GERMINATION OF SEEDS AFTER INGESTION BY RINGNECK PHEASANTS

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I also wish to thank Robert G. Ohlman, Frank and John Craighead, and Philip Barske for their many helpful ideas and suggestions which were made, unknowingly at the time during "bull sessions" and discussions.

A mere acknowledgment is inadequate for the help given by the late Professor H. M. Wight. Through his ability to comprehend the problems which confront budding wildlife technicians, I, like many other students, was guided by him to problems of importance and was given encouragement and inspiration until these problems were completed.

INTRODUCTION

In spite of the fact that it is an age old question, very little factual work has been published concerning seed dispersal by birds. If it is possible for a bird to eat a fruit at one place, and to deposit the seeds in a viable condition at another, the worthwhile part that birds play in dissiminating food-bearing plants for game would be established.

Judd, (1902), sent to the Botanical Division of the Dept. of Agriculture some seeds which he had obtained from crow pellets. Mr. A. J. Peiters, of the Department of Agriculture, germinated some of these seeds, thus demonstrating that regurtated seeds of fruits eaten by crows are distributed in a viable condition. Judd, (1902), in connection with birds on a Maryland farm states, " The large consumption of wild fruits results in a wide distribution of seeds, which are voided by birds, and which germinate where they are dropped." There is no doubt then that ornithologists have long recognized the part played by birds in seed dispersal, but there has been very little scientific investigation along this line.

Many wildlife technicians have been inclined to believe that birds obtain very little food value from fruits which are eaten in late winter. Seeds of these fruits are usually very hard, and many technicians have been dubious as to whether it is possible for birds of the order galliformes, which includes most of our upland game birds, to

break the seed coat and digest the kernel within. Errington, (1936), says, " With exhaustion of the available staple foods, the quail tends to fill up on fruits of sumach, wildgrape, rose, coralberry and sundry others of fleshy consistency or composed principally of indigestable seeds.

Barske, (1943), however, has proven that wild rose, sumach, grape, and nightshade seeds, after being broken into a mash form, are a very good staple food for ringneck pheasants.

This thesis is concerned with determining whether seeds ingested by the ringneck pheasant are viable after passing through the digestive tract, and the amount of seeds assimilated by this game bird. If a great percentage of these seeds can be assimilated it will prove without a doubt, in conjunction with Barske's findings, that these winter fruits contain great food value.

FIELD WORK

Every scientific study must have a beginning so this problem was started in the field. Some clue was sought which would lead to the types or species of seeds most likely to pass through the digestive tract of pheasants and still retain their viability. In the hope of finding whole seeds which had passed through the birds, droppings were collected in the field and analyzed. The collecting began in February and continued until May, at which time the droppings disinegrated rapidly. From laboratory analysis it was found that there were very few seeds in droppings after May 1st, and that most of the food consumed consisted of green vegetation; therefore, the collecting of droppings in the wild was discontinued.

In many cases a great variation of time existed between the time the droppings were voided by the birds and the time collected. Some droppings were collected the same day they were voided, while others remained in the snow for days and even months before being collected and taken to the laboratory for analyzation. All droppings were counted so as to give some idea of relative quantities of seeds to the total volume or number of droppings. One dropping was considered to be that amount deposited by one bird at one time.

Droppings from the field were taken to the laboratory and analyzed as soon as collected. They were placed

in a soil sieve and water was run through them until each particle that made up the droppings was distinquishable. Seeds and fragments of seeds were identified by using ten power binoculars and Ball's, (1939), seed key. The unbroken seeds were counted, put between moist blotters and kept at room temperature to test their viability.

RESULTS OF DROPPINGS COLLECTED IN THE FIELD

PHEASANT DROPPINGS

Seventy-five sets of droppings were collected during the months of February, March and April. Most of them were obtained from many different locations on Superior Township, Washtenaw County, Michigan. This township is typical of Southern Michigan farmland, consisting of cultivated areas, pasture lands, woodlots, and abandoned fields.

The seventy-five sets examined contained ninety-four whole seeds of eleven different species. Twenty-seven of these seeds were viable. This represents a 26.6% germinating capacity of all whole seeds collected in the field.

