INSECTICIDE EVALUATION AND POPULATION STUDY WITH THE BROWN RECLUSE SPIDER, *LOXOSCELES RECLUSA*

By

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PREFACE

During the past 20 years the Loxosceles reclusa spider has become recognized as an important pest of south central United States. The importance of this spider is attributed to the severe bite which may cause a necrotic lesion that is extremely painful and unsightly. Due to the spider's toxic bite and effect on humans, the public and scientific worlds have both become interested in a control of this nocturnal and shy spider. Dr. R. G. Price received a research grant from the National Pest Control Association to evaluate different insecticides as to their toxic and repellency actions against the brown recluse spider.

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INTRODUCTION

The search for adequate chemical controls of the *Loxosceles reclusa* spider has become more important in the last 2 decades. There are many commercial pesticides available to the public and pest control operators, but objective testing of chemicals for spider control has been limited.

With this in mind, 7 insecticides, commonly used by pest control operators, were evaluated as to their toxic and repellency actions. In addition, a short study was conducted concerning the effect of temperature and humidity on population build up. This information may be important in control and serve as an indicator to determine population outbreaks. Pest control operators and the public may find this useful in predicting the right time for controlling this pest.

This research project was centered around the needs of pest control operators and the public for additional information on adequate chemical control and proper time for application of these chemicals.

LITERATURE REVIEW

Since 1872 in North America and 1873 in South America, physicians have recognized a peculiar necrotic skin lesion, now referred to as "necrotic arachnidism" (Gorham, 1968). Schmaus (1929), a Kansas physician, described a rather mild case of necrotic arachnidism in which the spider recovered was identified as a member of the genus Loxosceles (Gertsch and Mulaik). Macchiavello (1947) reported that Loxosceles laeta (Nicolet) was the causative agent in South America in 1934. In 1957 much attention of scientists and medical practioners was attracted to the work of Atkins et al. (1957) who reported that Loxosceles reclusa Gertsch and Mulaik was an important cause of necrotic lesions in North America. Since then the brown recluse spider has been an object of study and of interest in the United States.

Since necrotic arachnidism has entered the medical literature in North America, there have been a number of reported cases of necrotic spider bites. Only a few of these reports have specimens of brown recluse associated with them, and the majority of these reports were based solely on clinical and pathological observations made on the patients.

The usual serious effects of necrotic arachnidism has attracted much attention in recent years, but it is still considered a rare disease (Dillaha et al., 1964). Parrish (1963) reported two fatal cases of necrotic arachnidism. A specific antivenin has been made available against the bite of L. laeta in South America but not in

North America against the brown recluse. Some good results have occurred in the use of a course of treatment employing certain corticosteroids.

The taxonomy of the genus Loxosceles has been worked out in North America (Gertsch and Mulaik, 1940; Gertsch, 1958) and in South America (Gertsch, 1967). Hite (1966) worked out the biology of the brown recluse in Arkansas, and Horner and Stewart (1967) worked on the life history of this species in Texas.

The distribution of the brown recluse spider, according to Wingo (1964), is most common in Missouri, eastern Kansas, and Arkansas (Baerg, 1959). There is now less certainty about the limits of its distribution. The brown recluse spider has been found in some Texas counties (Horner and Stewart, 1967), almost all of the Oklahoma counties, most of Mississippi, and in some counties in each of Louisiana, Alabama, Kentucky, Tennessee, Illinois, Indiana, Ohio, Georgia, and Nebraska (Gorham, 1968). This spider is amenable to having its range extended through human activity, which may be demonstrated by its recovery from a furniture shipment in Albany County, Wyoming [U. S. Dept. Agr. Coop. Econ. Ins. Rep. 14 (38)] and from packing-crate lumber in Los Angeles County, California (Waldron and Russell, 1967).

The Loxosceles spiders are very shy and reserved creatures toward man and the larger animals and are found in a variety of places. These areas are usually dark and quiet. Hite (1966) reported that in houses they are found in old clothing that has remained in storage for an extended period of time and in closets, basements, garages, under stacks of debris, wood, papers, etc. They also found them in barns, other out buildings, under rocks, under bark of trees, and other places. Horner and Stewart (1967) found barns to be good collecting areas.

Because of their nocturnal habits and isolated habitats, these spiders may go unnoticed for years. An infestation of L. laeta was discovered in the basement of a museum at Harvard University, where they were thought to have been established for about 20 years (Levi and Spielman, 1964). This species again was found to be well established in Sierra Madre, California. Here they were detected in buildings older than 4 years in a 5-block area (Waldron, 1969). They were also found to be well established in Alhambra, located 11 miles away, and were thought to have been established for at least 5 years or more.

The characteristics for recognition of L. reclusa and L. laeta are stated by Gorham (1968) as being small, brown spiders, slightly less or slightly greater than 1/2 inch in body length, with a dark brown fiddle-shaped marking on the carapace, and six eyes in three pairs. To distinguish the two species, however, is more difficult and may require attention of a taxonomic specialist with experience in identifying these species.

Due to the increased interest about this spider, important questions have arisen. How do we control this shy nocturnal creature, and, specifically, how effective are residual insecticides in controlling it? Levi and Spielman (1964) tested several insecticides on L. laeta at Harvard University. The majority of the infestation was isolated in the basement of a museum which was being used as a storage area. The spiders were distributed almost invariably on the floor. Adults were usually found singly, while 4 or 5 small spiderlings were occasionally found beneath objects distributed in a space of several square feet. The adult females appeared to establish a relatively permanent territory, whereas males and spiderlings seemed to be more migratory. The researchers used tubes from a WHO (World Health Organization) mosquito insecticide susceptability test kit for their test chambers in their susceptability to insecticide tests. The standard exposure tubes were lined with insecticide-impregnated paper, and jar caps of an appropriate size were used to close the ends. A single nonanesthetized adult female was transferred to each chamber which was then placed on its side for one hour. Each spider was then removed to an untreated jar, fed, and examined after 24 hours. Initially, standard WHO papers impregnated with 4.0% DDT and 1.6% dieldrin in risella oil were used. When these failed to affect the spiders, acetone solutions of 0.5% lindane, 0.5% dieldrin and 4.0% DDT were prepared from Entomological Society of America Standard Insecticides and from 2.0% chlordane from a technical grade concentration. Light-weight, absorbent, paper sheets, supplied with the kits, were dipped into one of these solutions, drained, and allowed to dry. These papers were used to line the exposure tubes in the tests described. Four spiders were exposed to each formulation, but none of the 20 spiders tested with DDT, dieldrin, or chlordane showed any apparent adverse effect. In another test, all 4 spiders exposed to the lindane died at the end of the 1-hr exposure period.

In tests by Norment and Pate (1968), Whatman No. 4 filter paper was impregnated with the following concentrates: 1.0, 0.5, 0.25, and 0.0625% by dipping each sheet into a tray containing the test solution. The filter papers then were held at room temperature for 24 hr, 48 hr, 1 week, and 2 weeks before each test. They used 5 females and 5 males to test each concentration. The test specimens were exposed for a 1-hr period to the impregnated filter papers in sterile 90 mm petri plates. Each spider then was placed in a plastic container and held for mortality counts at 24 and 48 hr after the 1-hr exposure period.

Norment and Pate (1968) showed data on diazinon and lindane which indicated that these insecticides would be good choices for control of the brown recluse. However, they stated that since the habitat of spiders may render them less accessible to immediate contact with the insecticide, lindane would be superior to diazinon as a control because of its longer residual action.

The method by which this spider overwinters may be of importance to its control. Hite (1966) reported that spiders held at 44°F for 15 minutes could not right themselves after being placed on their backs and became inactive at 40°F for 20 minutes under laboratory conditions. Horner and Stewart (1967) reported that the overwintering of the species is a very critical part of their life cycle. They hypothesized that spiderlings under natural conditions in northern-most portions of their natural range may go through 7 or 8 instars, whereas under favorable constant room conditions and continuous development, 8 instars were exhibited. This was also shown by Hite (1966) under artificial conditions.

MATERIALS AND METHODS

These experiments were conducted at the Oklahoma State University entomological research facilities during 1969-70. The brown recluse spider, Loxosceles reclusa, was used as the test animal. Nine hundred and eighty-four spiders were used in the tests. Specimens used in the experiments were collected from various buildings in Payne and Cleveland Counties of Oklahoma.

The methods of collecting the test animals consisted of placing a 1-oz plastic cup over a spider and slipping the pressed paper lid between the cup and the wall or surface on which the spider was resting.

After the spiders were collected, each was returned to the laboratory in an individual plastic cup. Cups were placed on an 18-inch x 28-inch tray where they resided until testing. The laboratory temperature and humidity were kept in the ranges from 70°F to 80°F and 50% to 60% respectively.

Spiders that were alive after each test were returned to their original collecting containers. These spiders were not reused for at least 30 days and were not reused in the same test in which they had appeared previously.

The test spiders' diet consisted of German cockroach nymphs and adults. These insects were fed to the spiders at periodic intervals.

Mortality from Residual Insecticides

Plastic petri dishes, 100 mm x 15 mm, were used as test cages. Each petri dish was ventilated by drilling 25 uniformly spaced 1/16-inch holes through the plastic tops. Whatman No. 4 chromatography paper, approximately 87 mm in diameter, was used as the treated surface. The chromatography paper was treated by submerging it into a prepared insecticide-water solution. Each test paper absorbed approximately 1 ml of the prepared solution. The treated paper was then dried for 1 hr before being placed into the test cage. Each insecticide was replicated 4 times. One spider, two-thirds or more mature, was placed in each cage. The test cages were placed at random on a turn-table which revolved at 1 rpm. Readings were made every 12 hr for 3 days to determine mortality in all tests except the first test where the readings were only made for 2 days. After each test, the spiders were removed and the treated papers were hung in a well ventilated room to await further testing. These same treated papers were again exposed to fresh spiders at 7, 14, 21, 30, and 60 days after treatment.

Mortality from Residual Insecticides on 3 Types of Surfaces

This test was conducted similarly to the first residual test except for the type of treated surfaces and method of treatment. The types of surfaces used were 1/2-inch plywood, 1/2-inch sheetrock, and 1/16-inch vinyl tile cut into 4-inch squares. The plywood and sheet-rock squares were painted with 1 coat of commercial grade latex house paint. These surfaces and the vinyl tile, which did not receive the house paint, were treated with a No. 8004E Teejet spray systems nozzle in a spray chamber, which delivered 1 gal/1000 ft^2 at 40 psi. The treated squares were dried for 1 hr and placed at random on turn-tables revolving at 1 to 3 rpm. A ventilated petri dish lid was placed on top of each treated square, creating a test cage. One spider was placed in each cage, and each insecticide was replicated 4 times. Test cages were visually checked every 12 hr for 3 days to determine the number of dead spiders. The test was repeated at 10 and 20 days for each type of treated surface.

Repellent Effect of Residual Insecticides

Test cages for the repellency test consisted of quart ice cream cartons. The ends of each carton were removed and replaced with nylon tulle for ventilation purposes. The treated surfaces consisted of one-half of a 5.17 inch x 6.50 inch sheet of Whatman No. 4 chromatography paper. One-half of each test paper was treated with approximately 5 ml of the candidate material by dipping it into the prepared solution. The treated papers were placed in a well ventilated room to dry for 24 hr. The cartons were placed on their sides near the periphery of a turn-table with their long axis on radii of the table. The treated paper was cut of an exact size to completely line the inner surface of the carton exclusive of the carton ends. The carton was rotated on its side to a position where the touching ends of the paper was above and parallel to a radius of the table; thus, the treated half of the paper was situated on one side of the stated radius and the untreated half on the other side. The mouth of a 1-dram vial, containing 1 spider, was placed in a perforation through the carton wall and chromatography paper at the mid-point of the sheet. On leaving the vial the spider entered the carton at the point equidistant from the treated and untreated areas and from the two ends of the carton.

