricultural workers results in loss of time and efficiency. The full use of recreational areas in the high mountains by farm people and others is reduced by mosquito annoyance.

## **Species in Oregon**

At least 35 species of mosquitoes are known to be present in Oregon. They belong to five genera—*Aedes*, *Anopheles*, *Culiseta*, *Culex*, and *Mansonia*. Only about a dozen of these species are plentiful enough or have wide enough distribution so as to cause monetary losses. Not all of them are found in the same locality or at the same time of the year. In a given locality annoyance from the pests may be caused by two to four species.

The species vary greatly in their requirements and habits, but all have one common characteristic; namely, they breed in water and water only. All have four stages—adults, eggs, larvae, and pupae. Some species are found in many parts of the state and in different

types of waters. For example, *Culex tarsalis* Coq. has been collected in every county in Oregon. Other species are rather exacting in requirements and are restricted in their range. *Aedes hexodontus* Dyar, for example, is found only in mountainous areas, where it breeds in snow water. Temperatures of air and water, alkalinity or acidity of the water, shelter, and vegetation are a few of the many factors that affect the abundance of certain species. Species also have different biting habits, life spans, and flight ranges. *Because of these differences, it is imperative, before any control program is instituted, to determine the species present.*

## Where They Are Found

Certain species will be found in several kinds of water, but in general the important species and the areas producing them are as follows:

- ▶ Overflow areas, especially along Columbia and lower Willamette River—*Aedes vexans* (Meig.) and *A. sticticus* (Meig.). Only one generation per year.
- ▶ Tidal flats along the coast—*Aedes dorsalis* (Meig.). Several generations per year.
- ▶ Snow water in mountain areas—*Aedes communis* (Deg.) most abundant species. Other important species are *A. hexodontus*, *A. fitchii* (Felt and Young), *A. cinereus* (Meig.), and *A. increpitus* (Dyar). Only one generation per year.
- ▶ Woodland pools along the coast and in foothills—*Aedes aboriginis* (Dyar), *A. excrucians* (Walk.), and *A. increpitus*. Only one generation per year.
- ▶ Irrigated lands—*Aedes dorsalis* is the most abundant species, and where conditions are very alkaline it is usually the only one. Other associated species are *Aedes vexans* and *A. nigromaculis* (Ludl.) (some parts of the state). Several generations per year.
- ▶ Semipermanent and permanent ponds—
  1. In areas west of the Cascade Mountains—*Culex tarsalis*, *Culiseta incidens* (Thomson), and *Anopheles punctipennis* (Say.). Several generations per year.
  2. In areas east of the Cascade Mountains, especially irrigated areas—*Culex tarsalis*, *Culiseta inornata* (Will.), and *Anopheles freeborni* (Aitken). Several generations per year.
- ▶ Borders of sluggish streams and ditches—*Culex tarsalis* and either *Anopheles punctipennis* or *A. freeborni*. Several generations per year.

- ▶ Artificial containers—*Culex pipiens* L. and *Culiseta incidens*. Several generations per year.
- ▶ Treeholes—*Aedes varipalpus* (Coq.). One generation per year.

Mosquitoes having only one generation per year are usually easier to control than those having several generations. Mosquitoes of the *Aedes* group lay their eggs on the ground after the water has receded. *Culex* and *Culiseta* lay their eggs in rafts on the surface of the water, whereas *Anopheles* lay theirs singly on the water surface. *Aedes* species overwinter in the egg stage (except *A. varipalpus*, which overwinters either as eggs or larvae). Other species overwinter as adults and can be found in cellars, caves, culverts, and buildings. In general, the *Aedes* species found in this state have a much wider flight range than mosquitoes of the other kinds. Some species are known to fly 10 to 15 miles from the point of origin. On the other hand, *Culex*, *Culiseta*, and *Anopheles* seldom fly more than 1 or 2 miles.

## Conditions Affecting Numbers

Weather, including winter snowfall, and irrigation practices are important factors in affecting the abundance of mosquitoes. Temporary ponds and flooded areas caused by excessive rainfall during spring and summer greatly increase the opportunities for mosquito breeding. Excessive winter snowfall in the high mountains not only produces more mountain mosquitoes but may result in increased runoff and flooded areas in the Columbia River watershed. Log ponds in western Oregon in many cases provide ideal conditions for the breeding of large numbers of *Culex* and *Culiseta* mosquitoes during the warmer months. Annoying swarms of mosquitoes in many towns and villages can be traced to these ponds. (See Figure 1.)

