VERTEBRATE PESTICIDES NO LONGER REGISTERED AND FACTORS CONTRIBUTING TO LOSS OF REGISTRATION

WILLIAM W. JACOBS, Registration Division (H-7505C), Office of Pesticide Programs, U.S. Environmental Protection Agency, 401 M St. SW, Washington, DC 20460

ABSTRACT: Many pesticide chemicals once used to control vertebrate pests are no longer registered in the U.S. Changes in pesticide laws and regulations have played a major role in the loss of vertebrate pesticides, but relatively few products, uses, or compounds have been lost because the U.S. Environmental Protection Agency (EPA) determined that they were too hazardous to be registered. Most canceled products, use patterns, and chemicals have been lost because their registrants abandoned them, choosing not to pay the fees or data development costs necessary to maintain registrations. Pesticide users or other interested parties may be able to "save" a threatened use of a pesticide by generating the data needed to assess the claim. Federal law now requires EPA to publish lists of pesticide chemicals that are in danger of being lost because of nonsupport by their basic registrants.

Proc. 15th Vertebrate Pest Conf. (J. E. Borrecco & R. E. Marsh, Editors) Published at University of Calif., Davis. 1992

Many compounds once available as vertebrate pesticides in the U.S. are no longer registered. Other chemicals still registered no longer may be used at certain sites or to control certain pests for which product labels once permitted (or did not prohibit) use. Numbers of registered products available for the vertebrate pesticide uses that remain typically are much lower than they were 10 or 20 years ago. Relatively few new active ingredients have been registered to control vertebrates in the past 20 years. Some that were are now canceled.

Except for certain uses and classes of compounds, similar trends toward fewer registered products, uses, and active ingredients have occurred among all types of pesticides. The small market potentials for most vertebrate pesticide uses mean that there is relatively little monetary incentive to develop new active ingredients to replace those that have been lost.

Although the U.S. Environmental Protection Agency (EPA) has initiated cancellation actions against certain vertebrate pesticides judged to be very hazardous, most vertebrate pesticides no longer registered have disappeared because producers of the active ingredient have elected to drop the chemicals or because all individual products have been cancelled due to requests or to inaction by their registrants. However, decisions to drop registrations may have been precipitated by actions initiated by EPA which would have increased the costs of maintaining the registrations.

This paper discusses the reasons why individual registrations, individual use patterns, and entire vertebrate pesticide active ingredients have disappeared from the U.S. market. Although this paper discusses causes individually, several factors often are involved in losses of registered products, uses, or compounds. The reason for the loss of the very last registered product often does not reflect all of the factors which interacted to place an active ingredient in jeopardy.

WHY INDIVIDUAL REGISTRATIONS DISAPPEAR.

PRODUCTS ARE CANCELED DUE TO VOLUNTARY ACTION OR INACTION BY REGISTRANTS.

1. Registrant goes out of business or does not inform EPA of address change.

Registration of pesticide products in the U.S. began when Congress passed the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) in 1947. Since that time, many companies which held pesticide registrations have gone out of business due to the death or retirement of key personnel or to the fortunes of commerce. While company closings have caused many pesticide products to be canceled, many other product registrations have been transferred to firms which remained in business. Regulations (40 CFR, § 152.122) require registrants to inform EPA of changes in address. If a firm fails to do so, its registrations may be cancelled.

2. Registrant loses interest in product.

Registrants have requested that their products be canceled for private reasons, some which might include loss of market shares to competing products or greater interest within companies in developing and promoting other products.

3. Product has elicited consumer complaints.

Companies might request cancellation of products if the level of complaints received from consumers diminishes profitability or makes retaining a product's registration a legal or "public image" liability. Complaints might address the effectiveness, safety, odor, packaging, or other aspects of the product.