Each concentration was replicated 4 times. Readings were taken every 12 hr for 3 days. If the spider was resting on either the untreated area or the tulle, it was awarded a "U"; and, if the spider was resting on the treated surface, it was awarded a "T". This test was repeated at 10, 20, and 40 days using the same treated surfaces.

Relative Number of Spiders Observed in a Grain Bin, January - May, 1970.

A population study was conducted on *L. reclusa* in an 8 ft x 14 ft wooden grain bin containing a small amount of insect-infested, mixed dairy feed. This building was located at a former dairy farm northeast of Stillwater. The bin had solid walls and ceiling and contained one door. When the door was closed during the daytime, the area was dark. A hygrothermograph was placed in the bin to record the temperature and humidity data. Visual counts of the number of spiders present were taken every 3 to 4 days. A flashlight provided illumination to permit accurate counts but caused little movement of spiders during the brief examination period. The research area included all areas of the bin except the ceiling, which was constructed of corrugated iron.

RESULTS AND DISCUSSION

Mortality from Residual Insecticides

The mortality effects of the 7 candidate insecticides at 2 concentrations, when spiders were exposed to the treated surfaces 1 hr after treatment, is shown in Table 1. Heptachlor killed the quickest, producing mortalities of 50% and 100% at 4 and 6 hr of exposure respectively, when used at either 0.5% or 1.0%. The next quickest insecticide was dieldrin which produced low mortality at 4 hr and 75 - 100% kills at 6 hr. In the baygon 1.1% treatment, 25% of the spiders were dead at 4 hr, but no more died until 48 hr. The killing action of chlordane was slightly slower, being 25% at 5 hr for the 3.0% concentration and at 7 hr for the 2.0% treatment. Both chlordane treatments gave 100% kill at 24 hr. Diazinon 1.0% produced 100% mortality at the end of 48 hr. CIBA 9491 and malathion were the least effective.

Further testing of the mortality and residual action of the 7 candidate insecticides used, each at 2 concentrations, is illustrated in Table 2. Dieldrin was the most effective treatment, producing 100% mortality at all test periods up to 60 days with the exception of the 7th day for the lower concentration. Chlordane at 2.0 and 3.0%, heptachlor at 1.0%, and diazinon at 1.0% gave from 50 to 100% mortality through the 14th day. The other treatments were less effective, and again, as in the short-term test, malathion was unsatisfactory. It was also shown in this test, as in the first test, that the chlorinated hydrocarbons were more effective for control of the brown recluse spider than the organophosphates and the carbamate tested.

Levi and Spielman (1964) tested dieldrin and chlordane as possible candidate insecticides for control of Loxosceles laeta in an outbreak at Harvard University. These candidate insecticides failed to show any effects after a 1-hr exposure on the 4 spiders tested on each insecticide treated surface. Norment and Pate (1968) used lindane and diazinon as candidate insecticides against the brown recluse spider and found lindane to be superior to diazinon in residual action and mortality effects. After a 1-hr exposure period, it was found that lindane at 1.0% gave 70% mortality at 1 week, whereas diazinon gave 90% mortality at 48 hr and was discontinued from further testing.

Mortality from Residual Insecticides on 3 Types of Surfaces

Sheetrock Surface Evaluation - The residual actions of 4 insecticides used, at 2 different concentrations each, on sheetrock painted with 1 coat of commercial latex house paint are illustrated in Table 3. The candidate materials and concentrations used are as follows: dieldrin at 0.5% and 1.0%, chlordane at 2.0% and 3%, diazinon at 0.5% and 1.0%, and baygon at 0.6% and 1.1%. The candidate material dieldrin at the higher concentration received 100% mortality up to 10 days and was reduced to 25% at 20 days. Chlordane ran second best giving 100% mortality at 1 hr after treatment and 50% at 10 days and 25% at 20 days. The other materials were less effective. The reduction in the residual period of sheetrock compared to tile and plywood may be due to its gypsum content, therefore possibly causing a faster breakdown of the insecticides.

Plywood Surface Evaluation - The initial effects and residual actions of 4 insecticides used, at 2 different concentrations each, on plywood painted with 1 coat of commercial latex house paint are illustrated in Table 4. The candidate insecticide and concentrations are the same as previously described. Dieldrin again produced 100% mortality up to 10 days and 25% for the 20th day. The other candidate materials failed to show mentionable results. The reason for less effective insecticidual control on wood may be explained by the absorption of the insecticide into the wood rather than left on the surface as a residue.

Tile Surface Evaluation - The initial effects and residual actions of 4 insecticides used, at 2 different concentrations each, on vinyl tile are illustrated in Table 5. The candidate insecticides and concentrations were previously described. The candidate insecticide dieldrin produced 100% mortality at its higher concentration up to 10 days and 75% mortality at 20 days. The next best insecticides diazinon and baygon, both at their higher concentrations, produced 100% mortality at 10 days but only 25% at 20 days. The other insecticide and the other concentrations of the insecticide mentioned did not show promising results.

It can be noted that mortalities for the tile treatments were somewhat higher in most cases than for the sheetrock and plywood. This better control on the tile surfaces might be due to more absorption of the insecticides into the painted surfaces than into the vinyl tile.

Repellent Effects of Residual Insecticides

Preliminary studies were conducted with *Loxosceles reclusa* spiders using 7 candidate insecticides at 2 different concentrations. The selected insecticides were used for the purpose of evaluating their repellency actions from the standpoint of a more adequate preventive control of the test animals. Individual insecticide and concentration evaluation are shown in Fig. 1-14 and the total evaluation of all the candidate insecticides at their various concentrations is shown in Fig. 15.

<u>Evaluation of Individual Insecticides at Their Different Concentrations</u> - The repellency action of candidate insecticides at their various concentrations is based on the number of spiders observed on the untreated side of the test cages out of 108 total observations over a 40-day period. These numbers and also the number of spiders observed on the treated area and the number of spiders dead are shown in Fig. 1-14. Refined malathion, an organophosphate insecticide, at 3.0% and at 2.0% concentrations gave the most repellent action. These results are illustrated in Fig. 1 and 2. The total numbers of spiders observed for the 3.0% and 2.0% concentrations were: on untreated--95 and 72, on treated--13 and 34, and the dead--0 and 2, respectively. The second best repellent chemical was baygon, a carbamate insecticide, at its lower concentration of 0.6%. The repellent data given in Fig. 3 were 72 spiders on the untreated surface, 36 on the treated, and no spiders dead. The third best treatment was CIBA 9491 - 0- (2,5-dichloro-4-iodophenyl) 0, 0-dimethyl phosphorothioate at its lower concentration of 0.5%. The results showed 62 spiders on the untreated side, 43 spiders on the treated, and 3 spiders dead (Fig. 4). The fourth-rated treatment was chlordane, a chlorinated hydrocarbon, at its higher concentration of 3.0%, where the number of spiders recorded for untreated, treated, and dead were 61, 29, and 18, respectively (Fig. 5). Heptachlor, another chlorinated hydrocarbon, depicted in Fig. 6, was rated

next to chlordane with 60 spiders on the untreated side, 22 on the treated, and 26 spiders dead. Fig. 7 and 8 show the data on diazinon at 1.0% concentration and heptachlor at 0.5% concentration where the data were 58, 48, and 2 for diazinon and 56, 52, and 0 for heptachlor. The repellency action of 2.0% chlordane and 1.1% baygon are essentially the same (Fig. 9 and 10). The results for 0.5% diazinon (Fig. 11) showed equal numbers of 50 spiders on each of untreated and treated with 8 spiders dead. This indicates that diazinon at its lower concentration is not an effective repellent. Fig. 12, 13, and 14 show that 1.0% CIBA 9491, 0.5% dieldrin, and 1.0% dieldrin were less effective repellents because there were more spiders observed on the treated side than the untreated.

Therefore, the results from these data indicate that the insecticides that proved to have the most toxic and long-lasting effects in the mortality test were not the best insecticides to use for repellent purposes at the concentrations used. This is especially true of the insecticide dieldrin where high mortality rates were recorded making it impossible to make valid repellency readings.

Total Evaluation of the Candidate Insecticides at Their Various Concentrations - The total evaluation of the candidate insecticides at their various concentrations as a group is shown in Fig. 15. The evaluation of the candidate insecticides is based on the total number of spiders observed resting on the untreated sides of the test cages over a 40-day period. The repellency of the 7 candidate insecticides at their various concentrations ranged from 35 to 95 spiders out of a possible 108 total observations.

Relative Number of Spiders Observed in a Grain Bin, January - May, 1970

During the population study the number of observed spiders fluctuated from 85 on January 23 to 234 on May 11, except on March 24 when only 72 spiders were observed. The temperature ranged from 30°F on February 2 to 75°F on May 11. The humidity fluctuated from 41% on April 17 to 85% on March 1 and April 21. The data for this study are shown in Fig. 16. During the periods of observation the spiders became immobile at temperatures below 41°F. At temperatures from 40°F to about 44°F the spiders, if touched, would move their limbs very slowly but become completely inactive at temperatures below 40°F. Hite (1966) also found that the spiders became immobile at 40°F under lab conditions. Throughout the cold season the spiders' abdomens were very light in color, but as they became more active and the temperatures increased, their abdomens became darker in color, presumably because the spiders began to feed as the temperatures increased. Also in periods of warmer temperatures some of the spiders molted and in April the numbers of spiders increased greatly because of the newly hatched spiderlings. This period of population increase may prove to be the best time for chemical control, because of the susceptibility of the young spiderlings.

SUMMARY AND CONCLUSIONS

Mortality from Residual Insecticides

Seven insecticides, at 2 different dosage rates each, were tested against the *Loxosceles reclusa* spider. The tests of mortality and residual effects were conducted over a 60-day period, using the same insecticide-treated surfaces. The insecticide receiving the highest mortality and the longest residual action was dieldrin, a chlorinated hydrocarbon, at both of its concentration, 0.5% and 1.0%. The organophosphates and carbamate tested failed to produce as good results as some of the chlorinated hydrocarbons. Therefore, the chlorinated hydrocarbons tested proved to be the best insecticides to use for the control of the brown recluse spider. Also it was found that newly molted spiders were very susceptible to all insecticides tested.

Mortality from Residual Insecticides on 3 Types of Surfaces

Sheetrock Surface Evaluation - Four insecticides, at 2 different dosage rates each, were tested on this type surface to evaluate their mortality and residual effects against the brown recluse spider over a 20-day period. The insecticide dieldrin at its higher concentration gave the best mortality and residual effects, possibly because of its extremely long-lasting residual properties.

Plywood Surface Evaluation - Four insecticides, at 2 different dosage rates each, were tested on this type surface to evaluate their mortality and residual effects against the brown recluse spider over a

20-day period. The insecticide dieldrin at its concentration of 1.0% again gave the best mortality and residual effects. Again it is possible that dieldrin produced the best results because of its long residual action and toxic effects. Even though it could have been absorbed into the plywood it would still perhaps stay on the surface longer than the other insecticides tested.