A study of table (1) reveals that seventy-five percent of the nightshade seeds germinated. This was the greatest percentage of all species of seeds collected. Another interesting fact was revealed when it was found that two of the seeds had started germinating before they were picked up, this being long before the usual germinating period.

Staghorn sumach seeds taken from droppings collected on March second had also started germinating.

Observations from this work would suggest that seeds of some species when embedded in droppings germinate more quickly than those embedded in soil, but a limited number of laboratory experiments gave no conclusive results. To obtain enough data upon which to base definite conclusions would be a study in itself, therefore it was left for future work. Perhaps droppings generate heat, thereby supplying the heat requirements for seed germination before heat from the sun is present in sufficient quantities to break the inertia of the seeds. Perhaps it is action by the digestive juices within the bird; or perhaps abrasive action, or a combination of many factors.

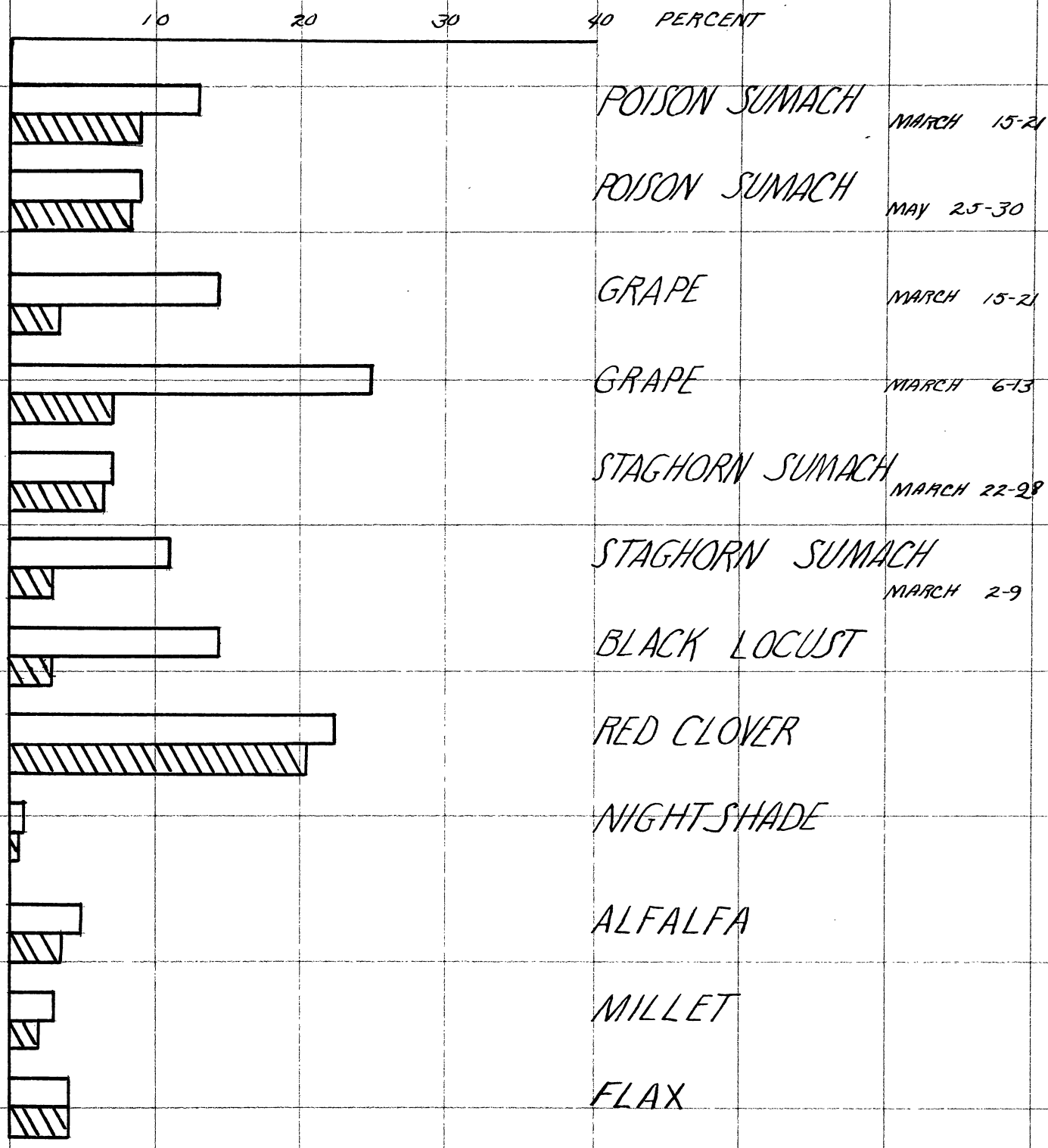
Examination of table (1) will show that the combined totals of Rosa spp. and Common Plaintain made up approximately two-thirds of the total number of seeds collected. None of these seeds germinated, thus proving that the inherit dormancy of these species was not broken by either ingestion by birds or by cold weather. Seeds enclosed in droppings may not undergo low temperatures, thus one of the necessary factors, as stated by Crocker and Barton, (1931), concerning germination of Rosa spp. seeds, would be lacking. No success was obtained by the writer in germinating Rosa spp. seeds.