4. Cost of maintaining registration becomes prohibitive.

a. Registration maintenance fees—In § 4[i][5] of the amendments to FIFRA passed in 1988, Congress imposed annual fees for maintaining federal pesticide registrations. Maintenance fees were set at $425 per product for 1989, but have been increased to $650 for the first registration and $1,300 for each additional registration until certain "cap" levels of total expenditure have been reached. The fee caps established in the 1988 amendments provided that all registrations from the one that drove total bill to $20,000 up to the 50th registration were free. Registrations 51 through 200 cost $100 each until the second cap of $35,000 was reached. In 1991, Congress raised fee cap levels to $55,000 for the first 50 registrations (or to $38,500 if the registrant qualifies as a "small business") and to $95,000 for the total bill ($66,500 for a "small business"). A fee of $1,300 is charged for the 51st and each successive registration until the total bill reaches the second cap.

No single federal action taken since 1947 has reduced the number of active pesticide registrations more abruptly

Table 1. Effects of registration maintenance fees on numbers of federal (§ 3) and "special local needs" (§ 24 [c]) registrations in the U.S.[a]

Product Information	Yearly Effects 1989	1990	1991	Composite 1989-1991
Maintenance Fees Collected				
§ 3	22,139	20,000	19,100	61,239
§ 24 [c]	3,067	3,000	2,600	8,667
Total	25,206	23,000	21,700	69,906
Registrations at Start of Time Period				
§ 3	35,539	23,800	20,413	35,539
§ 24 [c]	8,967	3,700	2,876	8,967
Total	44,506	27,500	23,289	44,506
Registrations Cancelled Because Fees Not Paid				
§ 3	13,400	3,800	1,313	18,513
§ 24 [c]	5,900	700	276	6,876
Total	19,300	4,500	1,589	25,389
Percent of Products Lost Through Failure to Pay Fees				
§ 3	37.7%	16.0%	6.4%	52.0%
§ 24 [c]	65.8%	18.9%	9.6%	76.7%
Total	43.4%	16.4%	6.8%	57.0%

[a]Data in this table were taken directly or derived through simple mathematical calculations from figures presented by Fisher (1989, 1991a, 1991b). Total numbers of registered products also are affected by cancellations for reasons other than failure to pay fees and by the issuance of new registrations.

than has the imposition of registration maintenance fees. In the U.S. in 1988, there were approximately 35,000 federal pesticide registrations in the U.S. (under § 3 of FIFRA) and about 8,800 "special local needs" registrations (under § 24[c]) limited to use within the state specified on the label (Fisher 1989). Numbers of registrations of both types have dropped sharply since maintenance fees were required, with the effect being more pronounced for the 24[c] products (Table 1.).

Many pesticide registrants have voluntarily canceled registrations to avoid paying maintenance fees. Others have lost products passively by not paying the fees. Many § 3 registrations lost in the first year of the fee program were dormant. No production of them had been reported in recent years (Fisher 1989). The § 24[c] products lost due to fees in 1989 included many vertebrate products held by county agricultural departments or commissioners in California.

Largely because of their small markets, vertebrate pesticides have been hit especially hard by maintenance fees. Prior to 1989, many vertebrate pesticide products belonged to firms which held fewer than five federal registrations. Fee caps provide no relief for such companies.

b. Product specific data costs—Regulations issued under FIFRA (40 CFR, Part 158) require that certain types of data specific to product formulations be submitted to support registrations of pesticide products. Although requirements to submit data from certain types of studies may be waived in many cases, some product chemistry data are required to support registrations of all pesticide products. Toxicology data or wildlife safety data may be required for certain (end-use) products, depending upon their formulations and how they are handled or used. Although EPA expects registrants to determine that all pesticide products proposed for registration are formulated so as to meet the claims made for them, the Agency waives the requirement to submit efficacy data for many claims. However, EPA typically requires that efficacy data be submitted or cited to support claims for control of pests which can pose threats to public health.