Tile Surface Evaluation - Four insecticides, at 2 different concentrations each, were tested on this type surface to evaluate their residual and mortality effects over a 20-day period. The insecticide dieldrin again produced the best residual and mortality effects at its higher concentration of 1.0%. Dieldrin received 100% mortality for the first 10 days and 75% mortality at 20 days. Diazinon and baygon followed dieldrin with 100% mortality up to 10 days but dropped to 25% at 20 days. The chlorinated hydrocarbon insecticides again gave a longer-lasting residual and toxic action than did the organophosphates and carbamate tested on different types of surfaces.

Repellent Effect of Residual Insecticides

Seven insecticides, at 2 different concentrations each, were used to test for repellency action against the brown recluse spider. These tests were conducted for 40 days to evaluate how repellent the insecticides at their various concentrations were against the spider. These preliminary tests showed malathion to be the most repellent insecticide at both the 3.0% and 2.0% concentrations, and dieldrin showed the least repellent action of the insecticides tested at both of its concentrations of 0.5% and 1.0%. The reason for dieldrin being placed last in the repellency test was probably the result of its high mortality rate at the concentrations used. With this high mortality rate, very few spiders were left in the test for the repellency evaluation.

Relative Number of Spiders Observed in a Grain Bin, January - May, 1970

In the population study during the months of January through May there seems to be a correlation between the temperature and the number of spiders observed. When the temperature decreased, the number of spiders declined as did the mobility of the spiders. As the temperatures increased, the number of spiders observed increased as did the mobility of the spiders. Results indicate that temperature and possibly humidity govern the number of spiders and their activity in an environment. This information indicates that chemical control of the brown recluse spider may be best when population numbers began to increase rapidly.

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APPENDIX

Table 1. Spider mortality from short-term exposure to residual insecticides on chromatography paper.[a]

		Per cent Mortality Hours of Exposure										
Insecticide	Dosage Rate %	1	2	3	4	5	6	7	8	12	24	48
Heptachlor	0.5	0	0	0	50	50	100					
Heptachlor	1.0	0	0	0	50	75	100					
Dieldrin	0.5	0	0	0	0	50	100					
Dieldrin	1.0	0	0	0	25	50	75	100				
Chlordane	2.0	0	0	0	0	0	0	25	50	75	100	
Chlordane	3.0	0	0	0	0	25	75	75	75	75	100	
Baygon	0.6	0	0	0	0	0	0	25	25	50	50	75
Baygon	1.1	0	0	0	25	25	25	25	25	25	25	75
Diazinon	0.5	0	0	0	0	0	0	0	0	0	25	25
Diazinon	1.0	0	0	0	0	0	0	0	0	25	50	100
CIBA 9491	0.5	0	0	0	0	0	0	0	0	0	25	50
CIBA 9491	1.0	0	0	0	0	0	0	0	0	0	0	25
Malathion	2.0	0	0	0	0	0	0	0	0	0	0	25
Malathion	3.0	0	0	0	0	0	0	0	0	0	0	0
Check	-	0	0	0	0	0	0	0	0	0	0	0

[a]Papers were treated and dried for 1 hr before testing was begun.

Table 2. Spider mortality from exposure to residual insecticides on chromatography paper at 7 to 60 days after treatment.

		Per cent Mortality Days after treatment[a]				
Insecticide	Dosage Rate %	7	14	21	30	60
Dieldrin	0.5	75	100	100	100	100
Dieldrin	1.0	100	100	100	100	100
Chlordane	2.0	100	75	50	0	0
Chlordane	3.0	50	75	25	75	0
Heptachlor	0.5	0	25	25	50	0
Heptachlor	1.0	25	100	50	50	0
Diazinon	0.5	25	0	0	50	0
Diazinon	1.0	100	25	0	75	25
CIBA 9491	0.5	25	0	50	25	25
CIBA 9491	1.0	25	25	25	75	25
Baygon	0.6	0	25	0	0	0
Baygon	1.1	0	0	25	0	0
Malathion	2.0	0	75	0	0	0
Malathion	3.0	25	25	25	0	0
Check	-	0	0	0	0	0

[a]3-day exposure period.

Table 3. Per cent spider mortality from exposure to residual insecticides on painted sheetrock.

		Period After Treatment When Exposure Began[a]		
Insecticide	Dosage Rate %	1 hr	10 day	20 day
Dieldrin	0.5	100	0	25
Dieldrin	1.0	100	100	25
Chlordane	2.0	50	25	0
Chlordane	3.0	100	50	25
Baygon	0.6	25	0	25
Baygon	1.1	75	25	25
Diazinon	0.5	0	25	0
Diazinon	1.0	75	0	25
Check	-	0	0	0

[a]3-day exposure period.

Table 4. Per cent spider mortality from exposure to residual insecticides on painted plywood.

Insecticide	Dosage Rate %	Period After Treatment When Exposure Began[a] 1 hr	10 day	20 day
Dieldrin	0.5	100	25	0
Dieldrin	1.0	100	100	25
Chlordane	2.0	25	0	0
Chlordane	3.0	50	100	0
Baygon	0.6	25	25	0
Baygon	1.1	50	50	50
Diazinon	0.5	0	0	0
Diazinon	1.0	0	25	25
Check	-	0	0	0

[a] 3-day exposure period.

Table 5. Per cent spider mortality from exposure to residual insecticides on tile.

Insecticide	Dosage Rate %	Period After Treatment When Exposure Began[a] 1 hr	10 day	20 day
Dieldrin	0.5	75	100	75
Dieldrin	1.0	100	100	75
Chlordane	2.0	100	25	25
Chlordane	3.0	100	50	75
Diazinon	0.5	100	50	0
Diazinon	1.0	100	100	25
Baygon	0.6	75	50	0
Baygon	1.1	100	100	25
Check	-	0	0	0

[a]3-day exposure period.

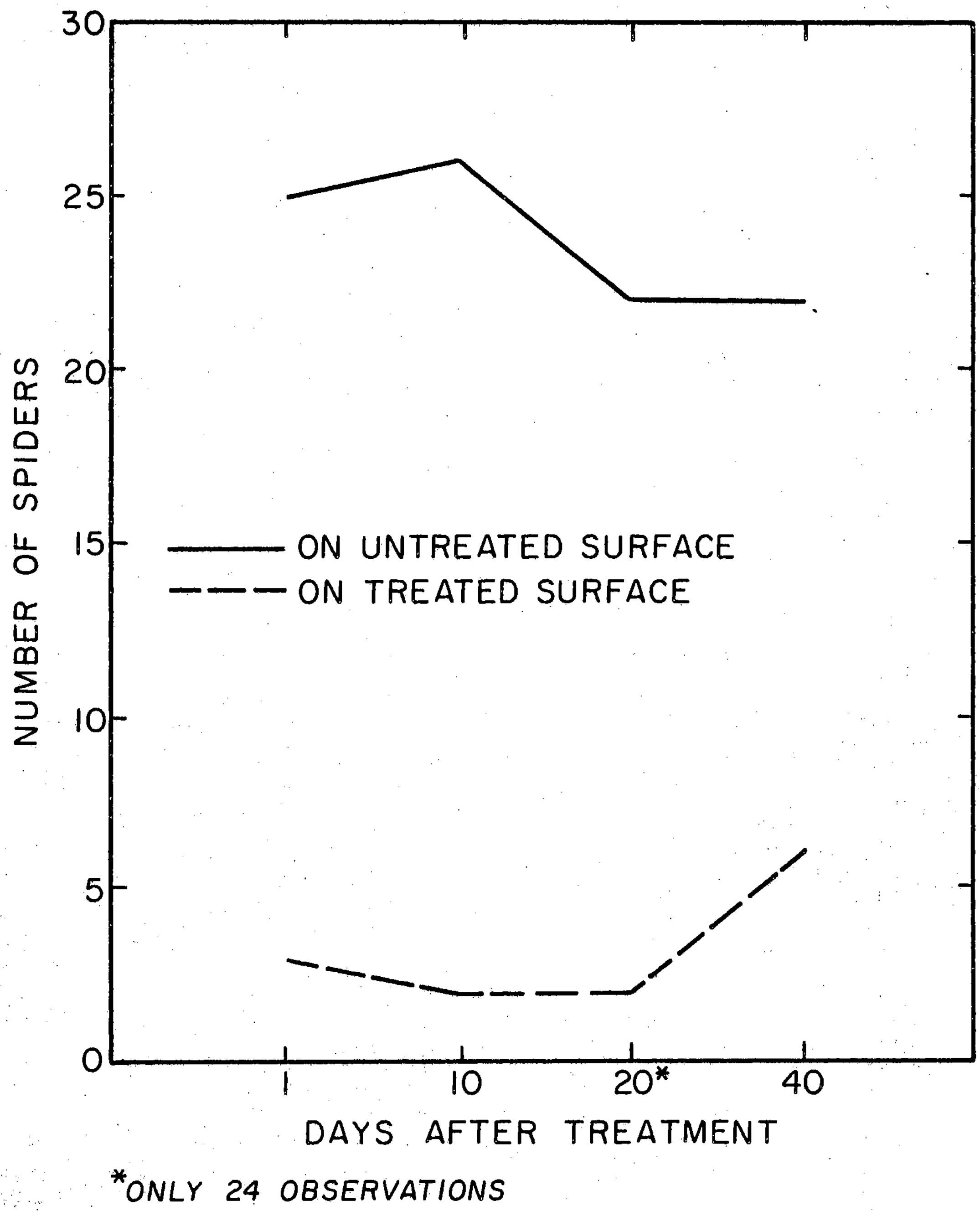
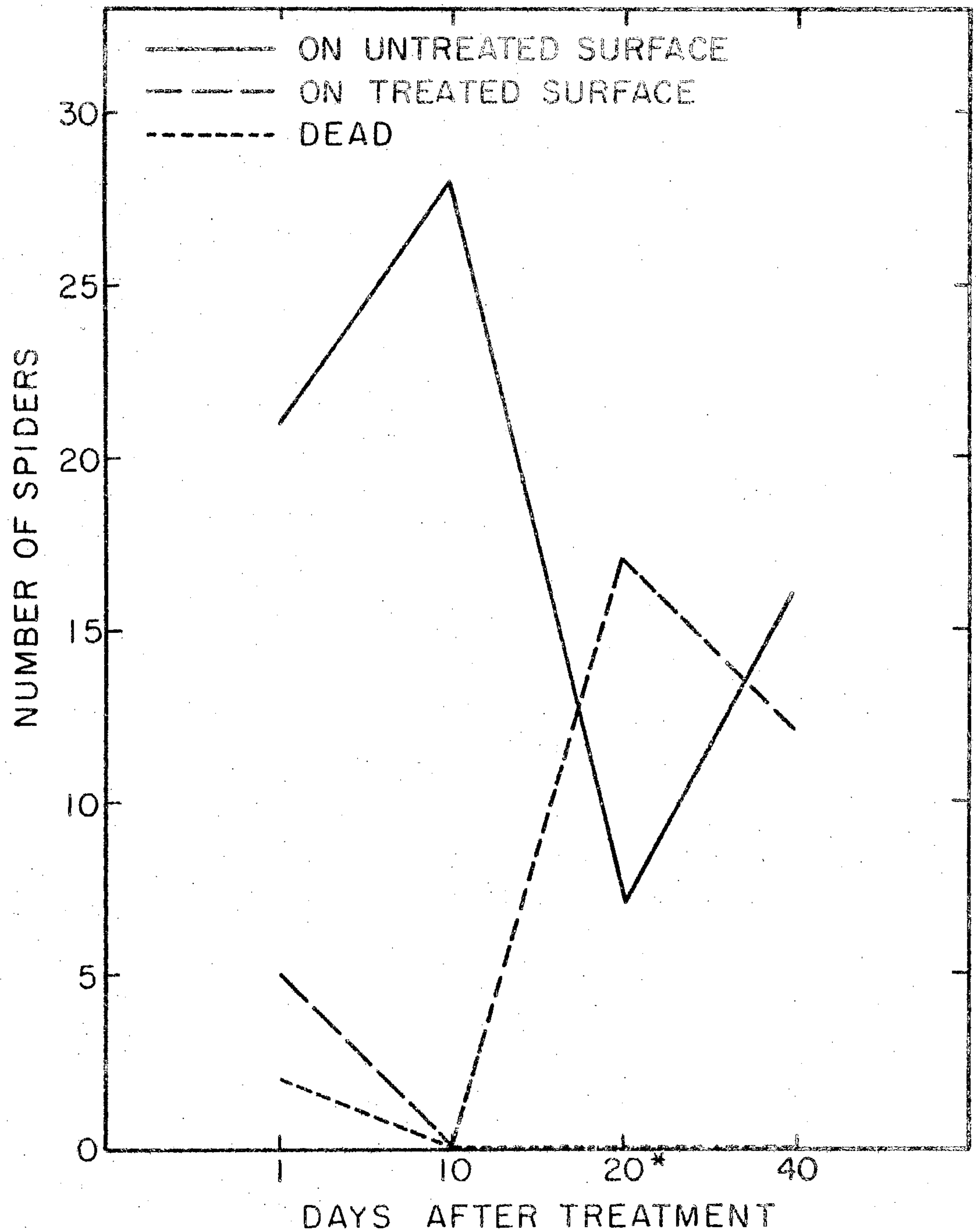


