INVITATIONAL PAPER

TRENDS IN INSECT VECTOR CONTROL OUTSIDE THE U.S.A.

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ABSTRACT. The current methods of controlling a number of insect vectors in the tropics and sub-tropics are outlined, with particular emphasis on mosquitoes and flies. Alternative or additional useful techniques are proposed, some of which are now in use. The place of the pyrethroid group of insecticides in vector control is discussed in some detail. The general view is put forward that the pyrethroid group is only at the start of a rapid development. It is considered that vector control techniques will continue to be based mainly upon insecticides. Improvements will come from the availability of new compounds and improvement in the techniques of delivery and usage in relation to insect biology. Success of environmental control is related to increases in the standard of living.

INTRODUCTION. The prevention of insect borne disease is at present passing through a difficult phase principally because of the increasing incidence of insecticide resistance amongst insect vector species, especially mosquitoes, house flies, lice and fleas (Brown and Pal 1971). International institutions, particularly the World Health Organization, can justifiably claim immense achievements during the last 20 to 30 years, bringing together all the disciplines involved, stimulating research and organizing eradication or control schemes, particularly for malaria.

The control of mosquitoes and black flies in the U.S. is largely a public service, inasmuch as many of these insect species, such as *Aedes taeniorhynchus* Wied., are often an unbearable nuisance or are no longer associated with transmission of diseases in man. The risk, however, of outbreaks of yellow fever or malaria is nevertheless always present where a potential vector is able to flourish and where movement of people may allow the occasional importation of carriers.

The situation in much of Africa, India, South East Asia and Central and South America is in total contrast with the U.S.A. Living standards vary enormously and are often unbelievably low and some Public Health Departments, overwhelmed with simple problems, are unable or unwilling to provide funds for even a modicum of vector control. Nevertheless, funds are often made available by local authorities for *ad hoc* urban insect vector control, and these bodies will normally carry out their own programme which is sometimes operated under a Ministry of Health umbrella.

INSECT CONTROL CHEMICALS. During the last 30 years we have seen the development of many excellent insecticidal compounds beginning with DDT which has long been the mainstay of malaria eradication programmes, through the organophosphorus and carbamate groups to the new growth retarding agents, sterilising compounds and the synthetic pyrethoids. I believe that the pyrethroids and the group of compounds which interfere with the nymphal instars of insects, preventing maturation of the imago are only at the beginning of a rapid development.

I would like, at this juncture, to say a few words about the development of the synthetic pyrethroids which are now becoming increasingly employed in the vector control field. As you know, the high cost of pyrethrins coupled with periodic shortages, stimulated a systematic search for synergists leading to the synthesis in the U.S. of piperonyl butoxide by Wachs in 1947. Piperonyl butoxide has been consistently shown to be the most efficient and economical methylene dioxyphenyl synergist available for the pyrethrins and remains the only synergist in large scale production today.

The synthesis in 1949 by Schechter, Green and La Forge, again in the U.S., of the first synthetic pyrethroid ((±)-*cis trans* chrysanthemic acid ester of (±)-allethrolone), allethrin, prompted a search for other pyrethroids with more potent insecticidal properties. Allethrin was not a replacement for pyrethrins, having only about 40% of the activity of natural pyrethrins in synergised formulations.

Following the laboratory evaluation of the geometric and optical isomers of allethrin by Gersdorff and Mitlin (1953), it was found that the (+)-*trans* chrysanthemic acid ester was the most active isomer both for knockdown and kill of house flies and mosquitoes. Commercial separation of the isomers was impractical at that time, but recent work by Martel and Huyn (1967) has resulted in an economical method of preparing the (+)-*trans* chrysanthemic acid. This permitted the large scale synthesis of the (+)-*trans* chrysanthemic acid ester of (±)-allethrolone (bioallethrin). More recently, another isomer, the (+)-*trans* chrysanthemic ester of (+) allethrolone has been prepared by Martel (1971). This compound, S-bioallethrin, is considerably more active than pyrethrins. It is the first synthetic pyrethroid commercially available to provide a more rapid knockdown of house flies than pyrethrins, although both bioallethrin and S-bioallethrin provide faster knockdown of adult mosquitoes than pyrethrins with a correspondingly greater kill at similar concentrations.

In 1967, Elliot, Farnham, Janes, Needham and Pearson synergised a new group of synthetic pyrethroids in which the alcohol moiety of the natural pyrethrin I has been replaced. Some of these pyrethroids retain most of the desirable properties of the natural compound, while eliminating some of the drawbacks.