The irrigation of large areas in the state has created ideal breeding conditions for mosquitoes. Improper use of water, over-irrigation, and poor drainage enhance these conditions. (See photo on cover.) The irrigation of uneven pastures with excess water and the runoff accumulations in low areas and roadside ditches aid in the production of large numbers of *Aedes dorsalis* and *A. vexans*, and also a secondary crop of *Culex tarsalis* and *Anopheles freeborni*.

Temperature has much to do with the rate of development and also the length of life of the adults. If temperatures are high, larvae will reach the pupal stage in 5 or 6 days and remain as pupae only 24 to 48 hours. If temperatures are low, the larvae may require several weeks for development and remain as pupae a week or more

before emerging as adults. Unusually high or low temperatures or a low humidity are unfavorable for adult survival. Species also vary considerably in ability to survive under unfavorable weather conditions.

## Hosts

The preferred hosts of mosquitoes have been studied. Some of our most common mosquitoes feed only occasionally on man. *Culex tarsalis* prefer fowls and wild birds. In Oregon *Anopheles* prefer animals rather than man. Most of our serious pest mosquitoes belong to the genus *Aedes*. Females of this genus readily attack man and animals and are vicious biters.

## Control Methods

Mosquito annoyance can be reduced in several ways. These methods include destruction of breeding places, chemical control of larvae, chemical control of adults, and the use of repellents. Some of the control methods require community action for best results. The use of repellents, spray for adult mosquitoes, and spraying of log ponds can be used by individuals to obtain protection.

### Basic principles

For a control program to be successful several essential principles must be recognized.

- ▶ It must be determined where the mosquitoes are breeding and what species are involved. To locate mosquito larvae, a search must be made of every water area in the locality, including ponds, artificial containers, ditches, swamps, overflows, etc. An ordinary water dipper may be used for taking water samples, and 10 to 20 dips near the edges of a pond usually will be necessary. A close-up examination of the dipper full of water will show whether or not wrigglers (larvae) are present. The kinds of mosquitoes present can be determined by sending samples of the larvae or adults to Oregon State College or to the Bureau of Entomology and Plant Quarantine, Corvallis, Oregon.
- ▶ Timing the application of insecticide is of utmost importance. Applications must be made before the larvae emerge as adults. Weekly checks on the water areas are necessary to determine when the larvae make their appearance. As soon as wrigglers are found, spray immediately. The smaller the larvae the easier they are to kill.

- Use the proper amount of larvicide and apply it uniformly over the breeding areas. Floodwater and mountain mosquitoes may sometimes require more than one application. Mosquitoes breeding in irrigated sections have several generations a year, and treatment must be made after each flooding. Permanent pools may require treatment every 10 to 14 days.

## Control of Mosquito Larvae

### Elimination of breeding places

Since mosquitoes require water for their development, any procedure that eliminates standing water will reduce mosquito annoyance. The elimination of breeding areas includes ditching, diking, filling, leveling, brushing, clearing, and control of irrigation water. Many marshes, swamps, and tidal flats can be successfully ditched and drained to eliminate mosquito breeding permanently. Ponds and low depressions can often be drained. The cleaning and straightening of meandering streams and partially filled ditches should be a part of any mosquito-control program. In irrigated sections good leveling, proper use of water, and quick removal of all excess water are essential. Water must remain in a pond or ditch or over the land for a week to 10 days during midsummer and slightly longer earlier in the season for a brood of mosquitoes to have time to develop.

Figure 1. Log ponds such as this produce numerous mosquitoes.



### Chemical control of larvae

Mosquitoes are usually controlled most economically by destroying the larvae. This is done by applying chemical "larvicides" to the water area where larvae are found. Satisfactory control usually requires community action. All residents of a town or a group of farmers in a rural area may be called upon to participate in and assist in financing a control program. Community action is necessary because mosquitoes may fly into treated areas from nearby untreated breeding places. Neighborly action can do much to reduce mosquito trouble.

At the present time DDT is the most widely used chemical for killing mosquito larvae. Several other insecticides, however, may be used. TDE is nearly as toxic as DDT to larvae. It has the advantage of being less toxic to fish, if these are present in treated areas. Lindane, toxaphene, and chlordane are not as toxic as DDT to larvae. Toxaphene gives better control at high temperatures than at low. Aldrin and dieldrin also are good larvicides but have not as yet been approved for general use.