Fig. 1. Repellency of malathion at 3% concentration to spiders.



*ONLY 24 OBSERVATIONS

Fig. 2. Repellency of malathion at 2% concentration to spiders.

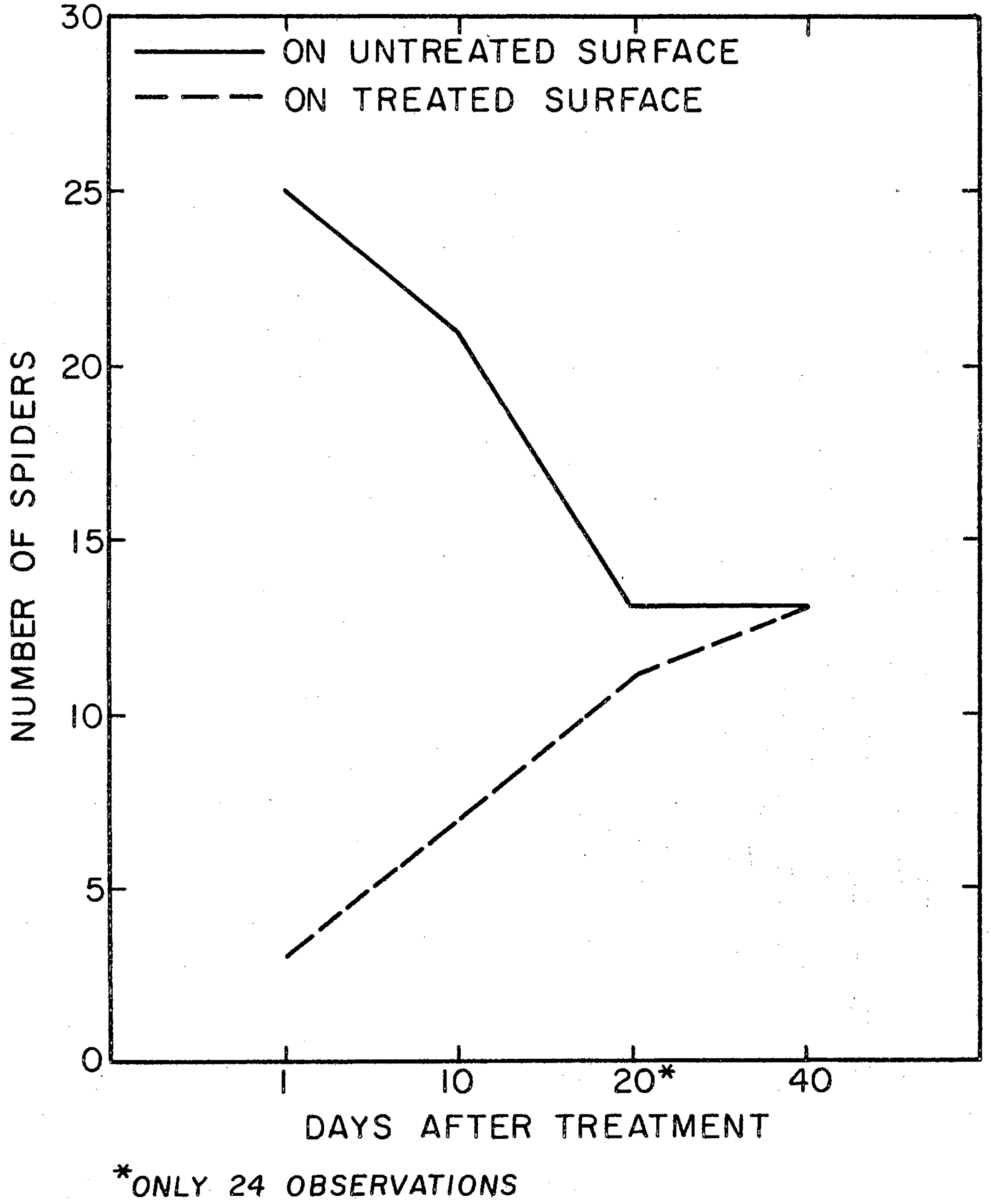


Fig. 3. Repellency of baygon at 0.6% concentration to spiders.

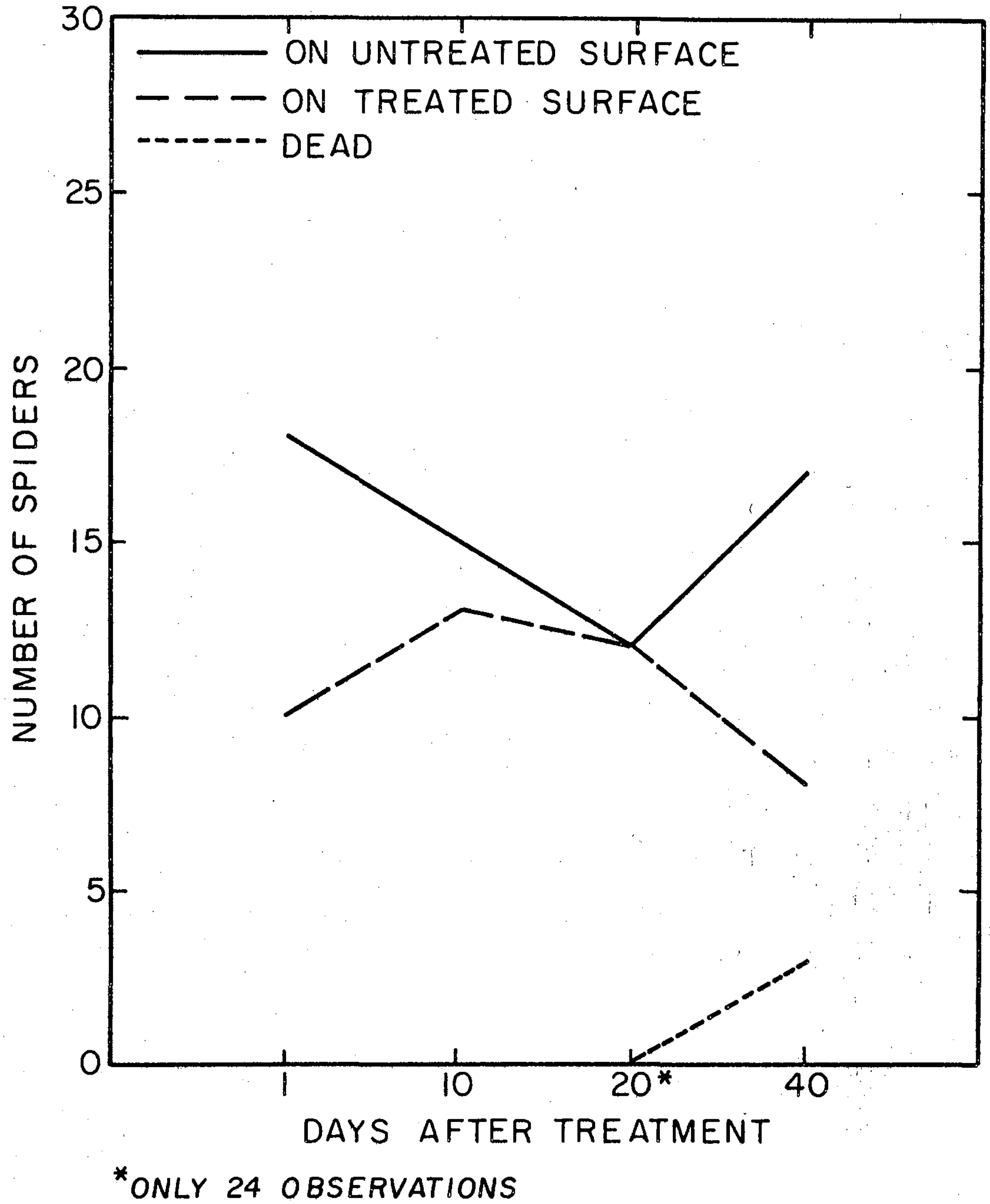


Fig. 4. Repellency of CIBA 9491 at 0.5% concentration to spiders.