Two promising groups of esters have been prepared, from 5-benzyl-3-furyl methyl alcohol and from substituted benzyl alcohols. In particular, 5-benzyl-3-furylmethyl-(+)-*trans* chrysanthemate (bioresmethrin) is reported by Potter (1973) to be 55 times more toxic for kill of house flies than the pyrethrins. He also adds that there is no record of death or illness of human beings resulting from the use of natural pyrethrins and this is also true of the synthetic pyrethroids currently available. Bioresmethrin is a very efficient and safe agent and probably the most active compound for insect kill at present commercially available. However, the knockdown quality of bioresmethrin is poor in some formulations, and so it is usually used in combination with a rapid knockdown agent, such as bioallethrin or S-bioallethrin. Nevertheless, in ULV formulations, bioresmethrin has a rapid knockdown activity.

One of the disadvantages in some situations of pyrethrins and the synthetic pyrethroids currently available is virtually complete lack of residual activity. A recent development has been the synthesis of a new race of pyrethroids with long residual activity on inactive surfaces. These compounds are much less susceptible to degradation by daylight. The first of these is a dihalovinyl analogue of 3-phenoxybenzyl alcohol, NRDC 143 (3-phenoxybenzyl (±) *cis trans*-2, 2-dimethyl-3-(2, 2-dichlorovinyl) cyclopropanecarboxylate). It was described in 1973 by Elliot, Farnham, Janes, Needham, Pulman and Stevenson and has been provisionally named Permethrin. This insecticide and related compounds may have a greater impact on the control of vector insects than any chemical ever synthesized. It is an insecticide with all the desirable properties of the available pyrethroids and an activity approaching that of bioresmethrin, yet it has residual properties providing great potential for long residual control. We will at last have a group of insecticides at our disposal which can be used as alternatives to organophosphates, chlorinated compounds and the carbamates, which have a different mode of action and yet are biodegradable and rapidly inactivated in man without accumulation in the food chain. Kamel (1975) working in Egypt has shown that Permethrin has a level of activity against the body louse *Pediculus humanus humanus* Linn, at least comparable to that of temephos and malathion, and yet it is also highly active against the plague flea *Xenopsylla cheopis* Rothsch, against which temephos and malathion are relatively poor. Permethrin is not yet commercially available and will not be so for some time, but is has marked potential for mosquito, fly, tsetse, louse, and flea control. Elliot, Farnham, Janes, Needham and Pulman (1974) have described further developments with esters of α cyano alcohol. Elliot et al. (1975) have claimed variants of Permethrin, in particular substitution in the alcohol by an α cyano group and replacing chlorine in the acid by bromine, particularly where the configuration is (+) *cis* has led to an extremely active insecticide, which probably has a higher degree of persistence.

In 1964, Kato, Veda and Fujimato announced the synthesis of the tetrahydropthalimidomethyl alcohol ester, tetramethrin. Although when synergized, it was a little less active than pyrethrins against house flies, it was still the first synthetic pyrethroid to approach the pyrethrins in biological activity. However, its toxicity was markedly less to *Anopheles stephensi* Liston and *Aedes aegypti* Linn. when compared with resmethrin and bioresmethrin (Hadaway, Barlow, Grose, Turner and Flower 1970). Japanese workers continue to be very active in this field and are well abreast in research and development.

BIOLOGY. Muscid flies, *Culex pipiens quinquefasciatus* Say and *Ae aegypti* or other *Aedes* sp. are invariably the Dipteran urban vector species. *Musca domestica* Linn. and its sub species are often described as vector species. Strictly speaking they are not, but Manson Bahr (1966) has indicated a connection between the house fly and local cholera dissemination, although of course cholera is substantially a waterborne disease. Cholera is still a fear-inspiring disease in the developing areas of the tropics and sub-tropics when it occurs. House flies also, because of their feeding habits, may as passive conveyors, transmit the causative agents of amoebic, bacillary and virus dysentery, poliomyelitis, hepatitis, trachoma, typhoid and paratyphoid fevers and other lesser known diseases of man. The house fly plays a fundamental part in urban life in many tropical and sub-tropical countries, thriving on urban squalor. It is a man-made affliction in urban districts and theoretically it should therefore be readily challenged by an environmental and educational approach. In rural areas where Muscid flies breed in cattle droppings and dung heaps, control presents a more diffuse problem and the environmental approach to control becomes more difficult although the house fly may appear in great numbers in village situations, where the economy is based upon housed cattle and where waste is removed infrequently, if at all.

