commented on the difficulty of obtaining funds for these kinds of projects; fiscal conservatism is the current rule.

The U.S. Department of Agriculture has long been involved in single-approach research and extension which are now being plugged into IPM. The FY 80 budget contains a total of $6.5 million for IPM research and pilot studies. At the time of this writing, the fate of the budget has not yet been decided. Research on insects affecting man and animals would be included. None of the money would be designated for operational implementation. The U.S. Agency for International Development hopes to move into mosquito IPM (which it prefers to call "comprehensive vector control") in a relatively big way. If all goes well, it will request something near $1 million for FY 81 but the likelihood of obtaining such as amount is uncertain. Currently, the Agency would entertain requests for small projects costing no more than $35,000.

In summary, it appears that funding for mosquito IPM will have to come largely from traditional sources, including operational support. The requests of several agencies for line-item IPM funding indicate conceptual endorsement of IPM; only time will tell whether the necessary money will be provided.

Paper No. 5

PESTICIDE REGULATION, PEST MANAGEMENT AND MOSQUITO CONTROL

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ABSTRACT. The policies of the United States Environmental Protection Agency (EPA) on pesticide registration and marketing are discussed with emphasis on recent changes. The impact of these policies on integrated pest management (IPM) and the conceptualization of IPM in EPA are discussed. EPA is attempting to encourage the development of the technology needed in IPM.

I'd like to spend most of my time discussing EPA's policies concerning integrated pest management, and some of the ways EPA can be involved in encouraging mosquito control technology. But first, I'd like to outline some of the recent changes in the pesticides law which may have an influence on mosquito abatement practices.

EPA has a very direct impact on pest management through the premarket pesticide regulatory program or pesticide registration—all pesticides must be cleared through EPA before going into sale and use. The Agency is not infrequently viewed as the "bad guy" when approval of products that are viewed as "essential" to effective pest management and maintaining high levels of crop production or protecting the public health is not immediately forthcoming. EPA has had significant legal, resource and administrative problems during the last few years in implementing the pesticide law, but I believe that the recent amendments to the Federal Insecticide, Fungicide, and Rodenticide Act, or the FIFRA, should bring relief in many serious problem

areas. The outlook is brighter for a new, vital, and efficient pesticide regulatory program.

Collectively, several new provisions of the law should serve to reduce costs and regulatory burdens, increase competition and thereby reduce user cost and also get pesticides on the market faster. Of particular interest to pesticide users, including the mosquito control community, is our new authority to issue conditional registration, and a broadening of user discretion by decreasing unlawful acts.

The amendments provide for 3 types of conditional registration:

1. conditional registration of old chemicals for essentially old or already registered uses; 2. conditional registration of old chemicals for new, never before registered uses; and 3. conditional registration of new chemicals when accelerated marketing is in the public interest.

Conditional registration permits EPA to register new products, new uses and new chemicals without requiring the full complement of supporting data needed for full registration. The "condition" on the registrant assures that needed additional data will be produced to satisfy our concerns about continued long-term registration and use. To expedite these reviews, especially for old chemicals, we will review only a minimum amount of data needed to satisfy ourselves on the social acceptability of the incremental risk of a new use, added to already existing uses. Full data review will be made over the next 10 or so years under the generic standards program without impacting our ability to make short term decisions, exercise flexibility in fulfilling data requirements while not diminishing our capability to protect public health. Our conditional registration program is already underway and paying off, and should ease the registration for new mosquito control chemicals.

The 1978 amendments also define, for the first time, the phrase "to use any registered pesticide in a manner inconsistent with its labeling," and establish four use practices as "consistent" which are not in literal accord with the labeling. So, users can now, at their own discretion: apply a pesticide at a dosage, concentration, or frequency less than that specified on the labeling; apply a pesticide for control of pests not specified on the label to a site which does appear on the label; employ any method of application which is not prohibited by the label; mix pesticides with fertilizers or other pesticides in tank mixes unless such mixture is prohibited by the labeling.