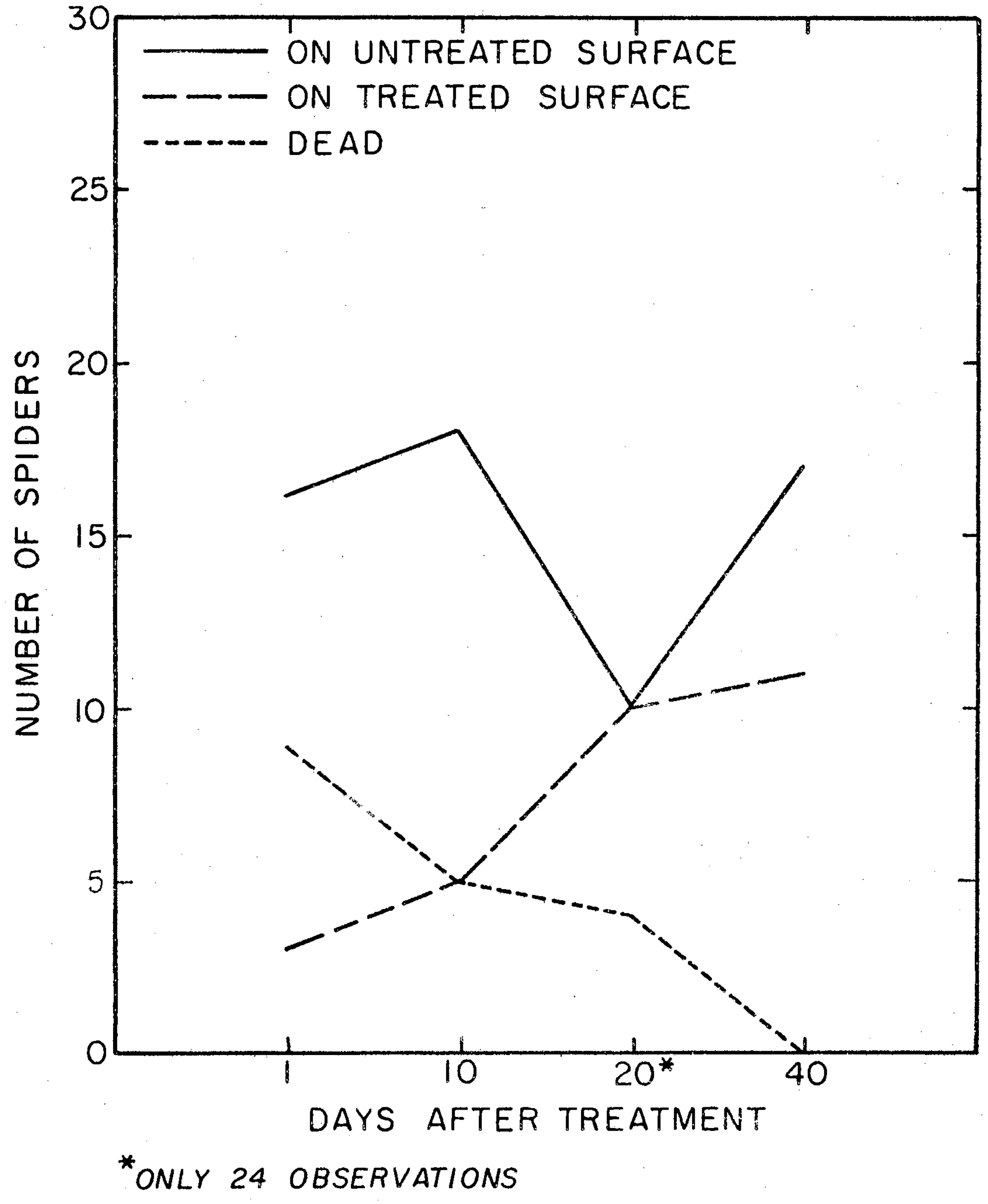


Fig. 5. Repellency of chlordane at 3% concentration to spiders.

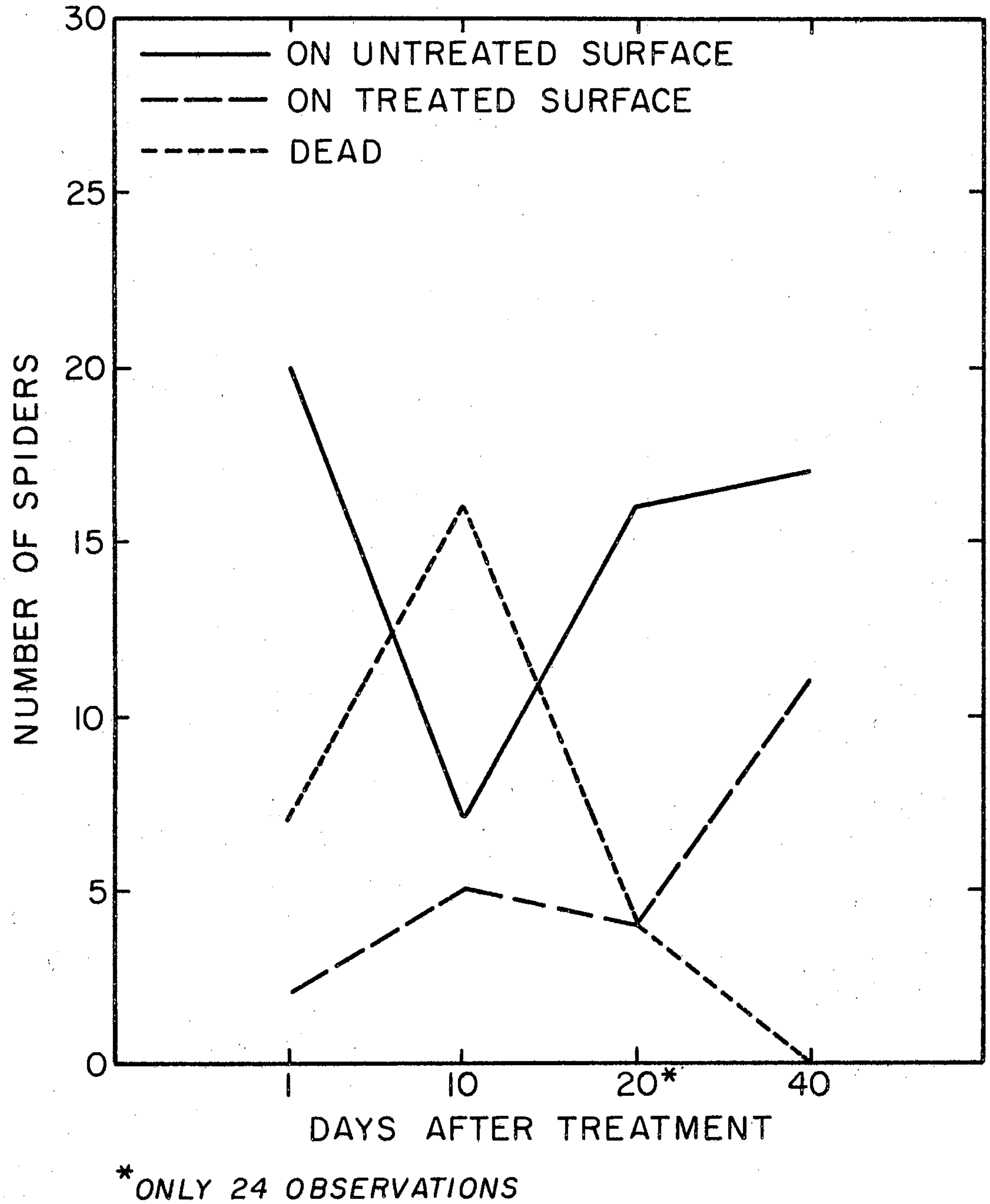


Fig. 6. Repellency of heptachlor at 1.0% concentration to spiders.

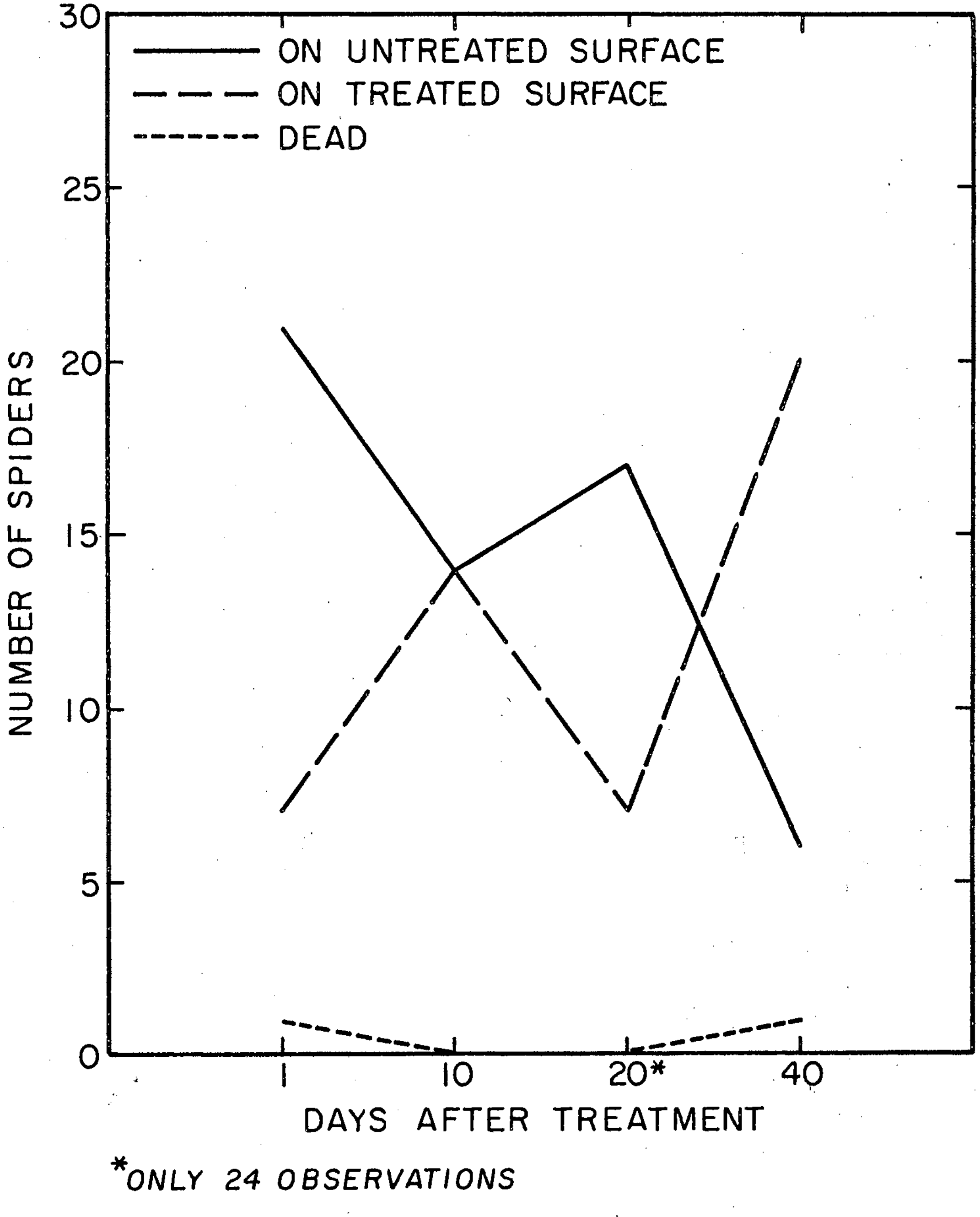


Fig. 7. Repellency of diazinon at 1.0% concentration to spiders.