Many attempts were made to obtain plantain seeds in sufficient quantities for feeding experiments, but at the time this study was started they were unavailable. This species occurred four different times, but the droppings

Table No. 1

RESULTS FROM PHEASANT DROPPINGS COLLECTED IN THE FIELD

Date collected	No. of droppings collected	Species Of Whole Seeds Found	Number of Seeds Found	Percent of Seeds that Germinated	No. of Days For 10% To Germinate
2-14-42	11	Poison Sumach	3	66.6	13
2-15-42	8	Wild Raspberry	5	0.0	-
2-20-42	14	Clover	32	62.0	16
3- 2-42	11	Staghorn Sumach	9	44.4	2
3- 8-42	18	Wild Raspberry	1	0.0	-
		Wild Rose	30	0.0	-
		Clover	5	80.0	12
		Nightshade	5	75.0	12
3- 8-42	20	Cinquefoil	2	0.0	-
		Common Plantain	1	0.0	-
		Clover	1	100.0	16
4- 1-42	18	Catnip	2	100.0	24
		Wild Rose	1	0.0	-
4-21-42	1	Common Plantain		0.0	-
		Wild Raspberry	1	0.0	-
4-21-42	6	Pigweed	8	100.0	10
		Common Plantain	3	0.0	-
		Wild Mustard	1	0.0	-
4-25-42	16	Common Plantain	23	0.0	-


10
20
30
40
PERCENT
POISON SUMACH
MARCH 15-21
POISON SUMACH
MAY 25-30
GRAPE
MARCH 15-21
GRAPE
MARCH 6-13
STAGHORN SUMACH
MARCH 22-28
STAGHORN SUMACH
MARCH 2-9
BLACK LOCUST
RED CLOVER
NIGHTSHADE
ALFALFA
MILLET
FLAX
PERCENTAGE OF SEEDS PASSED OF THOSE INGESTED
PERCENTAGE OF SEEDS GERMINATING OF THOSE INGESTED

collected on April 25, accounted for the major portion of whole seeds. The birds must have picked up the seeds from the ground, for at no time could seeds on the plant be found by the writer.

Other whole seeds found in droppings in such limited quantities as not to merit experimental feeding were: cinquoifoil, catnip, pigweed, and mustard. This group made up only 12.2% of the total seeds found. Pigweed, eight seeds, which were found in only one set of droppings, made up 66.6% of this last group.

DROPPINGS FROM OTHER GALLANICIOUS BIRDS

In order to make a limited comparison between the Ringneck Pheasant and other Gallanicious birds, a small number of droppings were collected from Bob-white quail and Ruffed Grouse.

Upon four different occasions quail droppings were collected from covey roosting spots for one night. The collection dates ranged from February 20 to April 21, at which time dispersal of quail flocks took place on the area studied. At this time disintegration of droppings had also started. Only once were whole seeds found in quail droppings, these being three small ones of the family Verbena, probably Verbena hastata.(Blue vervain) The fact that only three very small unbroken seeds were found is reason enough to make the writer believe that size of seed ingested and size of the bird ingesting the seed has much to do with the viable condition of a seed after passage through the digestive tract. Two (66%) of the

Verbena seeds were found viable.