Many products now registered were accepted prior to the time that all of the current data requirements were implemented. For most of these products, EPA has continued the registrations "conditionally," deferring the requirement to submit product specific data until the time when similar studies can be "called-in" (§ 3[c][2][B] of FIFRA) for all products which contain the same active ingredient. Most data call-ins have been issued by EPA pursuant to "reregistration" (§ 4 of FIFRA) or special review (§ 3[c][8]) actions.

Data call-ins require registrants to commit to submit the required studies according to established timetables. Registrants who fail to make or honor such commitments face EPA-initiated actions to suspend (and, ultimately, to cancel) product registrations. Faced with these prospects, registrants often elect to cancel certain product registrations voluntarily.

Data generation costs vary according to the numbers and types of studies that must be run. Many categories of product chemistry, toxicology, and environmental safety data that sometimes are required for end-use products are waived for vertebrate pesticide products which are grain-based baits limited to use "in and around buildings." Such products include baits used to control commensal rats and mice and comprise the majority of vertebrate pesticide registrations.

As commensal rodents and many, many other vertebrate animals are considered to be "public health" pests, EPA requires that efficacy data be submitted to support the claims made for them. The effectiveness of a bait is strongly related to its palatability to target species. In turn, palatability can be affected greatly by seemingly minor changes in ingredients, such as addition or substitution of dyes, or changing forms of the same grain. Consequently, efficacy data for baits are formulation-specific. This means that each formulation registered must be tested. EPA allows use of laboratory data to support claims for control of commensal rodents as long as there are existing data which show that baits made from the active can be used effectively in the field. However, even these laboratory tests, which must be run according to Good Laboratory Practice (GLP) Standards (40 CFR, Part 160) cost several thousand dollars.

EPA INITIATES SUSPENSION, CANCELLATION, OR DENIAL ACTIONS.

1. Registrant fails to respond to call-in or to honor commitment.

If a registrant fails to respond to a data call-in or, having committed to support a product, fails to submit data required by a call-in, EPA may initiate suspension/cancellation actions specific to the product or products for which commitments were not honored. Suspended products may not be

marketed legally, but registrants are obligated to pay registration maintenance fees for them. Although registrants have rights to appeal suspension actions related to data call-ins, such appeals are limited to determinations of

> "...whether the registrant has failed to take the action that served as the basis for the notice of intent to suspend the registration." (§3[c][2][B][iv] of FIFRA).

In the 1980s, many product registrations were suspended when registrants failed to meet data submission obligations imposed by data call-ins issued in conjunction with registration standards (reregistration documents formerly issued for specific active ingredients). Many registrations of Warfarin and Zinc Phosphide products were suspended temporarily for this reason. Most of these later were removed from suspension through compliance with the requirements of the relevant call-ins or are now canceled.

2. A specific product is found to be problematic.

If a specific pesticide product is found to be highly hazardous or is determined to be ineffective, EPA may initiate a product-specific cancellation action. In recent years, EPA has taken such actions rarely, primarily because EPA's regulatory efforts are concentrated elsewhere and because EPA no longer maintains laboratories capable of generating the data needed to support many types of challenges to product registrations. In the 1970s, EPA took actions against certain commensal rodenticide products which, according to EPA's data, were ineffective. EPA often will inform a registrant of the problems with a product and afford a period of time for remedying matters, unless the problems are extremely serious and/or are uncovered during enforcement actions.

3. Manufacturer did not apply for Federal registration of intrastate product.

In 1988, EPA denied registrations for products which had been registered by state agencies prior to initiation of the § 24(c) registration program and for which neither a § 3 nor a § 24(c) registration had been obtained.

WHY USE PATTERNS DISAPPEAR.

NO PARTY COMMITS TO PROVIDE DATA NEEDED TO ASSESS RISKS ASSOCIATED WITH THE USE.

Since the amendments of 1972, FIFRA (§ 3[c][5] has required EPA to determine that pesticides will not have "unreasonable adverse effects on the environment." § 2[bb] of FIFRA defines "unreasonable adverse effects on the environment" as

> "...any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide."