This should allow users greater flexibility in applying pesticides in the manner most suitable to their use conditions and particular pest problems and permit knowledgeable users to exercise more fully their expertise and judgment.

The Administrator of EPA also had to decide by March 31, 1979, whether or not application of a pesticide at a dilution less than that specified by the label—low volume or ultra low volume—should be considered consistent with labeling. During the 6 months following passage of the amendments we conducted a study of such application methods, which was transmitted to Congress last month. We concluded, and USDA and State comments agree, that ULV application does increase the potential for hazard of pesticide use through increased possibility of drift (and harm to non-target areas), increased residues on target crops or sites, and increased potential for harm to workers and other people in the vicinity of spray from dermal or inhalation contact with the more concentrated droplets or residues. But we support more flexible approaches to regulations which do not penalize an applicator who applies pesticides in a safe and economical manner, though not in literal accord with the label.

Consequently, what we plan to do is issue an advisory opinion in the next few weeks which states that, for this growing season, amounts of dilution as specified on the label should be followed. Then, by next spring, we will issue another advisory opinion which will provide more

user discretion once we have had the opportunity to consult in depth with USDA and the States. A number of mosquito control products are, of course, labeled for low or ultra low volume application and thus this action will have no impact on their method of application.

FIFRA amendments also permit the Agency to waive the requirement for submission of efficacy data and the finding by EPA that the product is efficacious. We requested this authority because we felt it would help us concentrate our scientific resources on evaluation of safety, and also reduce regulatory burdens on industry. Further, in many cases efficacy data rapidly becomes dated.

However, we are not closing our eyes to the question of efficacy altogether. While for many products, the market may be the best arbiter of efficacy, for others, particularly those used for public health purposes, we will still require a demonstration of efficacy. A public health use is indicated whenever the target pest organisms' continued presence may pose a threat to human health either by direct action or through transmittal of disease. Most mosquito control pesticides obviously fall into the public health category, including those for use on humans, like repellents, and those for use in the environment.

Another primary focus of the Congressional deliberations on FIFRA dealt with the need to accommodate minor uses in a way that removed as many disincentives to registration for those purposes as consistent with our ability to assess the benefits and risks of the use. Many public health uses, and I expect many mosquito control uses specifically, fall into the minor use category. We are faced with the situation in which a failure to perform efficaciously can result in a health cost but where the absence of a product due to inability or unwillingness to register a product can also result in a health cost. Should this inability or unwillingness result from regulatory requirements which are not absolutely necessary to the registration decision process, as contrasted to other private sector investment decisions, then regulation is clearly not serving the public.

The Congress has directed EPA to prepare a report on minor uses and to consider the costs, markets and potential human and environmental exposure of minor uses in developing data requirements. This report is due at the end of June 1979 and is currently in preparation. It will serve as the basis for future program adjustments attuned to the minor use situation. Some of your members have contributed their views to us already; I ask that you provide your views and ideas to us if you have not already done so. We need your help to understand your needs and problems in this area so that we may deal responsibly with them.

We can and will continue to improve the efficiency of the registration system and cut the time between application and registration decision-making for pesticides. We will also continue to support means by which currently registered pesticides can be used in the most effective way without endangering man or the environment. However, EPA also has a role in encouraging new and better ways of controlling pests, both through our regulatory program and research support activities.

Today, there are some very good reasons for us to take a hard look at current pest control practices, and especially at the limits to the advances that chemical pesticides have created. A number of factors suggest that there are sound economic, social, agricultural and public health reasons for exploring and using alternatives, and supplements to conventional chemical pesticides.

First of all, from an economic perspective, conventional pesticides are becoming increasingly expensive to develop and market and consequently are more costly to purchase and apply. Research and development costs increased nearly 179% between 1970 and 1976. Some of this in-

crease can be attributed to the costs of meeting EPA registration requirements—but registration related costs still constitute less than one-third of total R & D expenditures according to industry surveys.

Second, public concerns about the health and environmental hazards resulting from the extensive use of chemical pesticides continue to be directed to EPA, users and manufacturers. Science is improving our ability to identify and quantify these health and environmental risks, and is generating a constantly growing body of evidence to back up this public concern.

