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The History of Paraffinized Rodent Baits

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ABSTRACT: Paraffinized rodent baits developed initially for use in control of Norway rats in sewers by Lloyd Plesse of San Jose, California, an experienced bait formulator for Santa Clara County, significantly enhanced longevity and effectiveness of toxic rodent baits. Within a couple of years, this paraffin type molded bait's moisture resistant qualities and proven efficacy, especially for sewer rat (Norway rat) control, was the subject of several published articles. Those first 3 articles, 1959-1961, were responsible for rapidly launching this new paraffinized bait formulation into national usage, at first, mostly by health departments. The structural pest control operators and agricultural interests were soon to follow, using them initially for out-of-doors control of rats and indoors where high humidity normally caused bait deterioration. Recognizing the potential of paraffinized rodent baits, along with the published how-to information, commercial bait manufacturers were quick to get into production and distributors eager to market. Paraffinized rodent baits soon came into common usage and literally revolutionized rodent baits by not only making them more moisture and weather resistant but more convenient to use and versatile in applications. This resulted in greatly expanding the conditions under which commensal rodents could be more effectively controlled. The chronology and evolution of paraffinized rodent baits and their practical uses are followed from their beginning throughout much of their early existence, as are the changes in their manufacturing processes. The factors contributing to development and rapid acceptance for rodent control are enumerated, as are their advantages and disadvantages. The greatest emphasis is placed on the first 2 decades (1960s and 70s) of the existence of paraffinized rodent baits.

KEY WORDS: bait manufacturing, history, Norway rats, paraffin, paraffinized, *Rattus norvegicus*, *Rattus rattus*, rodent baits, rodent control, roof rat, sewer rats, weather-proof baits

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INTRODUCTION

Paraffinized molded rodent baits, which much later evolved into paraffinized extruded baits, changed the history of rodenticide bait formulation in a major way. Once the idea and simplicity of preparation were made known through published articles, and its effectiveness, versatility and significant advantages became apparent, this new bait formulation flourished.

The first article authored by Ecke and Cristofano detailing the efficacy of molded rat baits for Norway rat (*Rattus norvegicus*) control in sewers appeared in the magazine *American City* in October 1959. In this piece, the authors credited Lloyd Plesse of San Jose, California with making the first solid block-type paraffin anticoagulant baits for sewer rat control. Following soon thereafter, Marsh and Plesse (1960) published their how-to article, in a relatively obscure state agricultural bulletin, on the preparation of anticoagulant molded paraffin baits and their potential use on various rodent species. This article was subsequently republished in *Pest Control* magazine in August 1961, which triggered an explosion of interest from commercial rodent bait formulators, health departments, and other major rodenticide users. Numerous requests, mostly by mail, were received by the authors for more information on the process, the cereals, and the type of paraffin used, etc.

Remember, this was a time when the dissemination of technical and scientific information was unusually slow. Information regarding new rodenticides or new techniques or methodologies was almost entirely by word of mouth or from published articles that appeared mostly in trade journals or magazines. There were no Xerox machines to easily make copies, so it was necessary to go back to the

printer to have additional copies run off so that an article might be freely shared. There were no faxes, cell phones, or computers. The lack of an easy means of information transfer was in those times a major reason why progress of all kinds was normally slow, so it is somewhat of a phenomenon that paraffinized baits caught on and moved forward as rapidly as they did.

An article by Kaukeinen and Marsh (2009) provided a glimpse of the beginnings of paraffin embedded rodent baits and how they caught on for use in damp, moist places. Continuing on, the authors followed the commercialization progress of paraffinized baits up to the time of extrusion as the preparation process. That article was significant because it highlighted some of the early history by appropriately acknowledging the part played by Lloyd Plesse that had not been previously published. It also provided an up-to-date list of paraffinized rodent baits available to the pest control industry and changes that have occurred in bait production and improved efficacy. With this recognition, a somewhat more comprehensive chronology with additional documentation seems warranted for inclusion in a publication that is more readily available for researchers. Once developed, its evolution progressed simultaneously along several paths, making the organization of its history a challenge.

This history of paraffinized baits is intended to provide a more detailed and in-depth account with documentation as to how these baits originally came about, and how they were initially explored and evaluated, with rewarding success, for Norway rat control in sewers. Also documented is how the concept of such baits was adopted by those involved in rodent control and capitalized upon by the com-

mercial manufacturers of ready-to-use rodent baits. The way paraffinized rodent baits advanced effective rodent control is a major part of its history.

EARLY HISTORY

Paraffinized rodent baits have had an interesting evolution over the past 50 years. In the 1950s, Lloyd Plesse was well aware of the problems of rapid deterioration of cereal based rodent baits when used in sewers. The problem had become more serious when warfarin and other early anticoagulant rodenticides became available, which required repeated feedings and hence larger bait placements. Lloyd claimed that the idea of incorporating a cereal bait into wax came to him when talking with an acquaintance who reported that he had a box of candles that had been chewed up by rats during shipment. Lloyd Plesse was a Deputy Commissioner for the Santa Clara County Department of Agriculture headquartered in San Jose, California. Along with his other duties, Lloyd was in charge of the Department's rodent bait mixing facility and had under his immediate direction several employees. The county had long prepared rodent baits for the control of commensal rodents and a wide range of pest field rodents of concern to agriculture. Lloyd was intimately familiar with bait preparation and with the characteristics of a variety of toxicants available at that time, including sodium fluoroacetate (1080), red squill, thallium sulfate, zinc phosphide, strychnine, and the early first-generation anticoagulant rodenticides. Highly knowledgeable in both commensal and field rodent control, Lloyd was experienced in problem solving.

With state legislative authorization, nonprofit rodent bait making was commonly practiced during the 1940s, up until about the 1980s, by most of the 58 county Agricultural Departments of California. The baits were sold at cost to the respective county residents, mostly farmers and ranchers. Rodent baits were also sometimes supplied to certain city and county Health Departments for their rodent control activities; however, in some counties the health department made its own baits from rodenticide concentrates. Rodent bait making in those days was not very sophisticated.

The bait making facility where Lloyd and staff prepared baits was in the Department's warehouse-type building constructed of sheet metal. In addition to bait making, it served as a warehouse for other supplies; located in a back corner was the facility's office. This building stood a few hundred feet from the south-west turn of the horse race track on the county fairgrounds located on Tully Road just south of San Jose.

My personal connection to this story came about because, when Lloyd was experimenting with paraffinized baits in the latter half of the 1950s, I was also employed by the same county department as an Agricultural Inspector. In late 1959, I took an Assistant District Supervisor position with the California State Department of Agriculture, Bureau of Weed and Rodent Control, but remained headquartered in San Jose, the approximate center of my assigned region. It was in this state position that I had a much greater contact and association with Lloyd and became more familiar with his bait making expertise and, in particular, his paraffin embedded anticoagulant grain baits

and methods of field evaluation. As a relatively young biologist, I gained considerable knowledge from my association with Lloyd.

I learned that Lloyd had intermittent communications with Dean Ecke and others at the County Health Department and on occasion had provided guidance and consultation concerning rodent baits and occasionally prepared rat baits for their use. It was Lloyd's collaborative relationship with the Health Department that inspired the preparation of molded paraffin baits, leading to highly effective sewer rat control. About 1957, and prior to any methods publications, preliminary trials were conducted using Plesse's formulation in the sewers of the city of Santa Clara, California with good results. Based on this success, the nearby cities of Los Gatos and Sunnyvale began to also use these same types of paraffin embedded anticoagulant baits for their sewer rat control. These successes were subsequently the basis of the Ecke and Cristofano (1959) article entitled "City-county Team Wins War on Rats".