To assess the effects of pesticides in systematic and defensible ways, EPA must review appropriate research data. EPA has issued regulations stipulating data requirements and guidelines for conducting studies to generate the necessary data. Since 1972, data requirements have been expanded in variety and scope.

For a pesticide product that is not registered, EPA may withhold registration until all (or all of the most important) data have been submitted. As they have evolved since 1972, EPA's policies for determining the environmental effects of pesticides that are already registered may be summarized by the following general statements:

a. EPA determined that criteria and, therefore, data requirements similar to those used to assess new pesticide active ingredients must be used to assess the risks associated with ("old") products and active ingredients already registered;
b. risks associated with pesticide products might be effected by the active ingredients they contain, the inert ingredients they contain, the types of formulations (e.g., liquid, wettable powder, granular, etc.), the application methods used, the sites where the products are to be used, and many other factors;
c. wherever possible, risks should be assessed using the technical grade active ingredient as the test material;
d. if use of the technical would not be expected to provide an accurate test of the potential for risk, the appropriate formulation must be tested;
e. as stipulated in § 2[bb] of FIFRA, the risks associated with a pesticide use are to be weighed against the benefits expected to be derived from that use; and
f. all products containing the same "old" pesticide active ingredient would be considered for reregistration at the same time, with missing data being required through § 3[c][2][B] data call-ins.

These statements suggest many potential areas for scientific inquiry. In many cases, specific data requirements have been established. The more data that are required to assess risks associated with a particular use, the more expensive it becomes to support continuation of that use. To assess risks associated with pesticide applications which involve treatment or likely contamination of items used for human or animal foods ("food or feed" uses), EPA requires submission of data from entire series of tests that often are not required for "nonfood" uses. Among the more expensive of these tests are those to assess carcinogenicity, developmental toxicity, reproduction, general metabolism, and the effects of chronic feeding. EPA and/or the Food and Drug Administration (FDA) must establish tolerances for the active ingredient in raw and/or processed foods or feeds.

Outdoor terrestrial and aquatic uses which involve treatments of large land or water areas typically elicit more extensive data requirements than do uses limited to small prescribed areas such as perimeters of buildings or indoor treatments to greenhouses, homes, or other buildings.

Although data from some studies can be applied to several uses, the data needed to support a large-scale, outdoor non-food use can cost hundreds of thousands of dollars or more. Costs are much higher for food uses. Faced with such potential bills, producers of pesticide active ingredients frequently elect not to support some or all uses of their compounds.

If the registrant of an active ingredient decides not to support a use pattern, registrants of end-use products with labels which include directions for the use being abandoned must either drop that use from their labels or commit (individually or through a consortium) to generate the necessary data. Parties who are not registrants also may commit to pro-

vide the data necessary to retain a use pattern on product registrations.

Frequently, no party commits (or honors a commitment) to provide the data needed to support a use in which the basic registrant is not interested. Food uses of strychnine and all rodenticidal uses of sodium fluoroacetate were lost because the necessary supporting data were not provided.

When registrants fail to provide data to support all uses of a compound, EPA often requires that labels of products containing the same active ingredient bear statements which prohibit the uses that were not supported. Consequently, a given label may prohibit use of a product on a particular site because EPA has determined that such a use would "cause unreasonable adverse effects upon the environment" or because the Agency did not receive enough relevant information to support any conclusion.

EPA DETERMINES THAT THE USE CAUSES UNREASONABLE ADVERSE EFFECTS.

If EPA concludes that a particular pesticide use causes unreasonable adverse effects on the environment, the Agency takes actions to prohibit that use in the future or to require label modifications which, if followed, would be expected to mitigate the adverse effects. EPA has occasionally drawn national attention through pesticide cancellation actions such as bans on most uses, including all vertebrate uses, of DDT in 1970 and cancellation of predacidal uses of sodium fluoroacetate, strychnine, sodium cyanide in 1972 (Ruckelshaus 1972). However, such dramatic actions have been rare in recent years. Although many hazardous uses and chemicals have been canceled already, the slowdown in broadscale, EPA-initiated cancellations has occurred primarily because the process for taking such actions has become very slow and complex.