Social education, sound public health practice and efficient regular collection and disposal of waste ought to be the prime factors and weapon against the house fly. Unfortunately, however, the approach is often haphazard, machinery provided for collection becomes damaged, while covered household disposal receptacles become the target for petty larceny. Nevertheless, it is the one method against which the insect is not affected by resistance or adaption and in the long term is the only permanent solution.

Faced with a lack of sound public health programmes and escalation of urban population with inadequate housing, shanty town growth and all the attendant waste, insecticides are now widely used for fly control in the developing countries. The organochlorines DDT, BHC and dieldrin were used as residual adulticides and larvicides for many years until resistance rendered them ineffective. They were then replaced by the organophosphorus compounds, diazinon, malathion, iodofenphos and others. Now resistance has appeared to many of these. Table 1 shows how resistance and cross-resistance has affected these control measures.

Table 1. Comparison of susceptible strain and local strains of *Musca domestica* using a microdrop technique

	Compound	Standard strain LC50μg/♀	Local strain LC50μg/♀	Local strain Resistance factor
BAGHDAD	Malathion	0.74	60	81
	DDT	0.26	110	423
	Pyrimiphos-methyl	0.09	1.8	20
	Diazinon	0.05	0.37	7.4
AMMAN	Bromophos	0.092	7.88	85.7
	Fenthion	0.139	3.70	26.6
	Propoxur	0.491	12.65	25.8
	Pyrimiphos-methyl	0.203	3.64	17.9
	Dimethoate	0.007	0.18	26.4
	DDT	0.153	55.03	360.0
MONROVIA	Malathion	0.74	138	186
	DDT	0.26	37	142
KUWAIT	Propoxur	0.243	2.09	8.6
	Diazinon	0.028	2.60	93
	Dichlorvos	0.003	0.69	229
	Lindane	0.02	12.3	614
	DDT	0.159	59.4	373
	Bioresmethrin	0.019	0.037	2.0

Synthetic pyrethroids are being generally used in some countries as ultra low volume space aerosols. Control with combinations of S-bioallethrin and bioresmethrin has been excellent, when applied as ultra low volume mists from such an atomiser as the Leco HD to provide 10g of total pyrethroids per hectare with a particle vmd of 17μ–20μ. Used on a planned regimen, attempts have been made to interrupt the life cycle of *Musca* sp. and this has been demonstrated by Mahdi, Taha, Brooke, Kamel and Nawawy (1976) in Egypt, with a very high level of control. A mean daily adult fly density reduction of about 99% was obtained representing a reduction from 1,147 flies per grill count to only three. This work has been confirmed by Mason, Johnson, Brooke and Stewart (1975) working in Liberia. The use of aircraft in public health urban spray projects for fly control is only very recent and El Huseiny, Brooke, Jones and Hasan (1976) have shown in Saudi Arabia that although an airspray over an urban area may effectively control flies outdoors, control indoors and in covered areas is inefficient because of the poor horizontal penetration achieved by the necessarily large droplets used. Such techniques are adaptable for any insecticide provided there is no resistance. Where pyrethroids are used, the method is, in other respects, suitable for use in areas where food and water are uncovered and particularly where people are exposed to particle inhalation.

For house fly control, then the long term solution, as in N. America and Northern Europe, is hygiene and good public health practice. In the short term, the judicious use of residual insecticides and the planned application of ULV space mists. But before any insecticide usage is considered, the resistance status of the insect species should be checked. I should add that the operational approach to urban vector control in some of the developing countries is sometimes untidy because of over-extended resources.

The removal of the tsetse fly is vital to agricultural development of much of the African continent. The diversity of species requires different control methods whether environmental, as with riverine tsetse, such as *Glossina palpalis* Robineau Desvoidy or *Glossina tachinoides* West, where bush clearance along the watersides of rivers and lakes is a standard control technique, the use of insecticide placement at known resting places attractive to the species concerned, or overall spraying of savannah type vegetation with insecticide to control *Glossina morsitans* West. At present, endosulphan has been found to be extremely effective sprayed as a ULV aerosol from aircraft at very low concentrations. However, the use of residual bands is a promising development, while the new residual pyrethroid, Permethrin or its isomers, may well have a potential in this field.

From the vector point of view, mosquitoes are probably the most important group of insects although the number of species directly concerned are few. I will begin with malaria which still remains the most widespread and the most resilient of the vector borne diseases.