None of the aforementioned chemicals are very effective against pupae and areas should be treated before larvae have time to pupate. If necessary, pupae are best killed by the use of oil. Diesel or fuel oil No. 2 can be used either straight or emulsified with water. If used straight, the dosage is usually 25 to 30 gallons per acre but if emulsified only 3 to 5 gallons will be required. The emulsified oil is prepared by adding 3 to 5 per cent of a suitable oil soluble emulsifier to the oil.

The emulsified oil can be applied as a mist spray directly to the water or diluted before application with water in varying amounts and applied as a coarse spray. These oil emulsions are good larvicides but are more expensive than DDT and more bulky to transport and apply. In some sections of the country larvae have developed resistance to insecticides and increased dosages are required. In extreme cases of developed resistance it may be necessary to resort to oil for satisfactory control.

The control of larvae in log ponds, rain barrels, and lily ponds needs special mention. On log ponds a fair degree of control can be obtained with a surface application of DDT in oil, using 0.3 to 0.5 pound of DDT per acre surface. Applications must be repeated every 10 to 14 days. The best preparation is an emulsion of DDT and should be used at the rate of  $\frac{1}{3}$  of a pint of a 25 per cent concentrate to about 15,000 cubic feet of water. This dosage usually prevents reinfestation for 3 to 4 weeks. A log pond 50 feet across and 8 feet deep would contain approximately 15,700 cubic feet of water.



In lily ponds containing fish or ornamental plants and in tubs or barrels where the water is to be used for household purposes or for stock, the safest chemical to use is pyrethrum emulsion. Usually a tablespoon of a commercial emulsion concentrate containing 1 per cent pyrethrum added to 50 gallons of water will kill the mosquito larvae.

A recent method to control *Aedes* mosquitoes is the application of DDT to the area where the eggs have been laid before the ground is flooded. The application can be made several weeks or months in advance of the flooding. Best results with this method have been in areas where there is no water movement or at best only a sluggish current in or out of the area. The advantage of this method is that treatment can be applied before the breeding area is flooded or covered by snow. Some mosquito breeding grounds are nearly inaccessible, especially in mountain regions, at the time larvae are present. Good control has been secured with DDT deposits of 0.5 to 2 pounds per acre applied either as a liquid or in dry form.

#### **Insecticide formulations for larvae**

The insecticides are formulated or prepared in a number of different ways. These mixtures are generally prepared by the manufacturer and can be purchased from local stores or insecticide distributors. The usual types of preparations are oil solutions, emulsions, wettable powders, and dusts.

► **OIL SOLUTIONS.** A 5 per cent solution of DDT in No. 2 fuel oil or diesel oil has been used widely in mosquito control. To prepare a 5 per cent solution of insecticide, dissolve 0.42 pound of the technical grade in each gallon of oil. Frequent stirring over a 24-hour period may be necessary to dissolve the chemical. A prepared 25 per cent DDT concentrate in special solvents may be purchased from your dealer in insecticides. A 5 per cent solution of this concentrate is made by adding 4 gallons of fuel or diesel oil to 1 gallon of the concentrate. The recommended dosage is 2 quarts of 5 per cent insecticide solution per acre. For application with hand equipment, it is usually necessary to dilute the mixture to contain 1 per cent of toxicant (1 pint of the 25 per cent DDT concentrate diluted with 3 gallons of oil) and use it at the rate of 10 quarts per acre of water surface.

► **EMULSIONS.** Insecticide emulsion concentrates contain the technical insecticide, an organic solvent, and an emulsifier. The concentrate is diluted with water to obtain the desired strength of toxicant for application, usually 1 per cent. Many emulsion concentrates are commercially available, including the useful war-developed mix-

ture composed of 25 per cent of DDT, 65 per cent of xylene, and 10 per cent of Triton X-100 (an aralkyl polyether alcohol).

The emulsions are useful for applying larvicides with knapsack-type sprayers, because the material can be diluted with water taken from ponds or ditches. When water from the breeding area is used, it should be poured through a screen to remove small particles of debris which might otherwise clog the spray nozzle.

► **WETTABLE POWDERS AND DUSTS.** These insecticides have been used to a limited extent for larval control, but they have not proved as satisfactory as liquid mixtures. Wettable powders are less effective than emulsions or solutions and require constant agitation in spray rigs to obtain uniform coverage. Dusts have not proved as toxic to larvae as liquids. Both these formulations can, however, be used effectively in prelarvicide treatment.

