A Review of Barrier Applications to Control Mosquitoes: 1944-2018

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“Barrier treatments for mosquito control involve the application of insecticidal products onto localized areas of vegetation or natural/man made surfaces where mosquitoes may rest during the day”.

Hoffman et al. 2009

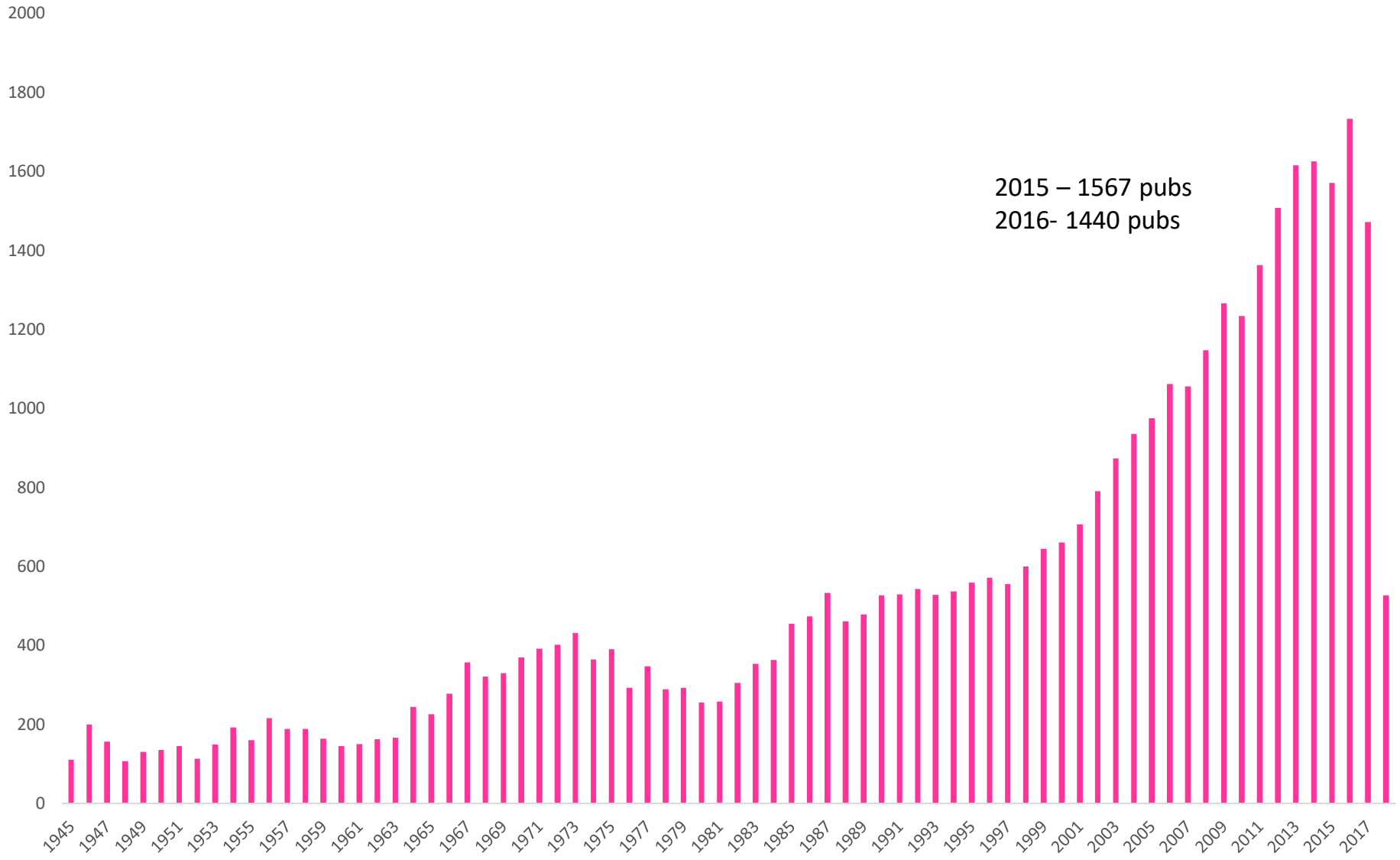
1) **Species targeted must rest in vegetation before and after taking a blood meal**
2) **Clear separation between vegetation and human dwellings must exist**
3) **Breeding sites must not be within the barrier**
4) **Insecticides with long residual times must be used**
5) **Adult mosquitoes must make contact with the applied insecticide.**