I was most impressed with Lloyd's experimentation with paraffinized rodent baits, although unsophisticated by today's standards. I could envision its potential in agricultural rodent control on farms and ranches involved in livestock production and even to protect crops such as rice. I encouraged him to write up his work on how to prepare such baits and how they might be used, not only for sewer rat control, but for rodent control to protect agriculture (Figure 1). Lloyd, a very modest and unassuming type of person, wasn't convinced that what he had accomplished was all that significant and was, therefore, reluctant to

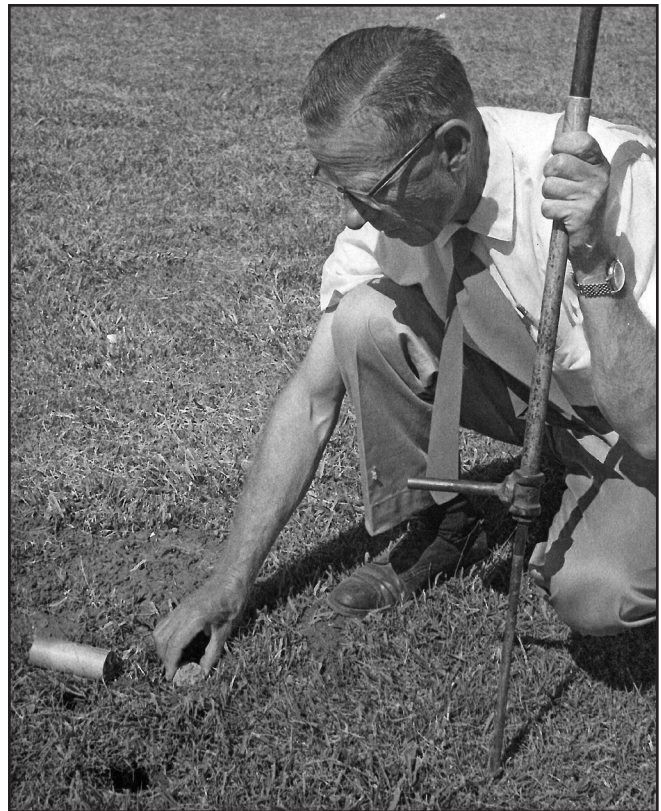


Figure 1. Lloyd Plesse (June 1960) inserting a small cylinder of paraffin warfarin bait into a pocket gopher tunnel on the playing field of the Franklin School, San Jose, CA.

write about his work and questioned whether it had worth as an article. After some time and a little more persuasion, I convinced him that we, working together, could turn out a short jointly-authored article for publication. Lloyd agreed to this, providing I took the lead in its preparation. Together we set out to do further testing, exploring different grains, mostly barley and oat since they were the least expensive here in the far west, and grain treatments or shapes for bait block preparation such as rolled, crimped, or coarse ground. It was found that the type of grain or combinations of grains, as well as the grain particle sizes and shapes, influenced the amount (percentage by weight) of melted paraffin (i.e., wax) needed to produce firm solidified blocks.

As the first step, the warfarin concentrate, according to label directions, was mixed with the grain to be used as bait and then this finished bait was mixed with melted paraffin as the second step, and was poured into molds to solidify. In our article, Lloyd and I indicated a grain bait ratio of 1 to 1½ lbs to 1 lb of paraffin. At that time, we thought the ratio range was most practical for ease of preparation and for good moisture resistance. Different size and shaped containers were selected as bait molds, matching volumes, sizes and shapes to the baiting requirements of the targeted species.

Since my supervisory roll with the state of California routinely took me to 13 of the North Coast Region counties, I was able to take Lloyd's paraffin bait making methodologies to other county bait preparation facilities and demonstrate how easily they could be made. The great advantage of paraffin anticoagulant baits for Norway rat control in sewers and other damp situations became immediately obvious; the bait did not rapidly deteriorate in contact with moisture or high humidity. This also permitted wider experimentation, with the inclusion of uses on species other than rats, such as for control of our native woodrat (*Neotoma* spp.), as was conducted in Humboldt County on California's north coast. Its use for Norway rat control at animal facilities such as dairies was also explored.

Totally unaware that Dean Ecke and his colleague at the Department of Health were also preparing an article about their activities, Lloyd and I went about our plan. Jointly we assembled our information and prepared a short manuscript divided into five short segments: 1) Need for Semi-permanent Baits, 2) Bait Preparation, 3) Rat Control in Sewers, 4) Controlling Other Rodents, and 5) Conclusions. Along with four photo illustrations, the manuscript was sent off to the Editor of "The Bulletin", a California Department of Agriculture quarterly publication. It appeared in the third issue of 1960 under the title "Semipermanent Anticoagulant Baits" by Rex E. Marsh and Lloyd F. Plesse.

Only the anticoagulant warfarin was mentioned in the article, as that was what we worked with. However, assuming that the heat involved in the process would not break down the rodenticide, any of the other then available anticoagulants – Pival, Fumarin or diphacinone – would have worked. At that time, we did not know for sure just how high a temperature any of the anticoagulants would tolerate without chemical breakdown. From the control we were obtaining we assumed that warfarin was reason-

ably stable at the heat levels being used. Our article made reference to paraffinized baits being successfully used, at least experimentally, on the following species: Norway rats (*Rattus norvegicus*), roof rats (*R. rattus*), meadow voles (*Microtus* spp.), pocket gophers (*Thomomys* spp.), and wood rats (*Neotoma* spp.). For house mice (*Mus musculus*), achieving adequate bait acceptance and to increase consumption, it was necessary to add whole canary grass seed and ground cull walnut meats to the predominantly crimped oat groats bait. The versatility of paraffinized baits was most encouraging.

I'm just not exactly sure how it came about that James Nelson, Editor and Publisher of *Pest Control*, asked if he could republish our initial article. I suspect he may have been prompted by Dr. Phillip Spear, since he had been in contact with me regarding our first article. Phil was, at that time, Technical Director of the National Pest Control Association (NPCA) – now known as the National Pest Management Association (NPMA). In any case, "Pest Control", the pest control industry's popular magazine, republished our initial article in August 1961 – nearly in its original form, and included three photo illustrations. This "Pest Control" article retained and used our original title, "Semipermanent Anticoagulant Baits" (Marsh and Plesse 1961).

The preparation of paraffinized baits was simple and easily accomplished by blending nearly equal parts melted paraffin (i.e., common household wax) with whatever cereal-based anticoagulant bait was normally used. This thick but flowable mixture was then poured into an appropriate mold and permitted to solidify. Either with the mold removed or left intact, the paraffinized baits were ready for use. In the beginning, there was no change in the amount of active ingredient to compensate for the added paraffin. Be reminded that in the 1960s, prior to the establishment of EPA, there were no rigid efficacy requirements for rodent baits, and a high percentage of all commensal rodent baits were prepared by the users from marketed concentrates.

As stated previously, the *Pest Control* article caught the attention of firms that marketed pest control products and the commercial rodent bait formulators, as well as members of the pest control industry and other entities that formulated their own rodent baits – in particular, health departments at the city, state, and federal level.

NEW BAIT FORMULATION PUT IN PRACTICE

Health departments were especially interested in these moisture-resistant paraffin bait blocks and it was for sewer rat control that they were first used with what public health personnel considered effective results. Remember at that time, in the early 1960s, public health officials did not have a good means of assessing rat kills in sewers and generally relied on bait disappearance as their measure of success. Paraffin bait blocks made it relatively easy to measure bait take without a significant added labor cost – helping to keep within limited budgets. Intrigued by the early findings, health departments, which conducted most of the sewer rat control at that time, began putting this new formulation approach into action. This required some experimentation and adjustment on their part to best gear up for mixing this new type of bait with their avail-

able resources and to test and establish protocols for its application in sewers and other damp rat infested environments. Because it all started here, county health and county agriculture departments in California were ahead in the move to adopt this new bait concept.