Risk-related cancellation actions typically are taken after a chemical has been placed into what is called Special Review (40 CFR, Part 154). EPA places active ingredients into Special Review after determining that they might pose one or more of the following hazards (40 CFR, § 154.7):

a. potential for "serious acute injury to humans or domestic animals";
b. potential to cause significant oncogenetic, "heritable genetic," reproductive, delayed or chronic toxic effects in humans, as determined through animal studies or human epidemiological data;
c. potential to cause acute or chronic toxicological effects or adverse reproductive effects in nontarget organisms;
d. potential to pose direct risks to threatened or endangered species;
e. potential to destroy or adversely modify critical habitat of endangered species; and
f. potential to pose other significant risks to humans or to the environment.

If EPA determines that at least one of these criteria is met for a use pattern and concludes (after reviewing additional research data, comments, and other information obtained through the Special Review process) that the risks cannot be mitigated through changes to labels or formulations and are not outweighed by the benefits of the use, EPA moves to cancel the use.

For vertebrate pesticides for which Special Reviews have been conducted, the risk criteria typically have concerned hazards to nontarget organisms including endangered species. Uses felt to pose such risks either have been retained following incorporation of label changes designed to mitigate the risks or have been canceled.

In the Special Review of above-ground uses of strychnine, EPA proposed to cancel some uses and to retain others, with label modifications. In some cases, efficacy data to determine minimum effective bait concentrations were required. All above-ground uses of strychnine currently are "temporarily canceled" pursuant to a U.S. District Court order which held that such uses violated the Endangered Species Act (Palmateer 1990).

WHY PESTICIDE ACTIVE INGREDIENTS DISAPPEAR.

ALL REGISTRATIONS BECOME CANCELED THROUGH ACTIONS ON INDIVIDUAL PRODUCTS.

If all registrants of all products containing an active ingredient request voluntary cancellation of their products or if no registrant pays a maintenance fee for any product containing the active ingredient, the entire pesticide chemical is likely to be canceled. Until recently, EPA automatically honored cancellation requests even if they meant loss of an entire pesticide chemical or a use pattern. Since passage of the 1988 amendments to FIFRA, EPA has published in the *Federal Register* lists of active ingredients in danger of being lost through voluntary cancellations or failures to pay maintenance fees. EPA now provides interested parties 90 days from the date of publication of the Federal Register notice to "make arrangements to continue" any registration covered by the notice (Fisher 1991b). "Arrangements" might include persuading the original registrant to continue the registration or to transfer it to another party.

Since the imposition of registration maintenance fees, the last registered products containing certain vertebrate pesticide compounds were canceled due to failure to pay the fees. These chemicals include the fumigant calcium cyanide, the canine repellent cinnamaldehyde, the rat toxicant/chemosterilant alphachlorohydrin (Epibloc), and many others (Table 2.).

The commensal rodenticide Vacor (N-3-pyridylmethyl N'-p-nitrophenyl urea) was voluntarily canceled in 1979 amid concerns over hazards to human health and the attractiveness of product packaging to children. In 1991, the last remaining registrations for strychnine sulfate were voluntarily canceled. No registrant had committed to support that active ingredient under a 1986 data call-in.

ALL SOURCES OF ACTIVE INGREDIENT DISAPPEAR.

If a source pesticide active ingredient disappears, manufacturers of end-use pesticide products containing chemical obtained from that source must either find a new legal source of the chemical or lose the ability to make their products. If there is no other source, loss of a technical pesticide product means eventual loss of the active ingredient unless the technical is transferred to another party who will continue its registration, or a new technical product (or other manufacturing -use product) is registered.

Table 2. Vertebrate pesticide active ingredients for which some or all uses have been lost since 1983.