While these two factors are certainly important, in the end perhaps the primary reason for seeking alternative strategies to purely chemical methods of pest control is simply that conventional pesticides will not be effective against a particular pest for a significant period of time. Scores of insect species no longer succumb to the pesticides that were designed to eliminate them, or are affected only by increasingly larger doses of a pesticide. Other pests have become economically important because chemical pesticides have eliminated their natural enemies.

Significant pest resistance problems have already appeared in many pest control sectors, including mosquito abatement. I am sure that you are all familiar with the problem of *Culex tarsalis* resistance to malathion which is especially severe on the West Coast. The clamor for new and effective mosquito insecticides is unceasing.

But new products will not necessarily be immune to the problem of pest resistance. It is clear that industry, researchers and pesticide users must look for new solutions to these kinds of traditional problems.

There is a need to examine pest management systems and turn away from control strategies which ask "what chemical can I use?" to approaches which ask "what pest control *strategies* best fit my pest problems?" Mosquito abatement decision makers have always had a variety of cultural control methods available to them, as well as the newer chemical controls. It's time that we concentrate our efforts to find the most effective means of integrating *all* appropriate means of control into a *system* of control.

What does EPA see as its function in moving toward such strategies?

EPA has a Congressional mandate under FIFRA to conduct research in integrated pest management techniques. Over the past few years we have supported a number of research efforts in pest management, and will continue to do so. Although most of our funding is dedicated to research into major crop ecosystems, we are also considering for funding a study in mosquito management recently proposed by a five-State consortium. The proposed project is designed to develop strategies for optimizing non-chemical approaches to manage mosquito populations in freshwater irrigated cropping systems. The study would use the riceland agroecosystem as a model. While I can't say now whether we will or will not fund this proposal, it has a lot of people at EPA interested.

Through our Denver regional office, EPA has been cooperating with scientists in the Montana Department of Health and Environmental Sciences to assemble a report on State Integrated Mosquito Management Systems within EPA Region VIII which encompasses Montana, Wyoming, Utah, Colorado, North and South Dakota. We have also been discussing with Montana and other Federal officials the possibility of developing a public education/training aids package addressing mosquito control problems and integrated mosquito management solutions which could be useful not only for Montana, but for the Northern Rockies as a whole. With representatives of the U.S. Department of Agriculture, Housing and Urban Development, and the Department of Energy we have also been considering the possibilities of establishing overwintering sites for *Gambusia*, or mosquito fish, in Montana.

EPA views integrated pest management as a pest population management system that utilizes *all* suitable techniques and information to reduce or manipulate pest populations so that they are maintained at tolerable or economic levels. I believe that IPM technology will grow and prosper even without EPA's involvement, (we look upon USDA as the lead agency in this regard, and welcome their leadership), but EPA can help to bring some of the technology about faster. In turn, we help ourselves in our job of environmental protection. The introduction and application of sound IPM technology will widen the range of choices we have in regulating chemicals.

Perhaps the most important thing that EPA can do through our regulatory program is attempt to provide additional incentives, or at least remove some perceived disincentives, to the development of truly innovative pesticides such as biological or bio-rational products. "Bio-rational" is a term I've taken from Dr. Carl Djerassi, President of Zoecon, to describe chemicals which depart from classical toxicity effects as a mode of action. These include such things as pheromones, chemo-sterilants, and growth regulating hormones.

The volume of applications for registration of biological and bio-rational agents has so far remained low. But the pace of development is quickening and will likely continue. A number of factors contribute to this trend: development of new technology, insect resistance to major toxic chemicals, loss of chemical availability through regulatory action, and a role for bio-rational pesticides in developing integrated pest management technology.

To date, the Agency has approved all applications for registration of biologicals that we've received, usually on the basis of less supporting hazard data than that which would accompany registration of a conventional pesticide. Due to the low volume of applications, the Agency has handled these registrations under *ad hoc* guidelines and registration review. But the *ad hoc* approach to registration has introduced a degree of uncertainty into the registration process both for the reviewers and the applicants and product developers. This uncertainty, in addition to a belief on the part of the registrants that they will be subject to the same data requirements as for conventional pesticides, has been claimed to be a strong disincentive to development of biological pesticides.