One set of Grouse droppings was collected on March 5, this being the only collection for this species of Gallanicious bird. Two whole Wild Rose seeds were found, but these seeds failed to germinate, the same as in all other instances of this species of plant.

FIELD PLOTS

In order to determine the time required and the factors contributing to the disintegration of droppings, ten field plots with droppings on them were established. All of the plots were covered with an upland grass-shrub-herbaceous vegetative type. The lower vegetation, which somewhat governed the ecology of the droppings, was composed principally of Cinquoifoil, blue grass, and clover.

Disintegration of droppings on the plots began around May tenth. There was a decided difference in stages of disintegration, which was due to differences of thickness of vegetative covering. Droppings on plots with sparse vegetation were exposed to the elements, therefore disintegration occurred rapidly; while droppings covered with thick vegetation remained unchanged for some time.

It was found that droppings hold moisture for a considerable period of time, thus increasing the possibility of seed germination.

Droppings are broken up by alternate shrinking and swelling of the individual particles. This is caused by changing of moisture content and by pounding of raindrops. Rainfall during the month of April in 1942 was less than usual, therefore the chances of disintegration of dropp-

ings, and resulting seed germination, were less. By June 15 droppings on all plots had completely disintegrated, and the plots were covered with a mat of thick vegetation. It could not positively be asserted that no seeds from droppings had germinated, but because of dry weather conditions and from observations, it can be stated that germination of any seeds which may have been within the droppings was highly improbable.

It is thought by the writer that at least two conditions exist whereby seeds contained in droppings may germinate and grow to mature plants:

1. An abundance of early spring rainfall to break droppings and give seeds a chance to germinate. Early germination is essential as this gives the plant a chance to compete with surrounding vegetation.
2. Seeds contained in droppings stay dormant the first season and then get an early start the following spring. Thus they are able to compete with surrounding vegetation. This may be especially true of Rosa spp. and other species of plants which stay dormant for long periods.

GENERAL SUMMARY FOR FIELD WORK

Droppings from pheasants, bob-white quail, and ruffed grouse were examined. Whole seeds were found in droppings from all three species of birds and a certain percentage of seeds were excreted in a viable condition. Results

from field data show that there is a tendency for the Bob-white quail, smallest of the three birds, to pass fewer whole seeds than the other two species.

Seeds enclosed in droppings occasionally show signs of germinating earlier in the season than seeds of the same species under normal conditions.

LABORATORY WORK

In seeking a basis for the standardization of the experimental work, the writer felt that seeds to be used experimentally must meet the following conditions:

1. The species has to be used as food by game birds.
2. The species should be available to game birds in late winter.
3. The seed coat of the species should be strong enough to withstand, to some extent, the pressure exerted upon it by the digestive tract of the bird.

Considerable importance was attributed to this third point at the beginning of the experiment, for at that time it was thought that very few seeds ingested by birds would retain their viability.

Seeds from fruits used as food by game birds were selected as one of the points because it was desirable to have conditions in the experiments correlated as closely as possible with those in the field. This facilitates interpretation of data as well as making the data of more value to the field worker.

Species having fruits available to game birds in late winter are considered important in wildlife management, for fruits and seeds constitute a large percentage of the food of many game birds in the late winter months. Very few of these heavy fruited species, however, have a method provided by nature to obtain wide distribution except by being transported by some animal. It is a part of this

study to determine if birds help to distribute the species of plants which provide them with food at what is usually a critical period, namely, late winter.

FEEDING EXPERIMENT PROCEEDURE

Twenty mature hen ringneck pheasants were obtained from the Department of Conservation and were separated into four groups of five birds each. They were placed in wire pens, out of doors, and pine boughs were put into the pens to afford some protection against snow and rain. The floors of the pens were made of wire mesh which permitted the droppings to fall onto paper which had been placed below.