Active Ingredient	Use Patterns Lost	Year of Loss[a]	Reasons for Loss[b]
Amyul Acetate	All (pets)	1989	MF
ANTU	All (Norway rats)	1989	MF
Arsenic Trioxide	Commensal rodents	1987	DCI
Bone Oil	Dogs	1991	MF
Calcium Cyanide	All (commensal rodents)	1989	MF
Carbon Disulfide	All	1987	DCI
Carbon Tetrachloride	All	1989	MF (EPA)
a-Chlorohydrin	All (Norway rats)	1991	MF (DCI)
Chlorophacinone	Bats	1991	DCI
Cinnamaldehyde	All (dogs)	1991	MF
Coal Tar	All (crows, seed tr.)	1986	EPA
Copper Oxalate	All (crows, seed tr.)	1987	DCI
Cresylic Acid	All (dogs, deer)	1989	IRD
DDT	Bats (rabies abatement)	1987	VOL
Endrin	Orchards, Seed treatments	1986	EPA
	Birds on perches	1991	MF
Eucalyptus Oil	All (pets)	1989	MF
Fluoroacetamide	All (commensal rats)	1989	MF (EPA)
Fumarin	Commensal rodents	1991	MF (DCI)
	Field rodents	1988	DCI
Fumarin, Na+ Salt	All	1987	DCI
Gophacide	Pocket Gophers	1991	MF
Hydrocyanic Acid	All (commensl rodents)	1987	DCI
Isopropyl Alcohol	All (dogs)	1988	MUD
Lauryl Sulfate, Triethanlolamine Salt	All (dog attack)	1991	MF
Magnesium Phosphide	All	1989	MF
Methyl Nonyl Ketone	Tree squirrels	1989	MF
Methylene Chloride	All (dog attack)	1989	MF (EPA)
1-Pentanethiol	All (pets)	1987	DCI
Phosphorus Paste	All (commensal rodents)	1989	MF (EPA)
Pindone, Ca++ Salt	All (commensal rodents)	1987	DCI
Potassium Cyanide	All	1988	IRD
Pyridine	All (pets, deer)	1989	MF
R-55 Repellent	All	1989	MF
Sodium Cyanide	Commensal rodents	1987	DCI
Sodium Fluoroacetate	All rodent uses	1988	IRD (DCI)
Strychnine Sulfate	All	1991	MF (DCI)
Strychnine Alkaloid	Voles, prairie dogs	1989	EPA (DCI)
	Porcupines	1989	VOL (DCI)
Tributyltin Chloride	Rodent repellent	1987	DCI
1,1,1-Trichloroethane	All (pets)	1989	MF
Valone (PMP)	Commensal rodents	1989	MF
Warfarin	All use but commensal rodents	1989	DCI

[a]Indicates year when last product covered by the use pattern heading was lost.
[b]Reasons for loss of last product for use pattern are presented first.
Parentheses indicate other factors prominently involved in losses of use, if known. The following abbreviations are used.

DCI—not supported in response to data call-in
EPA—loss due largely to actions taken by EPA (e.g., as part of special review) because of undesirable effects of compound
IRD—application for federal registration of intrastate product denied
MF—registration maintenance fees not paid
MUD—mail undeliverable, company not located, presumed out of business
VOL—cancellation proposed by basic registrant(s) of active ingredient

Technical products may be canceled for reasons similar to those noted for individual end-use products (e.g., voluntary action, failure to pay fees, company going out of business, failure to generate required data, etc.) When an active ingredient is in danger of being lost through a registrant's failure to commit to support it for reregistration, FIFRA now requires EPA to withhold immediate cancellation and notify the public by way of a *Federal Register* notice. EPA may cancel the registration 60 days after the notice is issued unless a party commits to support continued registration of the chemical.