As paraffinized baits caught on, other articles reporting their effectiveness, especially for sewer rat control, began to appear in magazines and in other publications. One of the early ones was an article by Joe Brooks of the California State Department of Public Health, entitled "Baits for Sewer Rat Control". Citing Marsh and Plesse (1960), Joe investigated paraffin baits for sewer use and presented further specific details on how they prepared and molded their experimental baits. In his study, Joe went a step further and in addition to making anticoagulant paraffinized baits, he also proposed and explored making them up incorporating the acute rodenticide, sodium fluoroacetate (1080), in place of an anticoagulant (Brooks 1961). Among California's public health officials, Dean Ecke and Joe Brooks stand out as key participants in the promotion of paraffinized baits for rat control.

In February 1962, at the First "Vertebrate Pest Control Conference", Joe Brooks again presented a lengthy paper on "Methods of Sewer Rat Control" in which he discussed all aspects of sewer rat control and included references to his earlier paraffin bait preparations (Brooks 1962). The Ecke and Cristofano (1959) and Marsh and Plesse (1960) articles are both referenced in his paper. Again in this paper, Joe mentions the use of sodium fluoroacetate (1080) but he also included fluoroacetamide (1081) paraffinized baits and indicated that they both showed promise (Brooks 1962). At that same conference, I presented a paper on woodrats (*Neotoma* spp.), in which paraffinized anticoagulant baits are included as an option for their control (Marsh 1962).

In Decatur, GA, paraffin baits proved most acceptable to rats and resistant to mold spoilage in sewer rat control, according to the Communicable Disease Center (CDC) of Atlanta, GA (Bjornson and Brooks 1962). In the following year, the CDC revised their rodent control training publication to incorporate how to prepare molded anticoagulant paraffin baits, citing Marsh and Plesse (1960) as sources of their information (Johnson and Bjornson 1964).

Rapid bait deterioration in damp sewers had long been a problem, and at about this same time period other researchers and practitioners were exploring a totally different approach to this problem. They were searching for and experimenting with suitable and palatable chemical mold inhibitors or preservatives to extend bait longevity without the loss of palatability (Larthe 1957, Howard 1959, Bentley 1960, Johnson and Bjornson 1964). Some progress was made and, for a time, several were subsequently used in commercially formulated rodent baits. These additives, although useful to some extent, could not match paraffinized baits for moisture proofing.

An extensive survey report of city sewer rat control across the U.S. was conducted as a research project of *Pest Control* magazine. This report describes what was going on at that time with regard to sewer rat control, or the lack thereof. Based on respondents' information, it was apparent that paraffin rat baits were being prepared and used by many cities that conducted sewer rat con-

trol. As reported, these included: Seattle, WA; St. Louis, MO; Silver Springs, MD; Lansing, MI; San Francisco, CA; Milwaukee, WI, and Toronto, Canada (Anonymous 1963a). The survey indicated a few health departments were using ready-made commercially produced paraffinized anticoagulant baits as they became available. It is also worth noting that a number of these cities were using 1080 as the active ingredient in their self-prepared paraffin sewer rat baits. However, no paraffin 1080 baits were ever commercially produced or marketed in the United States.

It is further worth noting that commercial pest control firms were only rarely involved in sewer rat control in the early 1960s, as most were conducted by the cities themselves (Anonymous 1963a, Anonymous 1964). However, this was also beginning to change, as illustrated by the details given of a most successful sewer rat control program conducted in Winston-Salem, NC by a pest control firm using a self-prepared molded anticoagulant paraffin bait (Whitman 1963). At that time, such occasions made industry news and Pest Control Operators (PCOs), as they were then called, began to seek out this sewer rat control business.

A year later (1964) Dean Ecke reported on the Santa Clara, CA County Health Department's ongoing evaluation of a commercially produced wax block containing 0.005% diphacinone with a photo included of outdoor bait placement for roof rat (*Rattus rattus*) control in residential back yards (Ecke 1964). John Beck and Paul Rodeheffer, U.S. Fish and Wildlife Service, Branch of Predator and Rodent Control, working with the city of Akron, OH Health Department, evaluated the sewer rat problem of the city and determined the cause and best control methods. After knocking back the initial rat population with an acute rodenticide, it was recommended that a follow-up maintenance control program using a commercially produced fish-flavored diphacinone bait block be initiated (Beck and Rodeheffer 1965).

During this period and, for that matter, continuing today, sewer rat control was rarely conducted routinely but instigated periodically only when complaints from the public became numerous. Usually, this was triggered by reports of rats entering homes via the toilets or being seen nearby emerging through holes from broken subterranean sewer lines. For sewer rat control, the moisture-resistant paraffin bait blocks, with a length of wire attached, could be lowered into a manhole and placed on the sewer's ledge or apron with considerable accuracy (Figure 2). The free end of the wire was then secured to the top rung of the manhole ladder and the hole relidged, thus providing lasting rat control. Manholes vary considerably in depth with many in the 8 to 12-foot range.

The flow of articles on paraffinized baits and their characteristics and uses continued for more than a decade (Brooks 1965, Rohe 1966, Anonymous 1968, Hickling and Peterson 1968, Anonymous 1970, Barbehenn 1970, Brothers 1972, Sipaila 1975). This exemplified the extent to which health departments were committed to the use of paraffinized bait. By the mid 1960s, they had commenced to hire PCOs to conduct the sewer baitings and to use mostly commercially produced paraffinized baits (Anonymous 1963a).

The published acclaims for paraffinized rodent baits coming from health departments across the country, in-

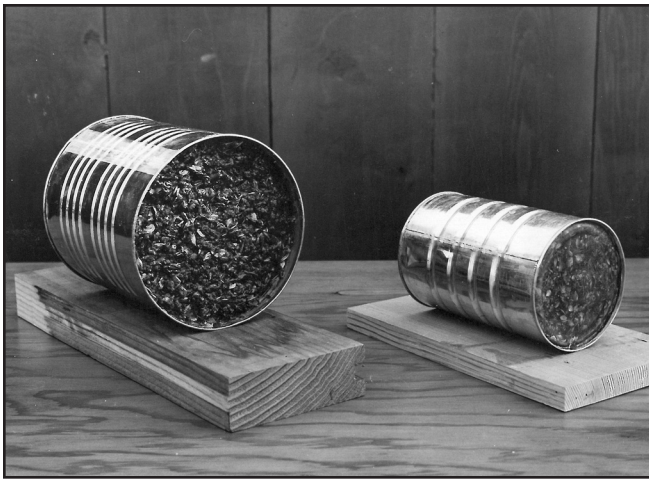



Figure 2. Gallon and two-quart-size user prepared warfarin paraffin grain baits used in the beginning for sewer rat control.

Eaton's "All-Weather"
BAIT BLOCKS

for
Rodent Control Outdoors



Handy 2 Ounce BAIT BLOCKS of Eaton's A-C Formula molded with pure Paraffin.

Safer, More Effective—regardless of the weather!

Packed 80 BAIT BLOCKS (10 lbs.) per box with either MEAT or FISH Flavor-Attractants.

ONLY \$3.95 PER BOX, F.O.B. Extra 5% discount with 40 boxes. Prices slightly higher on West Coast.

FOR INDOOR BAITING: Use Eaton's A-C FORMULA, packed in 5 pound bags. Blended with choice of 5 Natural Flavor-Attractants: meat • fish • coconut • molasses • tomato. Only 24¾¢ per lb., F.O.B. Extra 5% Quantity Discount with 400 lbs.

ORDER TODAY OR WRITE FOR FREE SAMPLE

Manufactured and Guaranteed by
J. T. EATON & CO., INC.
1106 Lakeview • Cleveland 8, Ohio

Figure 3. J. T. Eaton & Co. advertisement for their paraffin "All-Weather" Bait Blocks appearing in *Pest Control*, February 1964.

cluding CDC along with bait formulating companies promoting their respective paraffin type rodent baits, did not go unnoticed by the applied side of the industry. At first, using these new paraffin baits mostly for out-of-doors rat baiting where damp wet weather had often caused the older bait formulas to deteriorate, especially anticoagulant baits,

NEW longer lasting . . .