Wild fruits such as grape, poison sumach, rose, Virginia creeper and nightshade were gathered in February, placed on screen wire in the open air and exposed to natural weather conditions. Millet, flax, alfalfa, and clover seeds were obtained from a seed store and fed immediately to the birds. In most cases the seeds were offered to the birds in conjunction with cracked corn.

Seeds were placed in wire feeding hoppers which had been specially designed to prevent the birds from dropping the seeds on the collecting paper without eating them. This was necessary for it assured, as much as possible, that all seeds on the collecting papers had been ingested by the birds. In the case of fruits, the collecting papers were examined and all whole fruits which had dropped through the screen without being ingested were deducted from the number put in the hoppers. After the feeding of one species of seed and the collection of droppings was completed, the droppings were put in a soil sieve and thoroughly washed. This broke the droppings into

small pieces so the constituents could be determined by putting them in a small water-filled porcelain pan. Ten power binoculars were used during the examination so that none of the small seeds such as rose and clover, would be overlooked. The seeds were taken from droppings, counted, placed in petra dishes between blotter paper, and then placed in a moist chamber. Temperature in the chamber was kept around 70 degree f. The seeds were examined at intervals and germination was noted.

CHOICE OF SEED SPECIES TO BE FED TO BIRDS

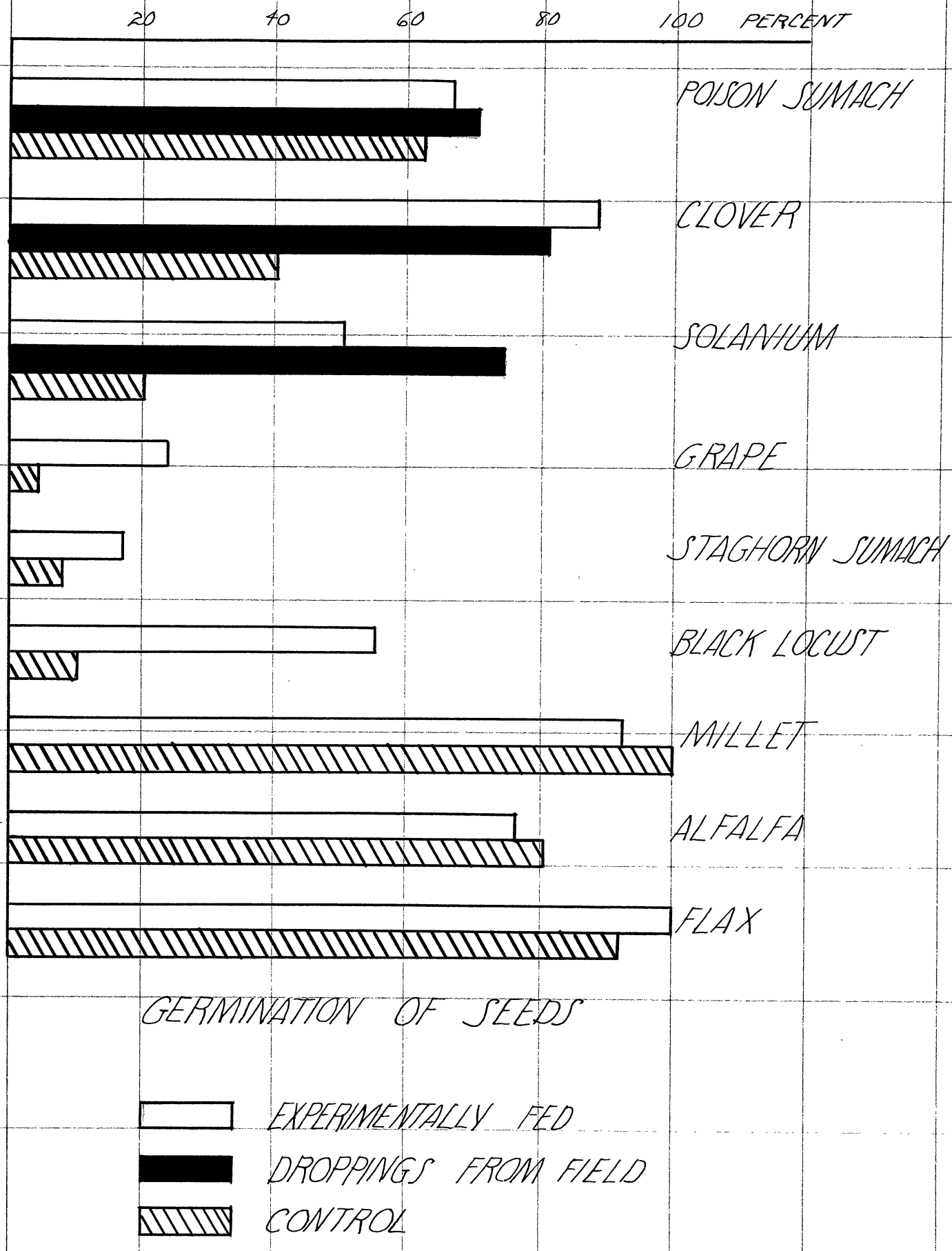
Fruits with hard seed coats were used in the initial laboratory feeding experiments for it was thought by the writer that only hard coated seeds could withstand the abrasive action by the digestive tract of the birds. After proving beyond a doubt that certain hard coated species are viable, the experiments with hard species were varied somewhat to see what changes would take place, if any, in the percentage of whole seeds passed, and in rapidity and percentage of germination. (See poison sumach)