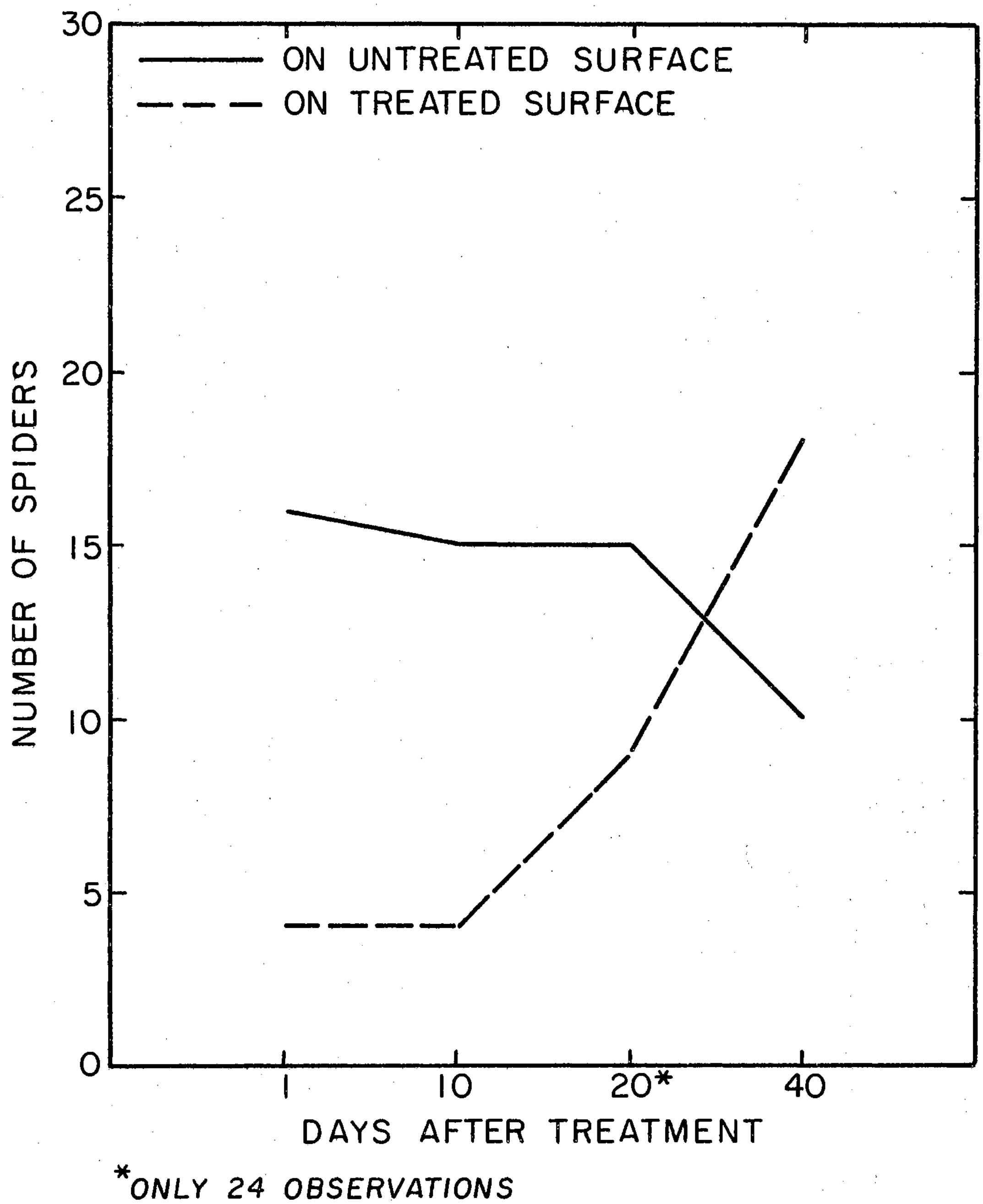


Fig. 8. Repellency of heptachlor at 0.5% concentration to spiders.

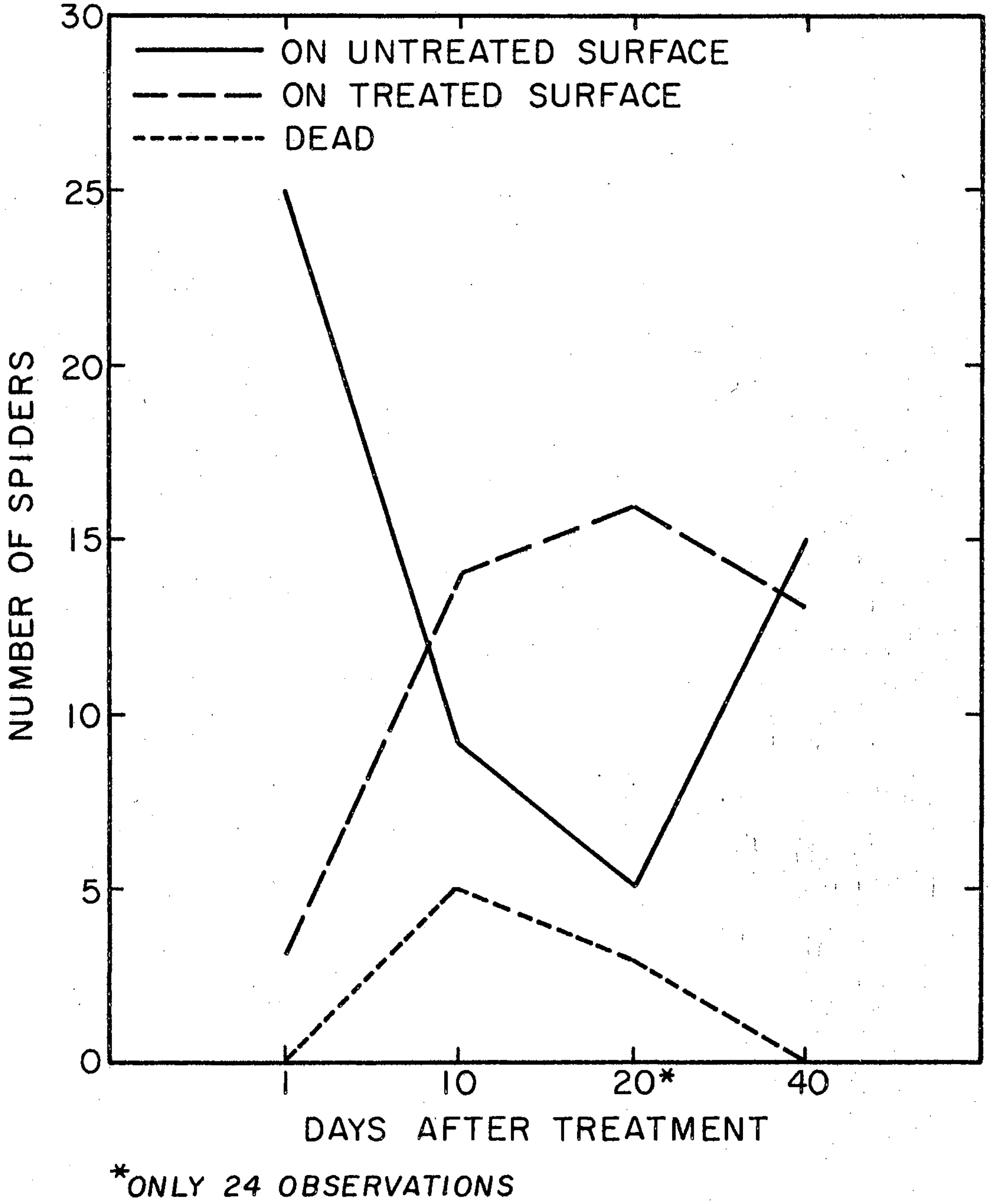


Fig. 9. Repellency of chlordane at 2% concentration to spiders.

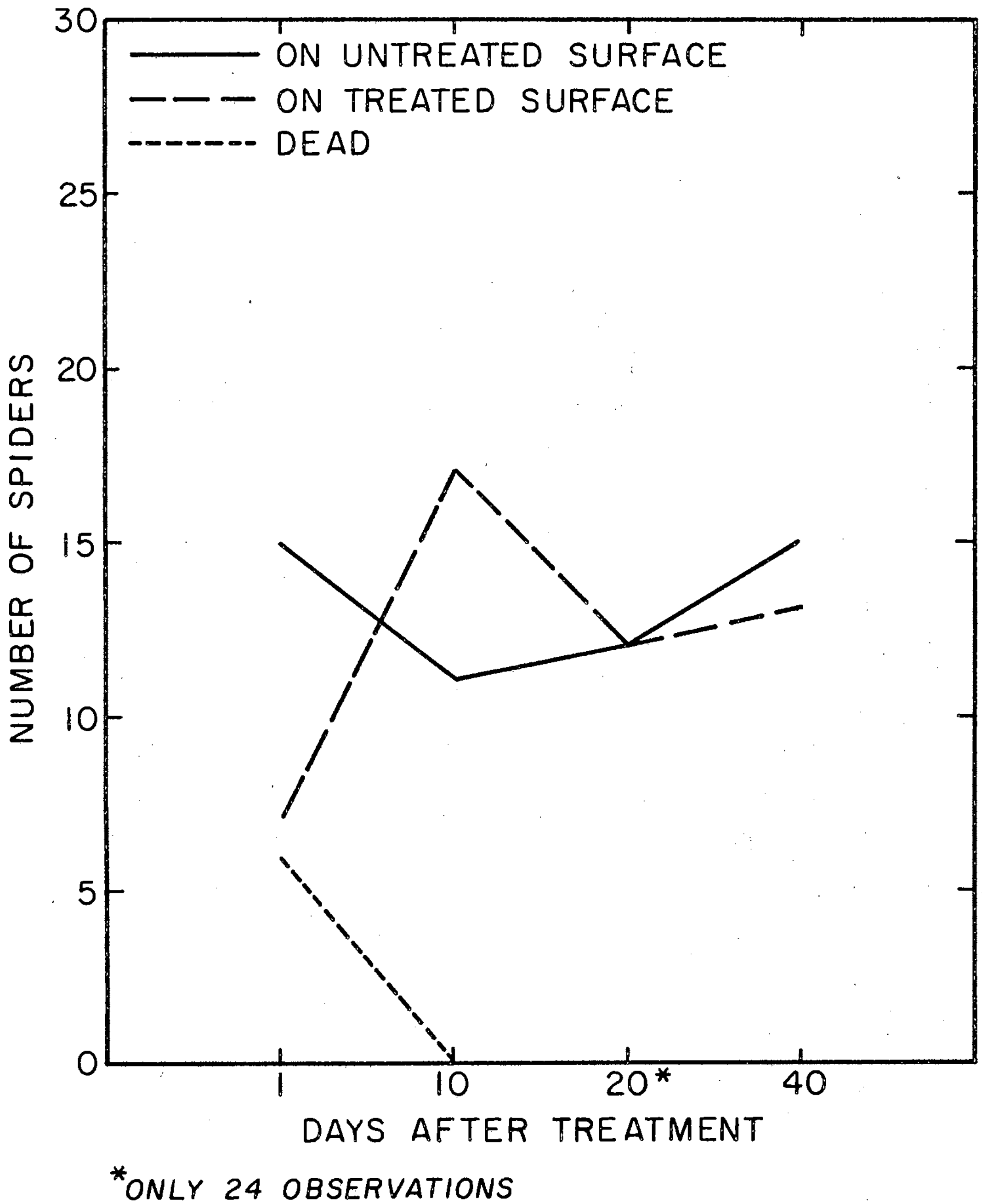


Fig. 10. Repellency of baygon at 1.1% concentration to spiders.