Rodent Cake

A PARAFFIN MOLDED ANTICOAGULANT BAIT

(See August, 1961 issue of *PEST CONTROL*, p. 28, for advantages of this type of bait.)

RODENT CAKE ADVANTAGES:

1. Ideal outdoor bait
2. Does not have to be replaced every month in damp locations
3. Mold Resistant
4. Water Repellent
5. Available in straight grain, chocolate and peanut
6. Proven "good eating" to rodents by extensive tests

PCO PRICES: \$32.00 per 100 lb. (approximately 500 cakes) FOB, Muscatine, Iowa

Write for complete price list

AMERICAN CHEMICAL COMPANY
Box 22 • Muscatine, Iowa

PEST CONTROL, February, 1962

Figure 4. American Chemical Company advertisement in *Pest Control*, February 1962.

it wasn't long before paraffinized bait found much broader uses in nearly all habitats. By now, the use of paraffinized rodent baits had become a common practice. This was also reflected in the commensal rodent control bulletins and manuals published in the late 1960s and throughout the 1970s (Anonymous 1969, Howard and Marsh 1974, Marsh and Howard 1976, Packham 1970, Storer 1968).

Within less than a decade after paraffinized baits had made their mark here in the U.S., such baits had become widely known and manufactured in Europe and a number of other developed countries of the world. Literature on overseas rodent control bears this out with numerous published articles referencing paraffinized baits (Bajomi et al. 1976, Gillbanks et al. 1967, Ku 1979, Lee 1969, Otto 1971, Smith 1967, Smith 1969, Wilson 1969). Paraffinized baits were mostly used for commensal rodent control; however, they also found use in specific agricultural crops such as rice, sugar cane, coconut, and oil palms.

COMMERCIALY PRODUCED PARAFFINIZED BAITS

Following the initial development of paraffinized bait and its subsequent rapid acceptance and use by health departments and other entities across the nation that prepared their own baits, there had been parallel interest and action ongoing in the commercial bait manufacturing industry

Announcing

RODENT CAKE®

A Paraffin Molded Anticoagulant Bait

(See August 1961 issue of PEST CONTROL, pg. 28, for advantages of this type of bait.)

Advantages

1. Does not have to be replaced every month in damp locations.
2. Mold Resistant.
3. Water Repellant.

Available in straight grain, chocolate, peanut or a combination of flavors.

PRICES

Minimum Order 100 lb. fob Davenport, Ia. . . . \$32.00
(Check or Money Order Please)

Write for Quantity Discounts Available.
Shipped in individual 3-4 oz. dishes, or 2 lb. blocks.

Manufactured by

BUG-X-COMPANY

216 E. 18th Street Davenport, Iowa

Figure 5. Bug-X-Company advertisement in *Pest Control*, January 1962.

and with pest control supply distributors. They too could see the potential of this new concept.

J. T. Eaton and Co. of Cleveland, OH, and the American Chemical Company of Muscatine, IA, were two of the first commercial firms to begin producing and/or marketing molded block type paraffinized anticoagulant baits in the U.S. (Figures 3 & 4). Shortly thereafter, the Bug-X-Company of Davenport, IA, began advertising and marketing a paraffinized “Rodent Cake”, which was made for them by the American Chemical Co. (Figure 5). Hopkins Agricultural Chemical Co. of Madison, WI was also making paraffinized baits. These marketed products appeared in 1962, a relatively short time – less than a year – after our Marsh and Plesse coauthored article appeared in *Pest Control*. Of interest is the fact that in the advertisements of the American Chemical Company’s and the Bug-X-Company’s “Rodent Cake” appearing in *Pest Control*, they actually referenced our article with the following: “(See August 1961 issue of PEST CONTROL p. 28 for advantages of this type of baits)” as part of their ad. This was early 1962 and the beginning of commercially prepared paraffinized rodent baits.

Following the lead and success of the first few commercial bait making firms, it wasn’t long before the other manufacturers followed suit. The competition between bait suppliers was significant – each firm attempting to

out-do their competitors by producing baits with qualities a little different and, assumingly, superior to the others. This was most evident in their product advertisements and a reflection of the beginning of the evolution of commercial paraffinized rodent baits.

Initially, in the 1960s, the baits were all prepared by pouring the heated and flowable paraffinized bait mixture into some type of mold, be it a disposable type of container sold with bait intact, or a permanent type of mold from which solidified baits were knocked free prior to sale. The anticoagulant rodenticides, although relatively new, had become very popular and at that time. Only the early first-generation anticoagulants were available for preparing baits – warfarin, Fumarin, Pival, Prolin, and diphacinone. One firm, ArChem, in the late 1960s did market a zinc phosphide paraffin bait. Chlorophacinone had not yet come on the scene. The second-generation anticoagulants had not been developed and were some distance in the future; the first two of this new generation, brodifacoum and bromadiolone, didn’t become available until around 1980.

As is true with the sale of most products, advertising was a key component in getting the attention of the potential users. Product names were selected to reflect the nature of these new solid block-type rodent baits. Names like “Rodent Cake”, “Eaton’s Bait Blocks®”, “Hubsco-147 Rodent Blocks”, “Marin Bars”, and “McCoy’s Rat Killer Blocks” were representative.

J. T. Eaton and Co. was one of the earliest firms to produce such baits and its forward-thinking president, Stanley Baker, secured “Bait Blocks®” as their registered trademark in 1962. This is one of the reasons why later-manufactured products frequently took on names with odd spellings, e.g. “Di-Blox”, “ParaBlox” and “WeatherBlok” (Kaukeinan and Marsh 2009).

Jockeying for that marketing edge, there were a variety of ways to modify or improve paraffinized baits through the selection of the active ingredient (i.e., toxicant) or the bait’s basic edible components, such as the kind and number of grains (i.e., cereals) incorporated and whether the grains were whole, rolled, crimped, cracked, or ground, and any combination thereof. Baits generally are made up of table-quality cereals, some sugar, and food grade paraffin. Corn, oats, wheat, millet, and milo are commonly used cereals (Corrigan 1990), corn and oats being the most common. Sweeteners such as various sugars, syrups, and molasses were often used to enhance bait acceptance. Various other added ingredients were also used to impart flavors/aromas to the bait. The goal, of course, was to have a highly acceptable bait that would produce the best control results (Marsh 1988).

Animal fats and/or vegetable oils such as corn or peanut oils are sometimes added to increase bait acceptance or to dilute or diminish the amount of paraffin needed yet still maintain a firm block. To avoid rancidity, baits incorporating animal fats had to be used fairly soon. Plant oils were more stable but still could present shelf life problems. The use of pure medicinal grade mineral oil alone or in combination with plant oils avoided or diminished this problem. Bait take by rodents generally increases with the least amount of paraffin used per unit and yet produce a solid bait block.

Paraffins are not all alike and what was initially used

was USP grade paraffin, which is of pharmaceutical quality (143-150 AMP) and was sometimes referred to as “household paraffin” because it was often used when preparing jams and jellies or for making candles. The melted paraffin was poured atop the glass or jar of newly made jelly to seal the contents. This quarter-inch-thick layer of paraffin, when hardened, blocked the air and microbes, serving to preserve the jam or jelly. Household paraffin (i.e., wax) was sold in 1-lb boxes, while the bulk product was sold in from around 10 to 18-lb slabs or blocks, with several making up a boxful. Paraffin was always melted in a metal container set in a water bath with the heat applied to the water to avoid setting the wax on fire. Less pure paraffins were explored by some bait manufacturers, as well as plasticized waxes. Paraffins of different melting points were also explored, as were different forms for ease of preparation, such as granular or flaked paraffins. Exact bait formulations are guarded secrets of the manufacturers.