The experiments were then continued with small seeds to find out if size of seed has any bearing upon the percentage of seeds passing through the digestive tract, and what the results would be upon germination.

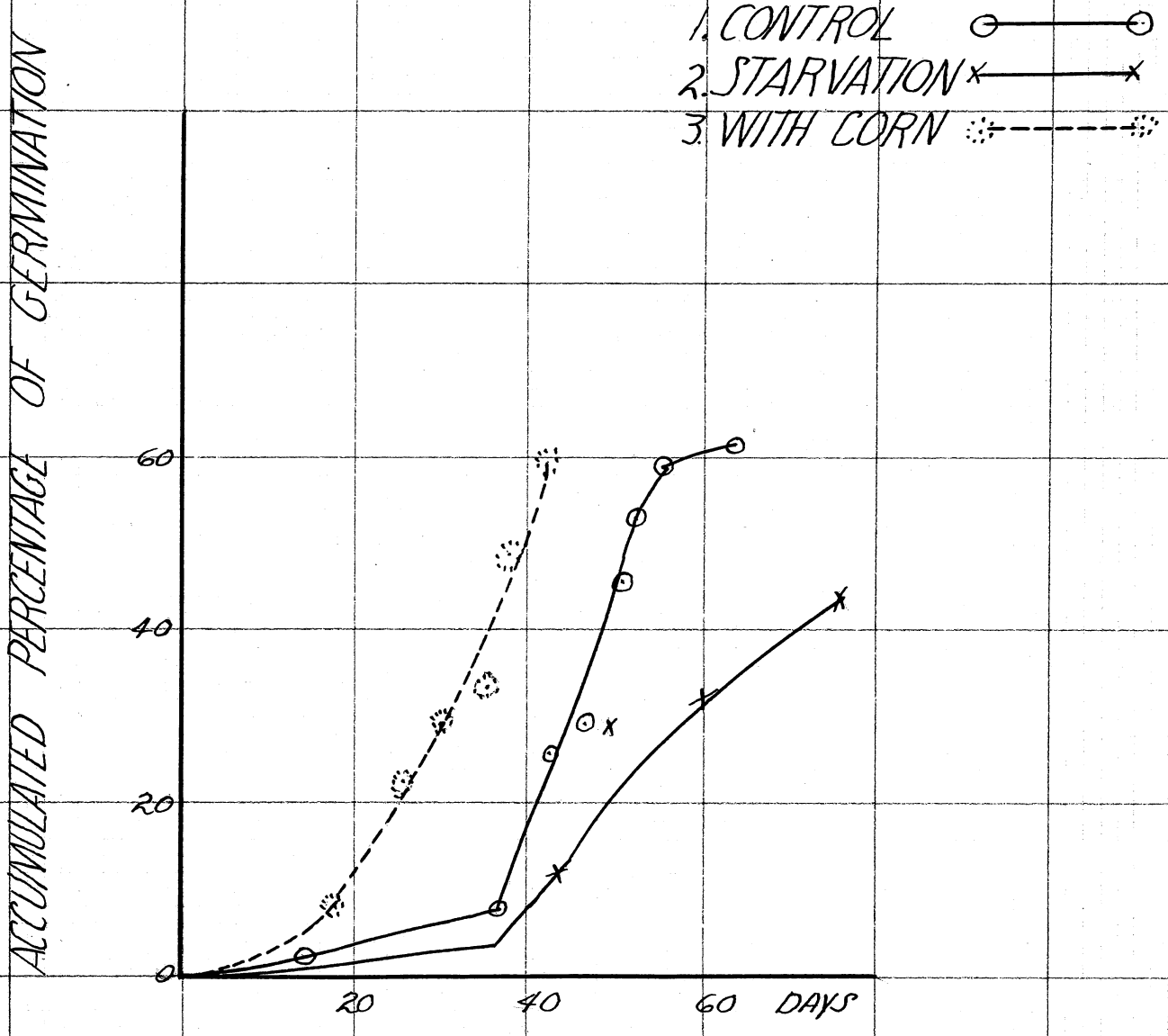
Some experiments were then conducted with seeds which have a soft coat, such as flax, and these results were noted.