With the introduction of DDT into the new malaria eradication schemes in the late 1940s and early 1950s, the future for malaria eradication looked promising and malaria was eradicated from Italy, Greece, Yugoslavia and the eastern shores of the Mediterranean. Of course, the prevention of malaria transmission revolves around the habit of most *Anopheles* sp. to rest upon an internal (sprayed) wall before or after the blood meal. This is a highly effective method of interrupting transmission, as long as:

a) selection of mosquitoes which are repelled or irritated by the treated surface does not take place
b) resistance does not arise (some authors believe that resistance in vector mosquitoes is entirely due to the widespread use of DDT and organophosphates in rice and other crops)
c) the *Anopheles* population is composed of anthropophilic, endophilic species only. If species are present which spend more of their adult life outdoors they may well increase in density to fill the niche created when the endophilic species is removed or declines
d) spray coverage of dwellings is complete or nearly so. Notonanda, (1972) describes only 40%–50% of houses in a village in Thailand being completely sprayed because of refusals, although this could be considered to be an exception.

Marked irritation of *Anopheles gambiae* Giles to DDT deposits has been reported by Davidson (1952) and Muirhead-Thompson (1960) while Hamon (1963) observed that at Bobo Dioulasso, Upper Volta, DDT sprayed surfaces in huts retained the irritancy effect when toxicity had disappeared. Resistance to DDT and some organophosphate insecticides amongst malaria vectors has been recorded (Brown and Pal 1971) while cross resistance between organophosphates is well documented. Resistance if it is not acquired through exposure to agricultural chemicals may be related to long exposure to doses which kill only a proportion rather than the whole population over perhaps 2–4 years, during the attack phase of eradication programmes.

The identification of different races or species of *An. gambiae*, each with markedly different habits, again illustrates how much more is known now, than say 20 years ago, and why perhaps some earlier control or eradication schemes reached disappointing conclusions.

There are six sibling species of the *An. gambiae* complex, three in fresh water (A, B & C) one in mineral water (D) and two in salt water (*An. melas* Evans and *An. merus* Donitz). Species A and B include most of the *An. gambiae* population in inland continental Africa covering the Ethiopian zone. Species A is highly endophilic while species B is partially exophilic in habit.

Endophagic females of species A will rest indoors for a day after feeding (Gillies 1954). These populations are well controlled by DDT residual application, and interruption of transmission is readily achieved (Bruce-Chwatt 1970). Species B is partially zoophilic but where its host(s) sleep(s) indoors then the bulk of the blood fed females remain to rest indoors on a surface and are controlled. When the hosts are also available outdoors, then species B may not enter a house to rest, especially where attractive sites are available outdoors. Species B may under some conditions become completely exophagic and exophilic. Thus residual spraying of houses will select species B for complete or partial exophily where there are suitable genotypes (White 1974).

The Twenty-first Report of the WHO Expert Committee on insecticides (1975) recommends a number of additional measures besides routine periodic indoor residual spraying with one of a series of approved insecticides. These measures include source reduction by environmental measures, although *An. gambiae* can select diverse breeding places during the wet season and source reduction, where even hoofprints contain larvae, is unreliable. On the other hand, *An. culicifacies* Giles in rice and *An. stephensi* in irrigation seepage can be controlled by these means because of the specificity of the site. Larviciding is also mentioned and this is useful where well defined breeding places are usual. ULV aerosols are also recommended for use outdoors against adult vector species and considerable space is given to this rapidly developing technique.

All adult *Anopheles* sp. spend well defined periods of their life cycle outdoors, i.e. the nulliparous females prior to the first blood feed, and parous females during oviposition, so at certain times they are well controlled by ULV aerosols.

Where malaria eradication schemes have foundered or where eradication is not possible because of funding or staffing, then malaria control by such means is an acceptable but less ambitious alternative. Control is fast becoming a practicable substitute measure to eradication. Space sprays have a part to play in such schemes in combination with chemotherapy and prophylaxis, and space sprays will inevitably interrupt transmission if the preliminary survey work and the spray programme are efficiently completed.

A relatively new development in the control of vector borne diseases is the use of mathematical models to describe the effect of natural and artificial pressures upon an insect population. Such models can be used to predict the stage at which artificial pressure will interrupt either the life cycle or transmission (Chadwick and Toner 1972) (LaBrecque, Weidhaas and Whitfield 1975). Brooke, Martin and Stewart (1975) have shown in a mathematical study how a theoretical population of *Anopheles* sp. can be reduced to nil malaria transmission within a few days by ULV mist applications of synthetic pyrethroids. In the U.S. the use of ULV aerosols of malathion and other organophosphorus insecticides atomized from such machines as the Leco HD unit have for many years been very successfully employed for control of nuisance mosquito species. In other countries, it is an entirely novel technique, especially for the control of vector borne diseases.