Early on, flavors/aromas were extensively used to promote baits and paraffinized baits were ideally suited for adding small amounts of flavoring ingredients into the mix. American Chemical Company’s “Rodent Cake”, in 1962, was available in straight grain, chocolate, and peanut flavors. J. T. Eaton’s 1962 paraffinized bait was available in meat or fish but two years later they had added coconut, molasses, and tomato flavors. When the single flavors were exhausted, the manufacturers turned to combinations of flavors to keep ahead of their competition, so we had fish and grits, molasses and cereals, meat and blood, and molasses-peanut butter. Some of these flavors and/or odorants would later be challenged by the EPA because of human and nontarget hazard concerns and would be withdrawn.

Often, nearly tasteless oil soluble dyes would be added to some formulations to further enhance their appearance and emphasize the flavor – green for apple, light brown for peanut flavor, and so forth. J. T. Eaton and Co. advertised having the first bait specifically marketed for sewer rat control (Anonymous 1963b); it was a professional looking molded 1-lb block and was dyed black. Colored baits assisted in identifying products and also helped prevent their accidental misuse. Later in the 1970s, some type of dye or coloring was mandated by the EPA/USDA to be in all rodent baits.

Other significant bait variables were size, shape, and the means of anchoring the blocks. The appearance of the various bait blocks varied depending on the kind and type of containers used for the molds. For years, the American Chemical Company’s “Rodent Cake” was molded in a shallow scalloped paper plate; disposable molds were either left intact or removed before the baits were packaged. Others employed reusable metal molds professionally made to specifications. Molded baits were often scored with thin connections between segments so that one block could easily be broken by hand into smaller blocks. The size of early blocks varied from about 4 ounces to the 1-lb size used in sewer rat control, but this changed later and they became much smaller. Some had preformed holes in them and/or had warning words molded into the block such as “Caution-Rat Bait”, which appeared on Eaton’s bait block. Eaton at one time provided a metal identification tag to be used on each block if desired. Others

had product or company names imprinted in the blocks. Southern Mill Creek Products Company applied individual add-on “caution” labels they claimed would stay on until the block was gone. Motomco Company in 1968 advertised their Pival block stating “The rats take everything but the label”.

Large baits, designed to be anchored in sewers by a wire, often had reinforced holes in them so that the wire would not pull through the block’s edge. Bell Laboratories advertised that their 16-oz “Rodent Cake” contained a high density polyethylene core for secure wiring or nailing. J. T. Eaton’s 1-lb sewer rat bait block had an added metal tab to reinforce its hole.

Other events relative to commensal rodent control were also in play during this evolution of paraffinized rodent baits. New lethal rodenticides (i.e., active ingredients) were being developed and coming on the market. A group of second-generation, more potent anticoagulants were developed, each generally by a different chemical firm, to combat a growing problem – rat and house mouse resistance to warfarin and all others of the first-generation series including chlorophacinone, the last of the group. Brodifacoum and bromadiolone were the first two of the new series marketed about 1980 (Kaukeinen 1979) and were followed by difethialone and difenacoum. All were highly effective in controlling the warfarin-resistant rodents and required much less bait consumption to be fatal to the rodent – thus, the so-called single-feeding anticoagulants.

Firms with proprietary rodenticides began to market their own paraffinized commensal rodent baits. For example, ICI (now Syngenta) initially marketed their brodifacoum bait as Talon Weather Blok. Chempar (now Liphatech) marketed their RoZol chlorophacinone bait, and later Liphatech marketed their Maki bromadiolone and Generation difethialone rodent baits, all as paraffinized baits.

In the late 1960s, the first non-anticoagulant rodenticide, zinc phosphide, an old toxicant, was commercially formulated as a pelleted form of paraffin bait. This will be discussed in some detail later. In the late 1970s, the non-anticoagulant, Vacor, was marketed for a relatively short period and, it too, was formulated into a paraffinized bait. Today, the non-anticoagulant bromethalin is being marketed as a paraffinized bait by both J. T. Eaton and Bell Laboratories as “Top Gun All Weather Bait Blocks” and “All-Weather Fastrac Blox” respectively. Bell, in 2010, came out with Terad, Ag Blox for the organic food industry containing cholecalciferol as the active ingredient.

The market for paraffinized rodent baits continued to grow nearly annually. The development of warfarin and related anticoagulant rodenticides led to some profound changes in commensal rodent control. Maintenance baiting became a common practice; bait stations were maintained in the rodent’s environment over a sustained period. This significantly grew bait sales, as did the adoption of perimeter baiting.

In the 1960s and 70s, commercially produced paraffinized baits were mostly sold to the professional market for use by commercial pest control operators and other major users such as health departments. They were also commonly used by farmers around animal facilities and

livestock food storage. Over-the-counter (OTC) paraffinized rodent baits were eventually made available to the homeowners as well. Today they now make up a substantial portion of that OTC market and appear destined to be mandated by the EPA as the only type of homeowner-use bait allowed in the future.

THE MANUFACTURING PROCESS ADVANCES

There were some inherent problems in producing molded paraffin bait on a commercial basis. This was beside requiring a mold to form the bait and being more labor intensive than the preparation of a meal or loose grain bait. The ingredients in the flowable wax mix sometimes settled out, depending on the particle size and density; causing an undesirable layering or stratification. Shrinkage sometimes occurred in the cooling process, leaving a depression in the center. The shapes of blocks had to have rounded edges for easy removal from molds. It took time for the molded baits to set up before they could be removed from the molds and packaged (Kaukeinen and Marsh 2009). While these problems could generally be solved, it was not without cost.

Over time manufacturers worked out ways to make the molding process as simple and rapid as possible – some were quite imaginative. One such innovative approach was employed by ICI (now Syngenta) in preparing their brodifacoum “WeatherBlox” for the professional market. According to Dale Kaukeinen (pers. commun.), in order to produce smaller size baits more economically, the hot mixture was poured into disposable plastic 420-gram (14.81-ounce) flattened circular molds with pie-shaped break-apart channels. Once filled, the molds were sealed with a cardboard label lid and could be packed while still warm. They were marketed in their molds and until opened they did not stick together nor deform in heat.

Let’s step back to the 1960s when the molding process for producing baits was slow and labor intensive at best; there was an innovative individual who sought a solution. Howard Arbaugh of ArChem, Portsmouth, OH, in an effort to come up with a less expensive and faster way of producing paraffinized baits, developed a means of pelletizing paraffinized rodent baits – producing a solid waxy pellet. Howard filed for a patent on his process in October 1968 and was granted patent no. US3624198 in Nov. 1971 and with this new process produced several different baits. ArChem referenced one as a “paraffinized-pelletized anticoagulant rat and mouse bait” with diphacinone as the active ingredient and named it “Parapel”. It was available in pellets of 3/16 and 3/4-inch diameters. The process produced a glazed over waxy pellet that appeared much like a rabbit pellet or large pelleted cattle rations but smooth and without fissures. The pellets’ length was considerably longer than the width.

Using the same process, Arbaugh also produced a 1% zinc phosphide paraffinized pelleted bait called “ParaZinc”. I was once told that the company had a sizeable market in the Caribbean and South American countries, where the paraffinized pellets were marketed principally to the sugarcane growers for rat control.

At least one other firm, Chempar, in addition to having a molded type paraffinized block bait, also explored and marketed a pelleted paraffinized bait. Their product,

INDOORS OR OUTDOORS


"Rodent Cake"TM

IS PALATABLE TO BOTH
RATS AND MICE.

- INSECT PROOF
- WEATHERPROOF
- MOLD RESISTANT

CONTAINS DIPHACINONE THE
PREFERRED ANTICOAGULANT

AVAILABLE IN FLAVORS FOR
VARIETIES IN BAITING.