### Equipment and methods

► **AIRPLANES.** For mosquito control over large areas the airplane is both effective and economical. Excellent results have been obtained over extensive floodwater lands along the Columbia River and in large irrigated sections. Commercial operators can generally be relied upon to do a good job.

Figure 2. Applying DDT as a residue on vegetation for protection against mosquitoes.



► **GROUND EQUIPMENT.** Application of larvicides to small areas involving a few acres can be accomplished with 3- or 4-gallon, garden-type sprayers. Paint-type air sprayers producing an atomized spray can be used in many places.

Power equipment of various types is being used in many places for mosquito control. This equipment includes orchard-type sprayers, mist blowers, heat-generated aerosol machines, and devices attached to the exhaust of trucks or cars. Ground machines are usually expensive and are also limited in the area over which they can operate. Frequently, however, the larvicide can be drifted downwind over mosquito-breeding water for 1,000 feet.

The type of equipment to use depends on the size of the mosquito-breeding area and the amount of money available. Frequently local mosquito annoyances can be alleviated at a comparatively small cost.

## Control of Adult Mosquitoes

Although the destruction of mosquito larvae is generally the cheapest and best method of combating the mosquito nuisance, much relief may be obtained by destroying the adult mosquito. This may be done by spraying in and around buildings, woodland areas, grass areas, and various resting places of mosquitoes. Some of the methods require community action, but usually individuals can obtain relief with comparatively little cost and simple equipment.

The spraying of vegetation surrounding buildings, as well as the building itself, so as to leave a poisonous film on the surfaces will reduce mosquito annoyance for several weeks. Application to give a deposit of 2 to 3 pounds of DDT per acre applied to foliage has given good control of mosquitoes in picnic areas for a period of 10 days or more. (See Figure 2.) Sprays for application with hand-operated garden-type sprayers or orchard power sprayers should contain about 2.5 per cent of DDT. If a 50 per cent wettable powder is used 4 pounds will be required to 10 gallons of water and if a 25 per cent DDT emulsion is used, 1 gallon of the emulsion should be added to 9 gallons of water. Door and window screens and places where mosquitoes rest should also be treated. When every householder in a village or rural area sprays his buildings and property, the degree of control is better than when only isolated sprayings are done.

The householder can often get temporary relief around his premises by spraying with an ordinary hand spray gun or a power device, such as exhaust generator or paint sprayer, producing a finely

atomized spray. The light spray mist can be drifted through the bushes, grass, and other vegetation to kill mosquitoes resting there. By this method only a small amount of insecticide is used, and usually residual or long-lasting effect is not obtained. While DDT in an oil can be used, the preferred insecticides are pyrethrin and allethrin (0.2 per cent) because of their rapid action on mosquitoes. Application every hour or two has made it possible to enjoy outings in the backyard as well as picnics in the woods. The use of atomized sprays will give much relief to berry and fruit pickers, lumber and road crews, and other crews of people working where mosquitoes are troublesome. This method can also be employed in parks and at public gatherings.

The airplane can be used to disperse insecticides for control of adult mosquitoes as well as destroy the larvae. Many large-scale operations are directed primarily at destruction of the adults. Airplanes equipped with either the boom dispersing system or the exhaust generator can be used although the last-mentioned device is not effective in winds of 10 or more miles per hour. A dosage of 0.2 to 0.4 pounds of DDT per acre should give good results.

## Repellents

Many good repellents have been developed that will give several hours' protection to man. Their use on livestock is of doubtful value. Some of these chemicals are available commercially, and among the best known ones are Rutgers 612 (2-ethyl-1,3-hexanediol); Indalone (n-butyl mesityl oxide oxalate); dimethyl phthalate; and mixtures of these. They can be used on the skin, and when sprayed on clothing will also keep mosquitoes from biting through.

## Cautions

Insecticides should not be sprayed over foods or utensils used for preparing foods. They should not be applied in excess over grass or fodder that is eaten by livestock. Do not use DDT and related insecticide emulsions for mosquito control when water to be treated contains fish. When using these insecticides in oil solutions do not apply more than 0.2 pound per acre over water containing fish. A particular caution is necessary to pilots applying sprays near ponds, lakes, and rivers.

Avoid excessive exposure to insecticides while handling or applying them. Wash off immediately any concentrated material which may be spilled on skin. Wash exposed skin after applying the diluted material used in treating for mosquito control.