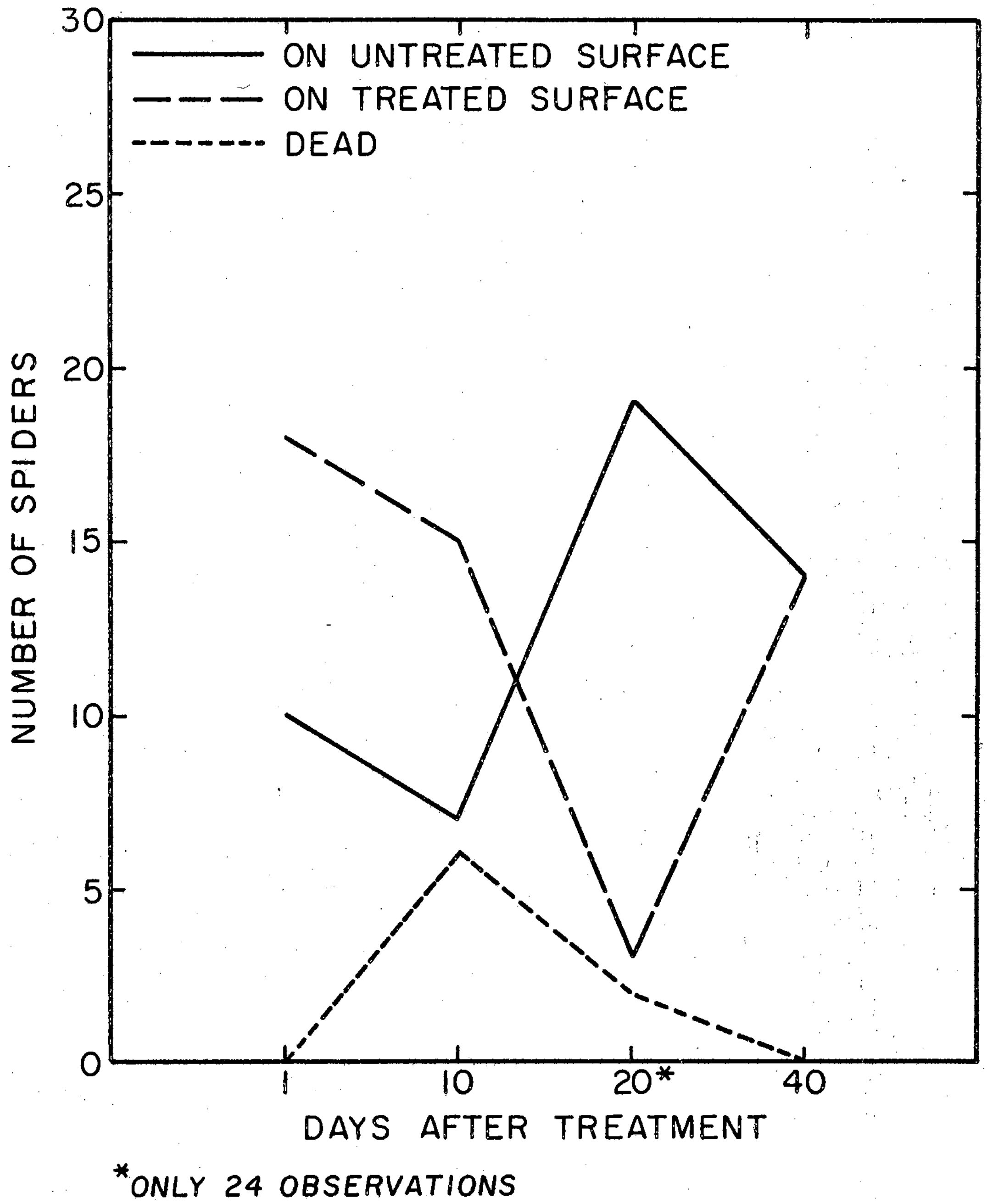


Fig. 11. Repellency of diazinon at 0.5% concentration to spiders.

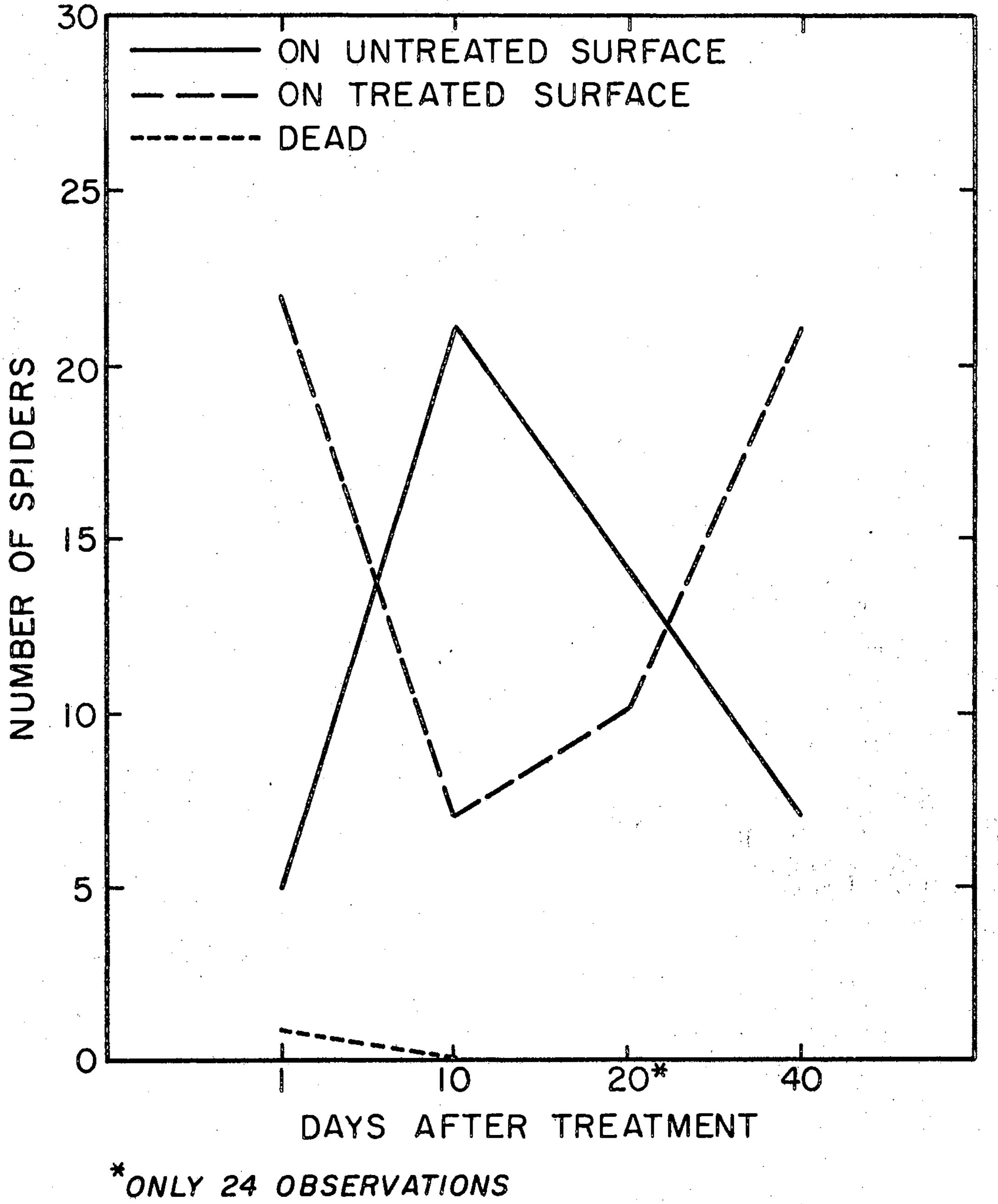


Fig. 12. Repellency of CIBA 9491 at 1.0% concentration to spiders.

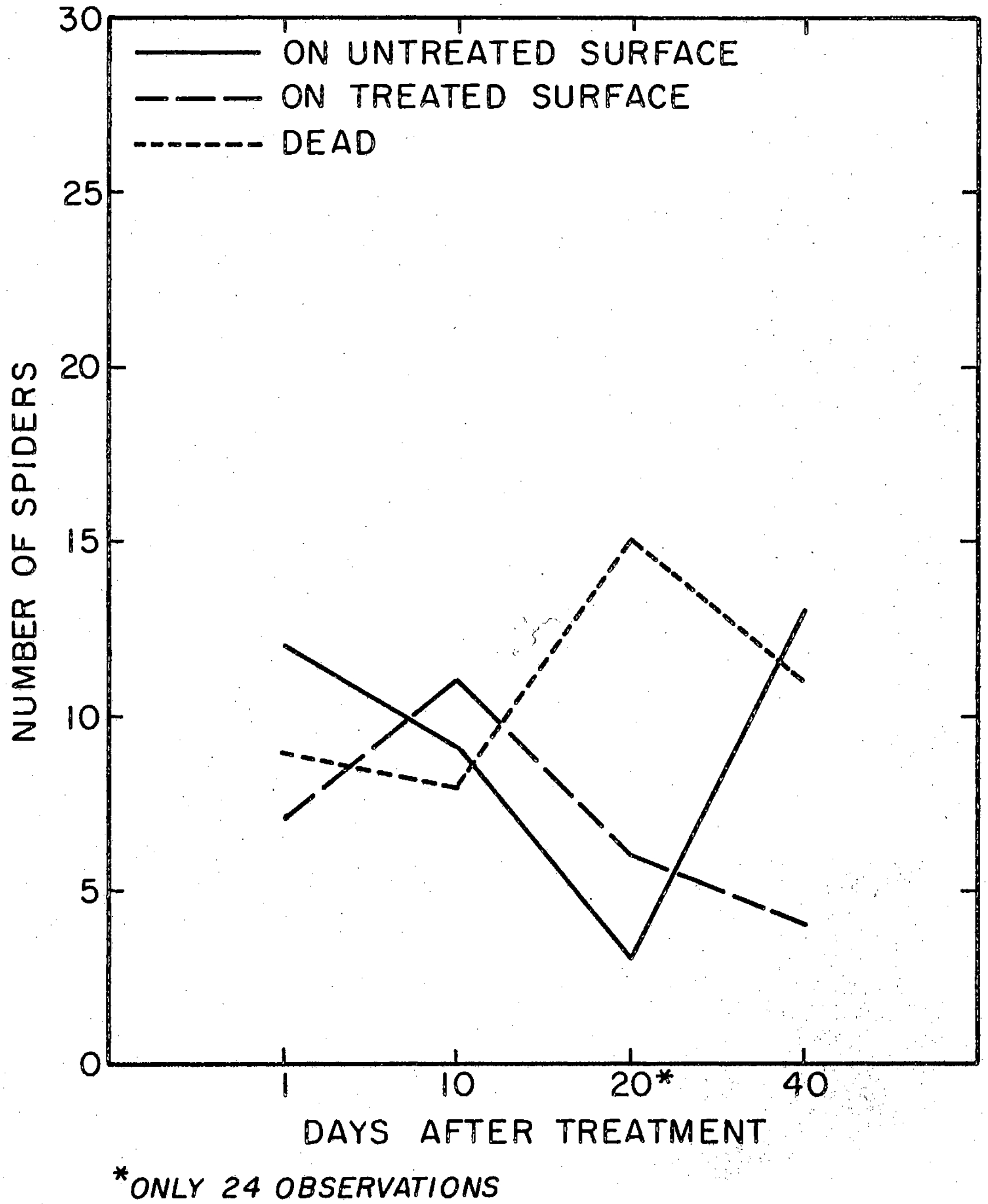


Fig. 13. Repellency of dieldrin at 0.5% concentration to spiders.