 **BELL LABORATORIES, INC.**
BOX 5133 MADISON, WIS. 53705

For More Details Circle (141) on Reply Card

Figure 6. Bell Laboratories, Inc. advertisement in *Pest Control*, June 1973.

chlorophacinone “Rozol Paraffinized Pellets”, marketed in 1975, was somewhat different in appearance than those produced by ArChem.

It wasn’t until much later that Malcolm Stack of Bell Laboratories researched and significantly improved this production process. As a result, Bell Laboratories applied for a patent in 1989, which was granted in 1991 (Patent No. 5044113). Bell Laboratories’ new development led to what is known today as the extrusion process that produces a waxy extruded block-type bait weighing around an ounce. For this extrusion process, the edible components (i.e., grain/cereal) are usually ground to the consistency of sand particles, allowing for a more homogeneous block (Kaukeinen and Marsh 2009). The extrusion process permits the use of dies that produce blocks with distinctive longitudinal characteristics or grooves and can even produce a hole through the core’s center. Bait blocks of distinctive shapes may be dyed different colors or shades of colors as a means of identifying a particular bait product. Grooved blocks are also sometimes promoted as having defined edges, supposedly making them more prone to rodent gnawing.

Noteworthy is the fact that in the early 1970s Malcolm Stack founded Bell Laboratories in Madison WI with the expressed purpose of producing a paraffin rodent bait called “Rodent Cake” (Figure 6). The bait’s name, including its

initial shape, was the same as had been used by American Chemical Co. Bell Laboratories, under the leadership of Stack, went on to become one of, if not the leading company in the production of technical grade rodenticides and of rodent baits of all types.

The extrusion process also allows for a reduction in the amount of paraffin needed and shortens the cooling time, since lower temperatures are used with this process than with molded baits. The process permits fairly uniform blocks, as they can be cut automatically at desired lengths. The great advantage of extrusion is its high volume production at much reduced costs (Kaukeinen and Marsh 2009). Reductions in costs are attributed to reduced hand labor, plus the lesser amount of incorporated paraffin. The price of paraffin has substantially increased over the years.

The extrusion process developed by Bell Laboratories has now been adopted by nearly all other U.S. rodent bait manufacturers and is likely for some time to remain the production process of choice for paraffinized rodent baits. I have no doubt, however, that sometime in the future there will be further innovative and improved processes adding to the evolution of paraffinized bait production.

USE PRACTICES

From the perspective of past history, "use practices" are of considerable interest because many have been lost over time through more rigid state and federal pesticide regulations and other considerations. In the early 1960s, rodent control with toxic baits generally followed established traditions. Upon the introduction of paraffinized rodent baits, control practitioners had a novel new bait form that was more moisture resistant and therefore more efficient. The block type bait was easier to place within the rat's environment and, hence, more effective. Paraffin block type baits, as would be expected, resulted in experimentation and exploration as to where and how they might fit in or be used in a variety of rat infested environmental and physical conditions. There was also an effort to expand their use to other anticoagulant susceptible rodent species on this continent and abroad. Most of this section on "use practices", with few exceptions, relates to the first 10 to 15 years of their existence and to molded rather than extruded paraffinized baits. Much of the emphasis is placed on their use in agriculture, for it was in that area of rodent control that some innovative uses and applications were experienced.

Use practices rapidly advanced from sewer rat control to the control of rats in a variety of other damp moist environments, such as along the banks of rat-infested drainage ditches, creeks, rivers and marshy areas, and for use in and around stream and ocean riprap. It wasn't long before anticoagulant paraffin block baits were being promoted for use in just about all types of out-of-doors rat infestations. They were particularly useful around animal rearing facilities, stables, cattle feed lots, farm buildings, loading docks, and port facilities. They held up well in high humidity situations and where baits in bait boxes may be needed and placed where they are exposed to rainy weather.

In regions where roof rats exist, paraffin type baits were soon found highly effective, and more so than any

previous type of baiting used for out-door landscaped and natural areas. It was because the bait blocks themselves could be fastened with a tie-wire to a limb of a backyard fruit or nut tree. This put the bait in very close proximity to the rat's travel route and gave the rats unrestricted feeding. California health departments in the 1960s found they could bring backyard roof rat populations under control in residential areas by nailing a block or two to the top of a wooden fence or to the telephone or power line poles. Several articles on these techniques were subsequently published (Brothers 1972, Ecke 1964). It should be pointed out that all the early uses of paraffin baits were prepared with one of the several available first-generation anticoagulants, as the second-generation anticoagulants were not yet available.

This means of achieving exceptional roof rat control did not go unnoticed and was soon adopted by southern California citrus and avocado growers (Clark 1975). With limited effort, growers could dramatically reduce fruit losses from roof rats by strategically hanging bait blocks on the limbs of the trees. Some of the county agricultural commissioner's bait mixing facilities produced paraffin baits with one end of a tie-wire already embedded in the blocks, making them easy to attach to trees. Placement of bait blocks currently is more restrictive; follow the product label instructions.

Another innovative approach involved a quart sized bait block made by California counties, which had a long slender stick embedded into the finished block with about 10 inches of the stick protruding from the end of the block. These bait blocks became known as "lollipop baits" (Anonymous 1968, Dana 1968). I always disliked the use of the lollipop name for a poison bait. I was fearful that some child might actually think the baits were meant to be licked or chewed upon. Fortunately, to my knowledge, this never happened. EPA now prohibits product names, designs, and labeling that looks or sounds like a food item.

The baits with sticks were highly effective for ditch bank Norway rat control. The sticks could be pushed into a ditch bank or the ground, leaving about an inch or two of space between the block and the soil. These pedestal baits were far enough off the ground so as not to be contaminated by moisture, soil or ground debris and at the same time were at a level where rats found them and could easily feed upon them. These baits were most useful in ditch bank rat control or any out door rat infestation where the soil was of a consistency that would permit the sticks to be easily pushed into the soil by hand. They were found particularly useful in California for rice field rat control and to establish a perimeter of baits along the edge of a vegetable crop that bordered a rat infested stream (Clark 1975, Marsh 1968). Such practices are no longer permitted and block baits must be placed within bait stations or within burrows.

Paraffinized baits found use in a number of agricultural crops in other countries. For example, very soon after commercial manufactured baits were available they were being used to protect the crop in coconut plantations of Jamaica where one block was placed at the foot of every 5th or 6th palm, with 3 to 4 applications annually. Paraffinized baits

were ideally suited for use in moist tropical climates, especially to protect coconuts (Smith 1967, Smith 1969, Wilson 1969, Valencia 1980) and oil palms of Southeast Asia (Wood 1990). Paraffinized baits found use protecting rice fields, especially the more valued rice research plots in many parts of Asia (Otto 1971, Kuo 1982, Hogue and Olvida (1988). In Taiwan, paraffin baits were explored for preventing tree squirrels from debarking the forest trees (Kuo 1982).

In this country, besides for rat control in agriculture, paraffinized anticoagulant baits found most use in vole (*Microtus* spp.) control, especially in apple orchards and certain other high value crops (Caslick 1970, Byers et al. 1976, Bryson 2004). Also, very soon after paraffin baits came on the scene, they were explored and found useful for muskrat (*Ondatra zibethicus*) control. Blocks placed in floating bait stations and on pond or stream banks resulted in effective control of muskrats (Dana 1968, Miller 1974, Shuler 2000, Storer and Jameson 1965).

Although pocket gophers were mentioned in our publication on paraffin baits (Marsh and Plesse 1960), little had been done after that article until the early 1980s when researchers and graduate students at the University of California–Davis campus, began serious studies of paraffin baits for pocket gopher (*Thomomys* spp.) control that subsequently resulted in a number of published papers (Tunberg et al. 1984, Campbell et al. 1992, Lee et al. 1992, Marsh 1992). As a result of this and other research, several commercially manufactured anticoagulant paraffin baits for pocket gophers were marketed for a time (Marsh 1987).