Perich et al. 1993

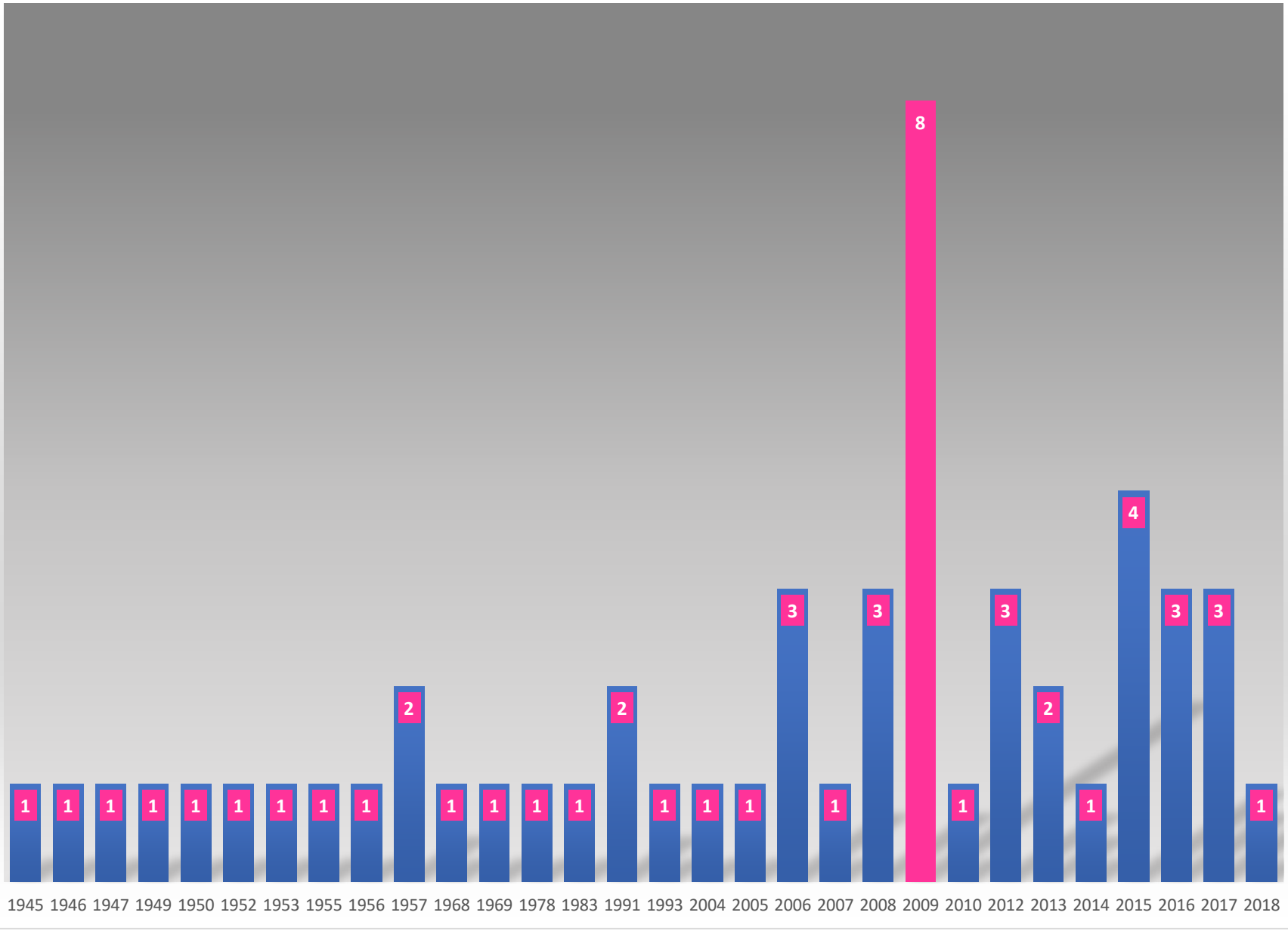
Droplets on the top of a leaf

Droplets on bottom of a leaf

Publications listed for 'Culicidae' since 1945



Publications for Barrier Applications since 1945



Joseph M. Ginsburg of the New Jersey Agricultural Experiment Station tested his newly developed "New Jersey Pyrethrum Mosquito Larvicide" by applying it to vegetation to control adult mosquitoes in outdoor areas in 1934.

The "larvicide" consisted of an emulsion of 66% kerosene, 0.5% sodium lauryl sulfate, 0.07% pyrethrins and 34% water.

The concentrated insecticide was thoroughly mixed and then 12 parts water was added which could be 1 quart to 3 gallons depending on the sprayer.

If applications were made to all of the vegetation, structures, benches and other surfaces mosquito numbers were lower in the area the treatment was applied.

The larvicide continued to be used in vegetation treatments in NJ until 1942 when the War Production Board no longer allowed the use of pyrethrins in the preparation of the larvicide due to the outbreak of World War II.

Photo from Gaugler
Wing Beats 2012

During the summer of 1944 USDA scientists A.H. Madden, A.W. Lindquist and E.F. Knipling, embarked on the first published tests of DDT applied as a barrier application to control mosquitoes

Vegetation was treated with DDT mixed with No. 2 fuel oil and DDT aqueous emulsions in No. 2 fuel oil.