The other mosquito vectors of importance are *Ae. aegypti, Cx. p. quinquefasciatus, Mansonia uniformis* Theobald and *Ma. africana* Theobald. Species responsible for transmission of Japanese encephalitis such as *Cx. tritaeniorhynchus* Giles are probably of less significance although Self, Ree, Shim, Shin and Jolivet (1973) working in Korea and using a Leco HD ULV atomizer, applied about 430 ml of fenitrothion per hectare in the early morning to provide 90% reduction of *Cx. tritaeniorhynchus* but no reduction of larvae. It would seem from general experience that although ground ULV applications are often preferable in urban areas, aerial spraying can be extremely effective in mosquito control. Self, Pant, Singh and Noordin (1974) obtained 99% control of caged adult *Ae. aegypti* outdoors using 210 ml per hectare of malathion sprayed from a helicopter over parts of Kuala Lumpur although only 21% mortality was achieved indoors.

Ae. aegypti, while eradicated from some island sites in the Caribbean, has recently caused concern because of outbreaks of dengue/haemorrhagic fever in S. E. Asia. *Ae. aegypti* like *Musca domestica* thrives in a man-made environment and can be controlled by removing the favorable conditions. In the advanced society of Singapore, control of *Ae. aegypti* which, is after all, a completely domesticated mosquito, has been successfully accomplished by the introduction of legislation providing strict penalties against citizens who permit *Ae. aegypti* to breed in water either inside their house or on their property. In the cities and villages of, for example, Thailand, such laws would be difficult to administer, and insecticide must be resorted to when outbreaks occur. Fenitrothion has provided 6–7 months control of *Ae. aegypti* where it has been applied indoors by a hand-held ULV atomiser, twice at the rate of 0.1 ml/m³ technical fenitrothion (Pant, Mathis, Nelson and Boonluan Phanthumachinda 1974). However, some toxic symptoms in spraymen were recorded in spite of precautions. Pant, Nelson and Mathis (1973) applying fenitrothion sequentially outdoors with a Leco ULV unit achieved 5 months control of the same species. Nevertheless, a mosquito with a flight range of perhaps 50 m and with highly specific breeding sites ought to be simpler to control than, for example, an *Anopheles* sp. with a multiplicity of potential resting sites indoors and outdoors and an average flight range of perhaps 500 m or more.

The synthetic pyrethroids have been shown to be extremely active against some non-vector species and Lee and Giglioli (1974) obtained reductions (12 hours after an airspray of 3g per hectare bioresmethrin) of 96%–98% of adult *Ae. taeniorhynchus.* In the same area, Brooke, Giglioli and Invest (1974) achieved about 90% reduction of *Ae. taeniorhynchus* using only 1.5g bioresmethrin per hectare atomized from a ground based ULV unit. The insecticidal activity of many of the new synthetic pyrethroids is substantially greater than existing compounds in other groups.

Cx. p. quinquefasciatus, the urban house mosquito, thrives on urbanization without sanitation. Bancroftian filariasis is widespread in India and S. E. Asia, and control ought to be achieved by larviciding the very specific breeding places. Control programmes using ULV aerosols from ground based ULV atomizers at peak outdoor activity periods, should interfere with transmission of filariasis in the same manner as malaria. With the increasing urbanization which is taking place in most tropical countries, the density of *Cx. p. quinquefasciatus* can only lead to a related rise in incidence of filariasis unless efficient control measures are resorted to. To follow an environmental approach as the sole method of control under such often appalling social conditions would be to invite a measure of failure. A great deal of social change must come about before filariasis recedes through improved sanitation. Much emphasis is now being placed upon the cytoplasmic incompatibility of some strains of *Cx. p. quinquefasciatus* (Laven 1967) (Yen and Barr 1972), radiation of the adult in a nitrogen atmosphere prior to mass release and the genetic manipulation of the sex ratio (Sweeny and Barr 1972). However, Smithson and Conceicao (1973) showed complete compatibility between *Cx. p. quinquefasciatus* from Bahia State, Brazil and New Delhi, India, and this is supported by other authors.