FACTORS CONTRIBUTING TO SUCCESS

Over the years I have given considerable thought as to why this new paraffinized bait formulation was so readily accepted and evolved into such a significant commercial and rodent control success. No history of paraffinized bait would be complete without enumerating those factors that are believed to have been most relevant.

- **A significant need for better sewer rat control** – There was an increasing sewer rat problem with numerous complaints of rats emerging from toilets in many cities. Several things were thought to be contributing to this increased rat population. Following World War II, the human population was growing and along with this came a great expansion in home building. Sewer systems were expanded as well to accommodate new subdivisions. Rats were thought to be increasing at a disproportionately high rate because of a more affluent society with an improved diet. The resulting sewer effluent solids proved to be more nutritious for rats as well (Beck and Rodeheffer 1965). The advent of home garbage disposals just exacerbated the problem by adding more food solids to the sewer system. Not only were there more rats, the size of the infestations expanded into the outer areas of the cities when previously they had been restricted mostly to the older districts and low rent areas of cities. Although we had acute rodenticides such as sodium fluoroacetate (1080), zinc phosphide, and red squill available for sewer rat control, they provided only short term results and the population rebounded. A long-lasting semi-permanent moisture resistant

anticoagulant bait was needed to maintain control once the population was knocked down with an acute rodenticide – paraffinized anticoagulant baits fulfilled this need.

- **The simplicity of formulating paraffinized baits** – The technique for making molded paraffin-type baits was extraordinarily easy and could be carried out by anyone familiar with rodent bait preparations. A minimum of additional equipment and utensils were needed. This definitely would not apply today since the extrusion process is most commonly used.
- **Chronic rodenticides such as warfarin were available** – Warfarin and later several other anticoagulant rodenticides had been introduced and available for about 10 years. Hence, the idea of a chronic rodenticide which required multiple feedings to produce death had been the recipient of a most effective training program by Wisconsin Alumni Research Foundation (WARF), the manufacturers of warfarin. Practitioners were now quite well-grounded with the concept of prolonged bait exposures, and more importantly they had first hand knowledge of their effectiveness as a rodenticide with minimal nontarget hazards – the ideal type of rodenticide for paraffin-type bait.
- **No patent or royalties** – There was no patent on the paraffinized formulations or for the preparation process, which left it open for uninhibited use. This was of great importance because it permitted all bait manufacturers to get into the market unrestrained by patents or royalties. As years passed, patents did come into play on machinery and processes for volume production of paraffinized baits. The first of these patents was applied for in October 1968 by Howard Arbaugh of ArChem.
- **Less stringent registration requirements** – Paraffinized baits had their beginning in the early 1960s when the U.S. Department of Agriculture oversaw pesticides registration and enforced the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). This occurred at a time when the existing standards made it much easier to put a new bait formulation of an existing rodenticide (active ingredient) on the market. When the Environmental Protection Agency (EPA) was created in 1970, the new agency took over, leading to the adoption of a whole group of previously nonexistent regulations on pesticides, which, of course, included rodenticides. Since the EPA's inception there have been an ever-increasing number of new regulations and demands placed on the manufacturers of rodenticides and the baits they produce. Use practices have changed and continue to do so, always becoming more restrictive.

I am thoroughly convinced that had paraffinized baits not entered the market and become well established as a highly effective rodent bait formulation for use in sewers and other damp places, under the authority and enforcement of the USDA they would not exist today. No manufacturing firm would have taken the gamble and gone to the expense associated with meeting all of the EPA's current requirements and hassle to introduce a dramatically

new bait formulation, for which no patent existed, without knowing first whether it would actually prove successful and, more important, be accepted by the pest control industry once developed. I can just imagine what the EPA would say if today a bait manufacturer went to them with the proposed intention of adding, in substantial percentage (30 to 50%), a new inert ingredient to their baits – a long-lived petroleum derivative. In addition, its inclusion will annually add X number of tons to the environment of the most populated areas of the country.

The EPA, once in existence, did, however, see the merits of the already existing paraffinized baits and are to be commended for initially lowering their bait acceptance standards and providing for some discretion for percentages of kill (Kaukeinen and Marsh 2009). This assured continued marketing and use of paraffinized baits.

It is rather ironic that the May 2008 decision of the EPA recommended the use of first-generation anticoagulant block baits (paraffinized baits) for homeowners use over all other bait types, and these must be sold prepackaged in bait stations – the belief being that such baits will be safer than others in preventing accidental exposure to children.

Although completely coincidental, the timing of the introduction of paraffinized baits in the early 1960s could not have been better for achieving its major success.

ADVANTAGES AND DISADVANTAGES OF PARAFFIN BAITS

Advantages and disadvantages were recognized during the first two decades of the existence of paraffin anticoagulant baits and prior to the development of the second-generation anticoagulants. Many factors have changed, especially in the regulation restrictions and use practices; however, the basic premises remain the same.

Advantages

- **Resistant to moisture related problems** – Paraffinized baits are very resistant to degradation by molds and bacteria and to physical breakdown from excessive dampness. They are more lasting and hence there is less need for replacement with fresh bait.
- **Unscatterable, adding to safety and efficiency** – As a block form, baits are kept in a confined spot and they are essentially self contained. This nearly eliminates bait scattering by the target species or from other forces. For even greater security, bait blocks can be anchored inside bait stations or wired or nailed in locations commonly used by rats or mice. All the bait remains intact and available to the target animals, avoiding spillage that might be accessible to nontargets. Bait clean-up following the end of control is made easier.
- **Safer to nontargets** – Paraffinized cereal based anticoagulant baits, from their inception, were thought to be a safer form of bait, although rarely promoted for that reason (Marsh 1985a). The first-generation anticoagulants were generally considered quite safe to nontarget species when compared with the single dose acute toxicants of the time. Anticoagulants of that period required repeated feedings to produce

death and there was a known good antidote for accidental poisonings. The paraffinized bait blocks were designed to be gnawed upon to access the toxicant. Since only rodents, as a group, are known as habitual gnawers, a certain amount of selectivity was built into wax block type baits, especially if the blocks were at least of a 4 ounce size or larger at the start. It was subsequently found that domestic dogs were at greatest risk and certain precautions were necessary (Challet 1986, Marsh 1985b,c).

- **Resistant to insect infestations** – Paraffinized baits are more resistant to insect infestations and are less likely to be consumed by certain other invertebrates. Baits are not prone to being carried off by insects.
- **Fast placement and easily secured in place** – Due to their sizes, hardness and shapes, they are easy to handle. Servicing bait stations or other bait placements can be conducted more quickly than with meal or loose grain baits. They can be readily secured in a wide variety of locations frequented by rodents. This can dramatically reduce baiting costs. In one sewer rat control project, it was stated that labor costs were reduced by half (Bjornson and Brooks 1962).
- **Minimal waste** – Block forms, plus moisture and insect resistance, result in less bait loss and wasted bait. This means more efficient use of bait.
- **Versatility of bait formula** – Paraffinized baits are very versatile in that it makes it easy to incorporate a wide variety of edible ingredients of varying particle sizes plus numerous additives such as dyes, flavors, mold inhibitors, Bitrex[®], etc. Some commercial baits claim to have more than ten different ingredients.
- **Ability to be used on different species** – Paraffinized baits are not limited to commensal rodents; such baits can be effective for other rodents such as muskrats, woodrats, voles, and pocket gophers. With additional research, they may be found suitable for other species.
- **Effective and versatile use** – In addition to all their favorable physical qualities, paraffinized baits are highly effective. Initially they found the most use for rat control in damp moist conditions such as in sewers, around docks, in stream and ocean riprap, etc. Over the years rodent bait formulating became more sophisticated and bait palatability improved. Paraffinized bait began to be successfully used in a wider range of rodent infested environments for all three of our commensal rodent species. After about a decade-and-a-half of use, paraffinized rodent baits had essentially become an all-purpose type rodenticide.