Active ingredients for which registration standards were issued are now called "List A" chemicals. The 1988 amendments to FIFRA required EPA to develop three additional lists ("B," "C," and "D") to schedule for reregistration chemicals for which no standards had been issued. All pesticide chemicals first registered before November 1, 1984, are on one of the reregistration lists. Most vertebrate pesticides are on Lists B, C and D. All anticoagulants other than Warfarin, fumarin, and their sodium salts (all List A) were included on List B. Generic and product-specific data will be called in for chemicals on each list.

Fumarin's complete cancellation was made inevitable in the 1980s after the producer of the technical product declined to support it for reregistration under the call-in issued pursuant to its registration standard. Failures to make or to honor commitments to support other "listed" compounds are likely to cause losses of additional vertebrate pesticide chemicals.

EPA CONCLUDES THAT ALL USES POSE UNREASONABLE ADVERSE EFFECTS.

If, after completing a Special Review, EPA concludes that the risks posed by a chemical are unacceptable for all uses, the Agency proposes to cancel all registrations containing that active ingredient. If none of the proposed cancellations is opposed or successfully rebutted, the active ingredient disappears from the ranks of pesticide chemicals registered in the U.S.

Prior to establishment of special review procedures, a number of pesticide active ingredients, including the rodenticide thallium sulfate, were effectively banned through federal actions because the agents were found to pose unacceptable risks to the environment. Since the RPAR (Rebuttable Presumption Against Registration) process—the immediate predecessor to Special Review—was developed, EPA has concentrated more on uses of chemicals rather than chemicals per se. Because environmental risks may be influenced by where pesticides are used and how they are handled and applied, it often is possible to conclude that certain uses may be retained if labels are modified so as to mitigate risks (if the new directions and precautions are followed). Consequently, RPAR and Special Review actions calling for outright cancellation off entire active ingredients have been relatively rare.

Active ingredients for which Special Reviews did not call for complete cancellation sometimes disappear after such reviews are completed because losses of use sites and/or new label restrictions resulting from the review have reduced the market for the chemical or otherwise have influenced its producer to seek voluntary cancellation.

CASES OF SPECIFIC VERTEBRATE PESTICIDES.

1. Warfarin

When Warfarin and the other "first-generation" anticoagulants were developed and registered, there was some premature thought that man's "war" with commensal rodents soon would be over. From the time of its introduction in the early 1950s until the mid 1980s, Warfarin was the most widely used rat-and-mouse chemical in the U.S. Historically, more than 400 products containing Warfarin have been registered. Many of these products also contained the antibacterial agent sulfaquinoxaline at equal strength with Warfarin, a combination often called "Prolin."

In early 1983, there were some 260 federally registered products containing Warfarin and 19 more containing the sodium salt of Warfarin (Jacobs 1983). As of January 1992, the total number of Warfarin registrations remaining numbers only in the sixties. Commitments to continue registration pursuant to the Reregistration Eligibility Document (RED) issued for Warfarin on June 6, 1991, suggest that about 55 Warfarin products will continue to be registered along with perhaps two products containing the sodium salt of Warfarin.

Many factors have been involved in losses of Warfarin registrations. Discovery of anticoagulant resistance in commensal rats and mice and the advent of "second-generation" anticoagulants, to which resistance is far less pronounced, and other new compounds reduced market interest in Warfarin products.

In the late 1970s, EPA concluded from tests run in its own facilities that sulfaquinoxaline added nothing to the effectiveness of Warfarin baits. EPA determined that sulfaquinoxaline should not be considered to be an active ingredient and should be removed from products. Some registrants elected to drop their "Prolin" products rather than change them to Warfarin-only formulations.

Many Warfarin registrations were suspended and eventually canceled after registrants failed to respond appropriately to the data call-in issued pursuant to the 1981 Registration Standard for Warfarin. Although relatively few studies were requested, the call-in did include requirements for efficacy data. By 1989, all special local needs registrations for Warfarin had disappeared because registrants did not commit to support uses. Many § 3 Warfarin registrations were lost because maintenance fees were not paid.