Application rates ranged from 5 - 20% DDT for the fuel oil solutions (2.5, 3, 5, 10 and 20 gal/acre) and 5% (5 gal/acre) for the aqueous emulsions.

DDT application reduced landing counts of *Ae. taeniorhynchus* and *Ae. sollicitans*.

Landing rate reductions were greatest in the 48-72 h with 89 to 99.8% reduction (Madden et al. 1945).

The study showed that a 5% DDT aqueous emulsion provided the best and longest lasting treatment.

Treated a 100 ft swath with 5% DDT in number 2 fuel oil at the rate of 10 gal/acre around a 0.5 acre untreated area as a “barrier treatment”.

A liquified-gas pyrethrum aerosol was used to “clean out” the 0.5 acre area within the barrier treatment.

Madden et al. 1945

In a prelude to the current “backyard” mosquito control industry, Bidlingmayer and Schoof (1956) reported that treating outbuildings and vegetation out to a radius of 100’ from a house with 5 lbs/acre DDT and 10 lbs/acre DDT resulted in 6 weeks and 9 weeks of control of *Aedes sollicitans* and *Aedes taeniorhynchus* respectively.

In concurrent tests of BHC, lindane and dieldrin in these residential settings, control only lasted from zero to two weeks.

Under high mosquito pressure the DDT treatments were also not considered effective after 2 weeks.

Bidlingmayer and Schoof 1956

Organophosphate Insecticides

Malathion was reported to be in widespread use in California by Geib (1957) but there isn't much published literature on the effectiveness of malathion or other OPs but there is no doubt they were used.

Anderson et al. (1991) found that permethrin controlled mosquitoes for an eight day period where plots treated with malathion were not different than untreated controls after 48hrs.

Early in the testing of pyrethroids some data on OPs like malathion and Chlorpyrifos was published.

That data shows OPs as they were formulated were not as as the new synthetic pyrethroids.

Field work by Helson and Surgeoner (1983) found that applications of permethrin resulted in decreased biting pressure in Ontario, Canada for *Aedes stimulans*

Table 5. Comparative numbers of mosquitoes collected in treated and untreated backyards before and after treatment with permethrin at 0.7 g AI/100 m²

Days after treatment	No. trials	Mean number ± SD		T paired samples	Significance[1]
		Control	Treated		
Pretreatment	5	85.2± 34.4	80.8±36.2	0.275	NS
0	6	79.3± 65.5	25.5±37.0	4.020	≈0.005
1	4	114.3± 91.8	39.3±53.9	2.873	<0.05
2	3	110.0±137.8	54.7±56.9	1.148	NS
3	2	32.0± 29.7	13.5±13.4	1.609	NS
4	4	47.3± 22.9	34.0±28.0	0.724	NS
5	1	21	18	—	—
6	2	32.0± 19.8	23.0± 7.1	1.00	NS
7	1	34	33	—	—

[1] 1-tailed T-test.

1993 to 2006……It works, why study it?


Photo by Steve Wilson

Biological Control Studies – emphasis at USDA

The widescale adoption of ULV from the 1970s to the 1990s especially with lower residual efficacy of OPs like malathion

2004 to 2018

Renewed emphasis (DWFP)

Testing new Pyrethroid formulations

Effect of plant species on insecticide

Mosquito behavior

Environmental conditions

New Mosquito specific Pest Control Companies
Large scale adoption of Mosquito Control to PCCs

Pyrethroids can last up to 4 weeks

- **Quality of application**
- **Vegetation**
- **AI and formulation**
- **Rainfall***
- **UV**
- **Mosquito Population***
- **Better than ULV alone in certain circumstances (AMCD)**

Difference in deposition on the tops and bottom of leaves but not necessarily in mortality

Sprayers with most power provide the best penetration of the vegetation

Different species are impacted differently by the applications

- ***Aedes* (*Stegomyia*) spp.**
- ***Aedes* spp.**
- ***Culex* spp.**
- ***Psorophora* spp.**
- ***Mansonia***

Research Priorities

New non-pyrethroid active ingredient

Where, when and what species of mosquitoes rest in the barrier vegetation in varied habitats for targeted applications

To what extent these insecticide applications are contributing to insecticide resistance

Do these applications lower risk of arbovirus transmission based on pathogen incidence and prevalence in humans

What wide-area and long-term impact these applications have on non-target organisms.

RECOMMENDATIONS

State and local health departments and mosquito control organizations should partner with universities and the U.S. CDC to understand what impact this method has on lowering risk of arbovirus transmission via controlled studies that combined mosquito collections and human or animal arbovirus cases and seroconversion data.

Private pest control companies should partner with universities and federal, state and local mosquito control programs to increase communication and understanding including:

1) **Invest in research and development into improving targeted techniques for barrier applications**
2) **Integration of novel control technologies to manage “backyard” mosquito populations**
3) **Understanding the impacts on non-target organisms**
4) **Develop regular testing programs for insecticide resistance detection to ensure prevention of resistance**

THANK YOU

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