Disadvantages

The disadvantages of paraffinized rodent bait are rarely discussed (Corrigan 1990). The list of disadvantages merely points out the most recognized shortcomings and does not negate their many positive attributes. Some of these are most apparent in laboratory studies.

- **More expensive** – Paraffinized baits, pound for pound, are more costly to produce than meal or loose

grain baits, resulting in a higher cost to the consumer. This higher cost is inconsequential since the advantages compensate for the additional expense.

- **Diminished recognition and acceptance as food** – When given a side-by-side free choice, rats and house mice will most frequently approach and feed on the loose grain or meal bait first before gnawing upon a paraffinized bait block with the same imbedded ingredients. Bait in solid block form may not be recognized as food when first encountered (Bentley 1960).
- **Poor heat tolerance** – Paraffinized baits tend to soften, melt, or stick together in hot situations. This is especially true when in transport, as vehicles become excessively hot when parked in the sun on a summer day. Paraffins of higher melting points may resolve some of these problems but there may be trade-offs. These may include reduced bait acceptance by rodents and also present additional block or extruded manufacturing problems.
- **Speed of bait consumption** – The speed with which a given amount of bait is consumed is slowed since paraffinized bait must be gnawed—a slower process than just feeding on a loose grain bait. This may or may not be a disadvantage with anticoagulant rodenticide baits but can lead to more frequent incidences of bait shyness with any other rodenticide that has a propensity toward the development of bait shyness. The reason is that symptoms may be felt by the rodent before a lethal dose has been consumed, resulting in bait rejection thereafter.
- **Gnawing behavior not uniform** – Not all rats of any given population will have the same propensity for gnawing. In the laboratory some wild-caught Norway rats will actually deprive themselves of food rather than enlarge a hole in 1/8-inch-thick soft wood to reach food on the other side of the cage. This may explain the slow start in bait take and the fact that survivors sometimes do exist long after the control program is underway.
- **Potential nontarget hazards** – Paraffin baits can be a hazard to dogs because of the animals' innate characteristics and their ability to find dropped paraffinized baits or dislodged partially eaten baits. Cached bait particles may also present a problem (Lund and Lodal 1990). A number of dog poisonings and deaths have been caused by the intake of paraffinized anticoagulant baits (Challet 1986). Dogs tend to chew on the blocks like chewing on a bone, or they may just gulp down the entire block (Marsh 1985b, 1985c). Cats, for the most part, seem uninterested in the blocks. EPA now requires tamper-resistant bait stations in most cases; this limits risk to pets, livestock, and children.
- **Complicates chemical analysis** – Using paraffin in baits complicates chemical analysis of such baits, presumably because the wax is binding up some of the active ingredient. This was of little importance in the days when many or most major bait users prepared their own baits from marketed rodenticide concentrates. However, in today's world of rigid regulations, precise analytical measurements are essential.

The degree of difficulty associated with the analytical recovery of active ingredient from the “finished bait” is of importance to bait manufacturers.

- **Reputation for being long lasting** – Long lasting baits that do not degrade rapidly in the environment may prove to be potentially more hazardous to certain nontargets. If accidentally dropped or misused in any one of a number of possible scenarios, these paraffinized baits could remain toxic for a very much longer period than would meal or loose grain baits degrade faster. Blocks cached by rodents (Lund and Lodal 1990) or placed in wall voids, attics, basement, etc. and forgotten may be an unrecognized hazard to subsequent property occupants.

HADN'T PARAFFIN BEEN PREVIOUSLY USED?

Sometimes the question arises as to whether paraffin had been used in the preparation of rodent baits prior to 1959 when Lloyd Plesse's formulation was disclosed. The answer is yes; there had been a number of researchers and practitioners both here and in the United Kingdom (U.K.), and probably elsewhere, who explored the use of paraffin in various innovative ways – mostly in an effort to provide the bait with a weather resistant surface coating.

For example, in an early 1924 Connecticut Extension Bulletin on protecting fruit trees from meadow vole damage, a bait formulation developed by the USDA Bureau of Biological Survey was provided. With some condensing, it read roughly as follows: Thoroughly warm a quart of strychnine poisoned rolled oats in an oven and sprinkle over them six tablespoons of a mixture of three parts of melted beef fat and one part of melted paraffin, mix until the oats are evenly coated. When the grain cooled it was ready to apply (Darrow 1924). This formula was a means of weather proofing vole bait.

Some four decades later, a similar coating principle came from Cornell University with the same objective – to weather proof orchard mouse bait. Instead of using a vegetable oil slurry to adhere the zinc phosphide to cracked corn, a melted paraffin slurry was substituted. The rodenticide laden paraffin slurry was poured over the warm cracked corn while tumbling in a heated mixer. Mixing continued until the grain was evenly coated. The heat was then removed from the mixer while continuing the tumbling until the corn particles had cooled and individual kernels remained separate (Caslick 1970).

Pemberton (1925) published information on the preparation of barium carbonate rat cakes and then coated these poisonous cakes with melted paraffin to make them more rain resistant for rat control in Hawaiian sugarcane plantations. The article included a photograph of their dipping process and of coated cakes spread on trays to harden. In a way, these were block type baits but in no way comparable to Plesse's molded paraffinized baits. Many years later, Doty, also in Hawaii, explored the use of melted paraffin to surface coat “torpedo” type rat baits to make them more weather resistant for use in sugarcane production. He later gave up on paraffin as it decreased bait acceptance (Doty 1945).

Howard and Kay (1957), in an innovative approach to rangeland rodent control, explored the use of numerous empty and cleaned one-quart oil cans as enclosed weather

resistant bait stations. A strychnine wheat bait was held in place within the cans by the use of melted paraffin. This bait paraffin mixture secured the bait and offered some weather proofing. Following completion of their study, the authors concluded that the paraffin procedure could not be recommended.

Early trials in Britain that actually incorporated melted paraffin into the bait mixture were generally not well accepted by rodents, especially by house mice, and were written off as not promising (Bentley 1960). Both Chitty and Southern in their three volumes touch on paraffin in relation to rodent baits but they were not sufficiently enthusiastic to explore it further (Chitty 1954, Southern 1954).

Aside from paraffin bait blocks, there were other attempts and successes in producing other kinds of block-type rodent baits that had some moisture resistant qualities. For example, molded bait blocks were made with a mixture of stearic acid, wheat starch, plus an anticoagulant rodenticide. Rodent bait blocks were also produced with linseed oil as the base. In the 1960s, these 1080-laden linseed oil blocks were actually commercially marketed for a time in the U.K.

There is ample evidence that paraffin and several other moisture resistant substances had previously been explored as components of rodent bait. The record is clear; however, it wasn't until Plesse's bait-making formulation was publicized that paraffinized baits, using his method, came into wide usage that continues to this day.

DISCUSSION

Thanks to Lloyd Plesse's initiative, both the rodent bait manufacturing and pest control industry have been favorably influenced as a result of that simply made paraffinized anticoagulant rat bait. From its modest beginning, no one could have predicted how rapidly the concept would be accepted and used in rodent control. It was, however, the rodenticide and bait manufacturing firms that advanced the idea, improved on the efficacy, and perfected its mass production. Paraffinized baits will be with us for a long time and its continued evolution will be the subject of some future article.

ACKNOWLEDGEMENTS

This article is dedicated to the late Lloyd Plesse, a long-time friend who never received the recognition he so deserved for first formulating an effective paraffinized anticoagulant rodent bait. Lloyd not only devised the formula and the procedure for its preparation, but played an invaluable role in disseminating that information. Many thanks go to Dale Kaukeinen, a most knowledgeable veteran of the bait manufacturing industry, for his review of the draft of this article. His suggestions for reorganization and modification were invaluable.

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