Some Warfarin registrations are expected to be lost due to the data call-in and other requirements associated with the 1991 RED issued for the compound. Although essentially no generic data (on technical formulations) have been required for Warfarin itself, data from certain tests in which solubility might affect results have been required for the sodium salt of Warfarin. Product-specific data being required under the RED include some product chemistry information and efficacy studies. For most products, efficacy data submitted already are likely to be adequate to support continued registration.

2. Strychnine Alkaloid and Strychnine Sulfate

Above-ground uses of strychnine were examined in the RPAR process (Palmateer 1990). Subsequent to publication of the "final" Position Document (PD 4) on strychnine in 1983, EPA has issued several data call-ins and entered into two negotiated settlement agreements involving this chemical. Parties taking issue with above-ground uses of strychnine

sued in U.S. District Court, alleging violations of various wildlife protection laws. This action led to the current injunction against above-ground uses of strychnine in the U.S., which has been upheld in significant part by the U.S. Court of Appeals. These uses cannot be reinstated unless the court is persuaded that strychnine products can be labeled in ways which ensure that use of the compound will not jeopardize the continued existence of endangered species.

Strychnine registrants have formed a consortium to generate data to support continued registration of strychnine alkaloid. Due to the injunction and members' interests, recent research efforts have developed data needed to support subterranean use of strychnine alkaloid to control pocket gophers. No party agreed to provide data to support strychnine sulfate. The last remaining products containing this active ingredient were voluntary canceled in 1991.

3. Other Compounds

The preceding discussions of Warfarin and strychnine compounds indicate how various factors can interact to "cripple" or, in the case of strychnine sulfate, to "kill" a vertebrate pesticide chemical. In the space allotted for this paper, it is not possible to discuss the other vertebrate control agents which have been lost entirely or for which significant uses have been lost. Table 2. presents information for compounds that were federally registered as vertebrate pesticides in January of 1983 (Jacobs 1983) and which had been entirely lost or had lost significant use patterns by January of 1992. Many of these compounds were used as animal repellents.

This paper does not provide such information for compounds canceled before 1983, although such agents (e.g., Vacor, DDT) are occasionally mentioned. Although all vertebrate uses of DDT were canceled in 1970, use of DDT powder to control bats for rabies abatement was reinstated in the 1970s, only to be voluntarily canceled in the 1980s. EPA (1990) provides additional information on certain compounds that have been canceled.

LITERATURE CITED

CODE OF FEDERAL REGULATIONS, Title 40 (40 CFR). 1989. Parts 152-189. Office of the Federal Register, U.S. Govt. Printing Office, 721 pp.

EPA. 1979. Rohm and Haas stops selling rodenticide, Vacor. Press Release of September 12, 1979. 2 pp.

EPA. 1990. Suspended, cancelled and restricted (SCR) pesticides. Office of Compliance Monitoring, Washington, DC 184 pp.

FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT (as Amended), Public Laws 100-460, 100-464 to 100-526, & 100-532. 71 pp.

FISHER, L.J. 1989. Cancellation of pesticides for nonpayment of 1989 registration maintenance fees. Federal Register 54: 200, 42936-42940.

FISHER, L.J. 1991a. Cancellation of pesticides for nonpayment of 1990 registration maintenance fees. Federal Register 56: 26, 4992-4995.

FISHER, L.J. 1991b. Cancellation of pesticides for nonpayment of 1991 registration maintenance fees. Federal Register 56: 201, 52025-52027.

JACOBS, W.W. 1983. Pesticides federally registered for control of terrestrial vertebrate pests. In: Prevention and control of wildlife damage (R.M. Timm, ed.), Great Plains Agricultural Council and Nebraska Cooperative Extension Service, G1-G30.

PALMATEER, S.D. 1990. Registration status of vertebrate pesticides with emphasis on 1080 and strychnine. In: Proc. 14th Vertebrate Pest Conf. (L.R. Davis, R.E. Marsh, and D.E. Beadle, eds.) Univ. of California, Davis, CA, 113–115.