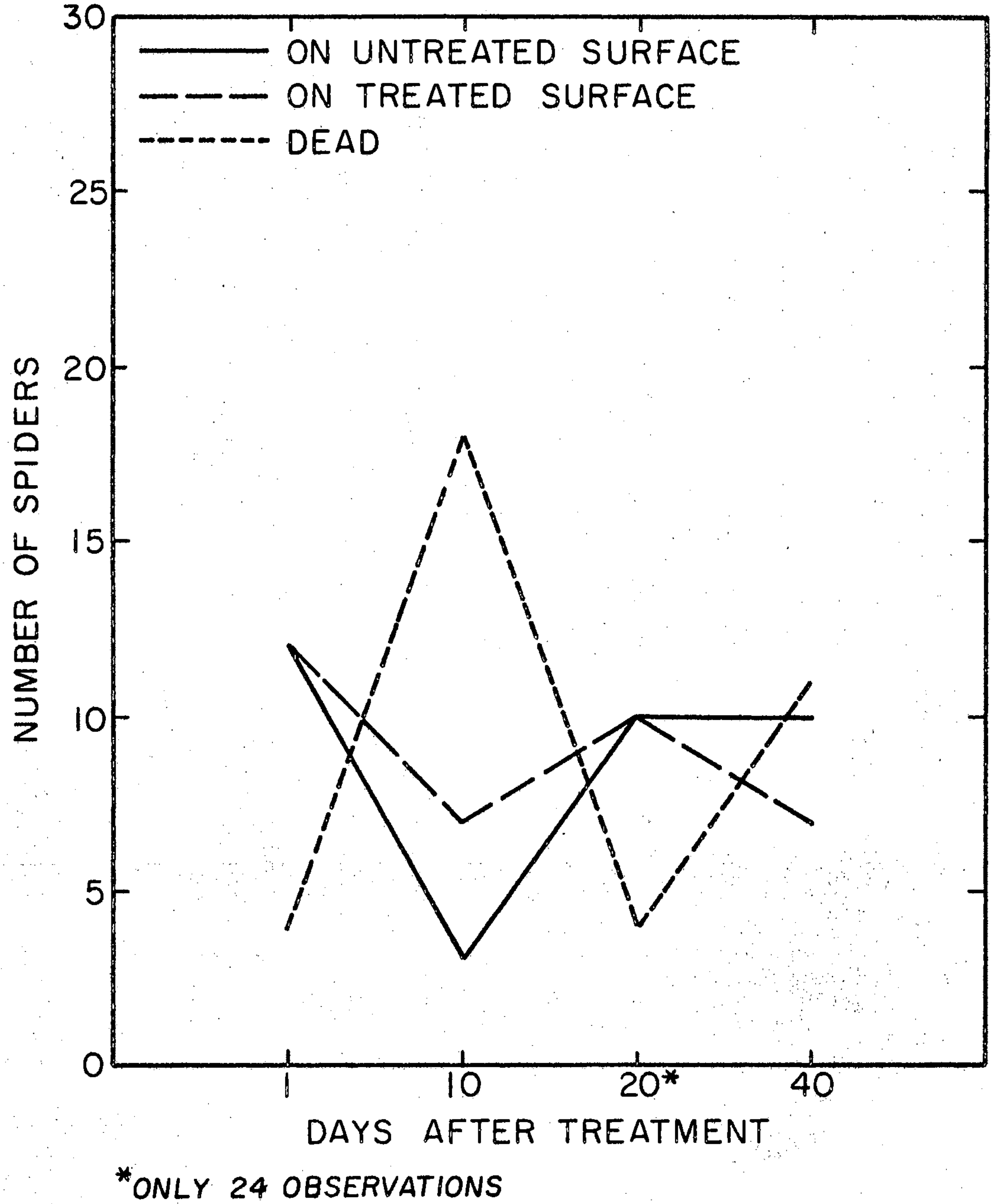


Fig. 14. Repellency of dieldrin at 1.0% concentration to spiders.

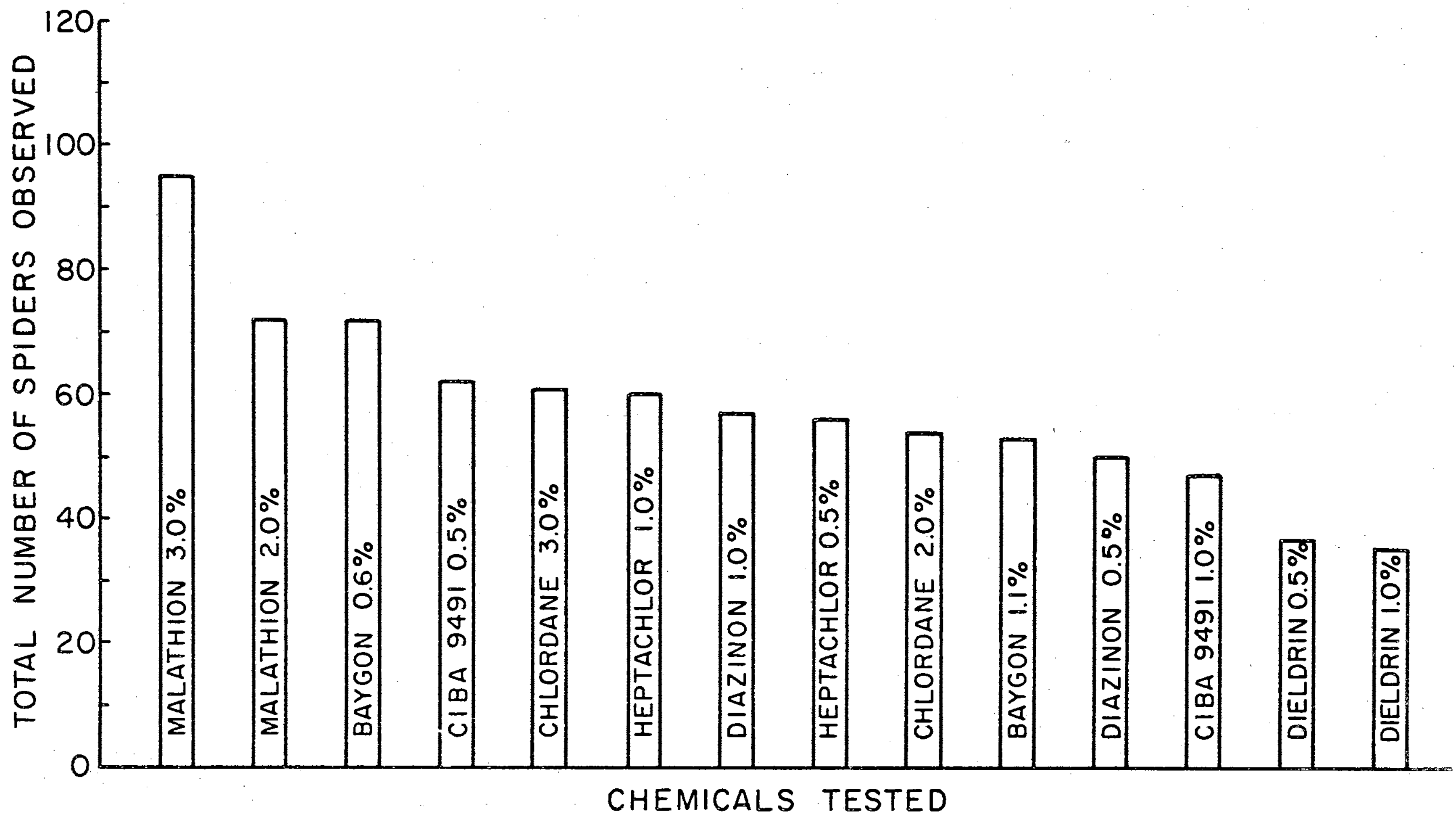


Fig. 15. Repellency effect of 7 different insecticides at two different dosage rates against the brown recluse spider as indicated by number of spiders resting on the untreated half of test cages.

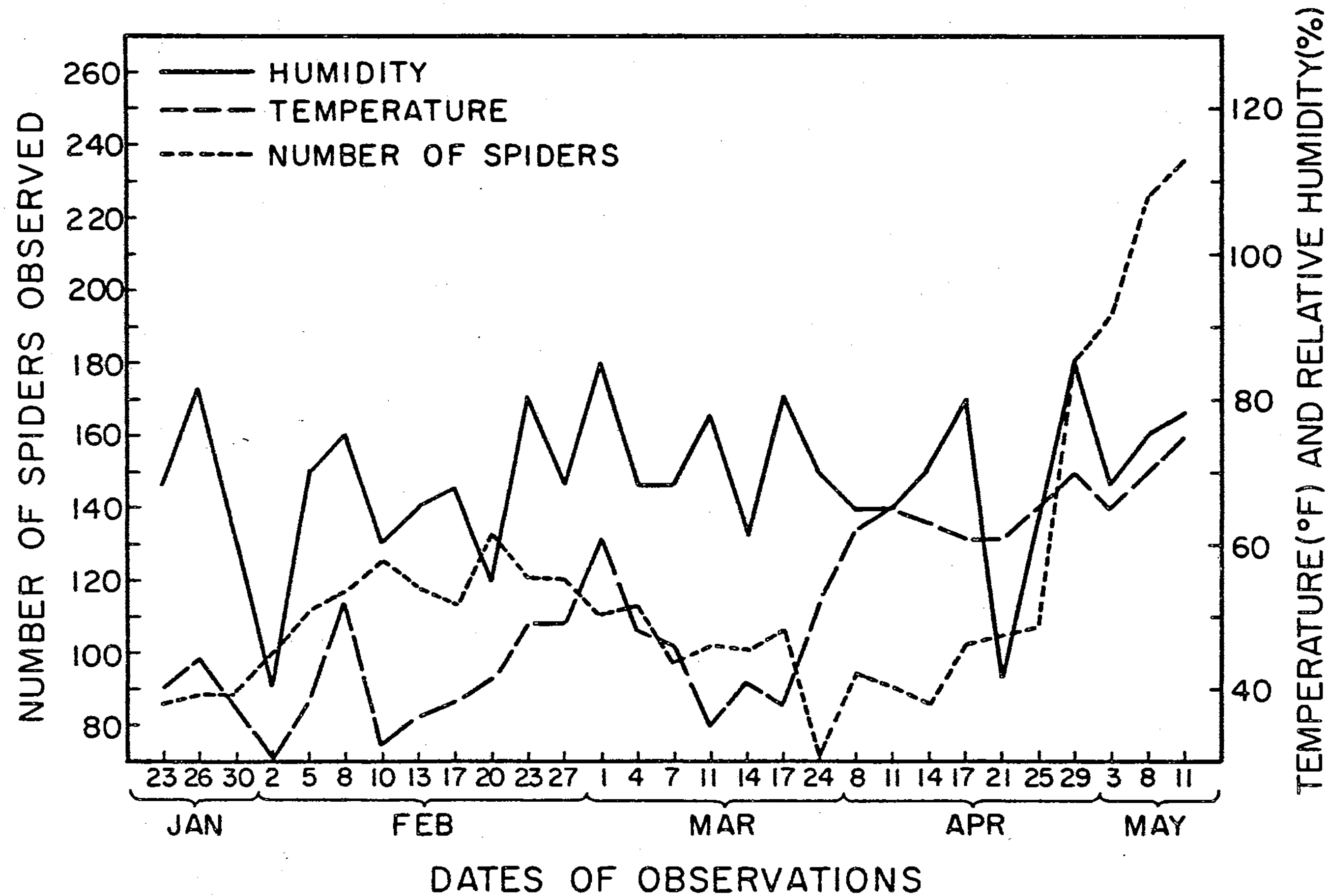


Fig. 16. Relative numbers of spiders observed in a grain bin, January-May, 1970.

VITA

Harold Ray Sterling

Candidate for the Degree of

Master of Science

Thesis: INSECTICIDE EVALUATION AND POPULATION STUDY WITH THE BROWN RECLUSE SPIDER, *LOXOSCELES RECLUSA*

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