The Agency recognizes that the different mode of action of the bio-rational pesticides also means that their potential for adverse effects on man and other non-target organisms differs from that of conventional chemical pesticides. Their unconventional nature must be considered in assessing their hazard for the purpose of regulation.

We are now taking steps to reduce the uncertanties involved in registering these materials. In the near future EPA will be publishing in the *Federal Register* a policy statement which will explain in detail our proposed registration guidelines for biologicals. I would like to give you some of the highlights of the program.

Guidelines will be developed which are appropriate to the nature of the biological agents.

Other Federal Agencies, the State Agricultural Experiment Stations, and the private sector will be asked for assistance. I hope that we can count on your active participation in the drafting process.

Tolerance fees for innovative pest controls will continue to be waived to reduce one regulatory cost to the producer when such waiver would be in the public interest.

Certain types of biological control agents will be excluded from regulation under the FIFRA, although legally they could be regulated. Under this policy we recently exampted from registration a nematode (*Reesimermis nielsenii*), which is a mosquito parasite. Such predators as *Gambusia* fish will also be exempt from the requirement for the EPA registration. USDA, the Department of the Interior, and the Department of Health, Educa-

tion, and Welfare have agreed to assist us in drafting the exemption regulations.

As you know, even under the "old system" we registered a juvenile hormone analog—ALTOSID—for mosquito control, in both a microencapsulated and briquette form. On the horizon for mosquito control—we are aware of two possible bacterial agents: *Bacillus sphaericus* and *Bacillus thuringiensis* which are currently being field tested.

As we work on the various elements of the biologicals registration program and on new concepts in registration, we need your active participation and input. Our programs need to be in tune with the directions in which you will lead research and development of the mosquito control systems of the future. We look forward to working with you.

PRELIMINARY STUDY OF TRANSMISSION OF WESTERN EQUINE ENCEPHALOMYELITIS VIRUS BY LABORATORY INFECTED *AEDES HENDERSONI* COCKERELL[1]

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ABSTRACT. A laboratory experiment was conducted to test the western equine encephalomyelitis (WEE) virus transmission ability of *Aedes hendersoni* Cockerell, a species thought to be closely related to *Aedes triseriatus* (Say), which has been shown in laboratory studies to transmit WEE virus. *Ae. hendersoni* became infected at a rate of 100% following ingestion of blood from viremic baby chicks containing $10^{9.8}$–$10^{11.3}$ suckling mouse LD_{50} of WEE virus. Thirteen days after ingestion of the infectious blood meal 56% of the mosquitoes were able to transmit the virus to normal baby chicks.

INTRODUCTION

Aedes triseriatus (Say) and *Ae. hendersoni* Cockerell are the most widely distributed tree-hole breeding mosquitoes in the United States (Zavortink 1972). They are considered to be sibling species because they are sympatric over much of their geographical range and the reproductive barriers between them sometimes break down (Truman and Craig 1968, Lunt 1969, Grimstad et al. 1974, Lunt and Peters 1976). Sibling species would be expected to have similar abilities to transmit pathogenic organisms. However, *Ae. triseriatus* is a transmitter of the LaCross (LAC) strain of California encephalitis virus in the north-central United States (Thompson et al. 1972, Watts et al. 1972), but *Ae. hendersoni* is not (Watts et al. 1975). *Ae. triseriatus* is a laboratory transmitter of western equine encephalomyelitis (WEE) virus (Chamberlain et al. 1954). WEE virus has been isolated from a pool of *Ae. hendersoni* collected in Colorado (Dr. D. Bruce Francy, pers. commun.); however, nothing was known about its ability to transmit WEE virus under laboratory conditions or in nature. The purpose of the present study was to collect data on the ability of *Ae. hendersoni* to transmit WEE virus under laboratory conditions.

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