River blindness or onchocerciasis, has long been a scourge in parts of Africa, Central and South America while the infection rate in man in the Black Volta river valley in Ghana reaches 60% (Williams 1970). The control of *Simulium damnosum* Theobald the main vector, in the Upper Volta river area of West Africa, is being undertaken as a joint project between several countries with WHO involvement. This programme requires continuous control of larvae in the breeding streams with Abate for at least 15 years until the adult stages of the filarid worm *Onchocerca volvulus* Leuckart in man die a natural death. Hopefully, during that time, little or no transmission of microfilariae will have occurred because of the low density of *S. damnosum*.

The obvious question is how long will a reasonable level of control be obtained before resistance arises and the immediate thoughts turn to the new synthetic pyrethroids. However, Quelennec (1971) applied resmethrin (NRDC 104) to a stream in West Africa and found that although a low concentration gave good control of *Simulium* sp., it also provided a kill of fish. Toxicity to fish is unhappily a property of natural pyrethrins and many of the synthetic pyrethroids currently available. Black fly species are not exempt from resistance, and DDT resistance has been reported from the Volta river in Ghana (Kuzoe and Moamesi 1968), Japan (Suzuki, Ito and Harada 1963) and elsewhere, while Brown et al. (1971) quoting Asahina, reported marked resistance by *Simulium ornatum* Mg. to diazinon and fenthion.

ULV mists outdoors are unlikely to be of value for adult *Simulium* sp. control because of their almost unknown life habit between emergence, pairing and the blood meal. The only likely place of assembly is at the host and usually outdoors. There is little doubt that many aspects of *Simulium* biology will remain obscure until successful culturing or colonization in the laboratory can be achieved, though how a species in which migration may be a necessary part of the life history can be colonised is uncertain.

Raybould and Grunewald (1975) have achieved a little success rearing black flies of the *S. damnosum* complex. The relationship of migratory flight to gonad development, the blood meal and pairing has barely been studied. McComb and Bickley (1959) assumed that the adults of *Simulium jenningsi* Malloch dispersed rapidly over many square miles soon after emergence. Many other workers have observed this with other black fly species to greater or lesser degrees. If migration following emergence is an essential part of the life cycle involving gonad development, host finding and mating, then larviciding compounds which prevent or depress development of thoracic flight muscles in the aquatic stages could be of value.

Machinery is an area where progress has been made during the last few years. Boize, Matthews and Kuntha (1975) have described an ultra low volume prototype hand held sprayer for controlled droplet size application. The purpose of the atomizer is to place droplets onto surfaces. Using technical Permethrin at 400 droplets/cm^2 using 0.3 ml/m^2, 100% knockdown of DDT resistant adult *Ae. aegypti* occurred within 40 minutes exposure to the treated surfaces throughout a subsequent 71-day test period. Mortality always exceeded 87%. When Permethrin was diluted to 10%^{ai}, then 100% mortality occurred over a 57-day test period. Such equipment which is battery driven may have a wide usage in house to house application of internal residual deposits for control of indoor resting species of mosquito. This would be an improvement over the cumbersome hand-operated pressurized knapsack high volume sprayers used at present. It could also be a more attractive proposition than house to house fogging, also another method of *Ae. aegypti* control.

The design and manufacture of robust ULV equipment which will disperse insecticides outdoors in narrow particle size bands has made great strides, and equipment is available which will provide particles in the 10μ–20μ band. However an atomizer on which the particle distribution can be easily changed over a wide range is badly needed.

To summarize these trends, vector control techniques continue to be based mainly upon insecticide application. It is not only the synthesis of more active and safer compounds, it is also the techniques of usage in terms of delivery equipment and a more logical approach to this in relationship with the biology of the species concerned. Environmental control is regrettably lagging far behind and will continue to do so until there is a gross improvement in living standards.

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CORRECTION

The dates of the New Jersey Mosquito Control Association were listed incorrectly in the advertisement in the September *Mosquito News*. Please note the correct dates: March 16, 17 and 18, 1977, Cherry Hill, N. J.

DESPLAINES VALLEY MOSQUITO ABATEMENT DISTRICT

8130 Ogden Avenue, Lyons, Illinois

Member of American Mosquito Control Association

Trustees

Charles F. Scheel, President; John E. Callahan, Vice-Pres.; Edward S. Rog, Sec.,
Wm. J. Murphy, Treasurer; Francis P. Creadon, Jr., Ass't. Sec.
Emanuel E. Fetzer, Manager

The District was created under state law adopted in 1927 by the General Assembly of Illinois. The District has functioned for forty-nine years.