CONTROL SEED GERMINATION

Germination of seeds which had passed through the digestive tract of the birds was compared with a control


20
40
60
80
100
PERCENT
POISON SUMACH
CLOVER
SOLANUM
GRAPE
STAGHORN SUMACH
BLACK LOCUST
MILLET
ALFALFA
FLAX
GERMINATION OF SEEDS
EXPERIMENTALLY FED
DROPPINGS FROM FIELD
CONTROL

GERMINATION OF POISON SUMACH



group of seeds. (Table No. 2) These seeds were taken from the same group that were fed to the pheasants. The fruit covering was removed from those species which possessed one. In all cases germination proceedures were performed the same for the control seeds as for the seeds which had passed through the digestive tract of the birds.

ANALYSIS OF LABORATORY FEEDINGS

POISON SUMACH (Rhus vernix)

Of all the species of seeds collected this was considered to be best to use in a variety of feeding conditions. The seeds are large, thereby reducing the probability of being overlooked when examining the droppings, and the fruits are readily taken by pheasants. Several seeds of this species had previously been taken from pheasant droppings collected in the field, thereby proving that this species passes through pheasants in the wild.

Seeds that were picked out of the feeding hoppers by the birds and then dropped to the trays below without being ingested were easily recognized, for those seeds voided by the birds had no fruit covering; whereas, those that were not eaten still retained their green covering.

Seeds of this species were offered the birds five different ways; mixed with corn, with regular poultry laying mash, without water but with corn, with a great quantity of seeds not in conjunction with other food,

Table No. 2

GERMINATION OF CONTROL SEEDS

Species Of Seeds	No. Of Seeds Tested	No. Of Seeds Germinating	Per. Of. Seeds Germinating	No. Of Days To Germin. Ten Per. Of Seeds	No. Of Seeds Not Germ. within Six months
P. Sumach	50	31	62	38	0
Nightshade	50	10	20	6	0
Red Clover	50	20	40	2	2
Alfalfa	50	40	80	2	0
Stag. Sumach	50	4	8	-	37
Virginia Creeper	50	29	58	15	9
Wild Grape	50	2	4	-	48
Black Locust	50	5	10	153	32
Barberry	25	3	6	-	0
Wild Raspberry	50	0	0	-	50
Millet	50	50	100	2	0
Flax	50	44	88	2	0

(Sumach alone), and a few seeds with no other food (starvation test). Upon five different occasions the birds were fed poison sumach in combination with cracked corn. From table (3) it appears that there is no uniformity to the percentage of whole seeds passed by the birds. This was true throughout the whole laboratory feeding experiment. The percentage of Poison Sumach seeds passing through the digestive tract in an unbroken condition varied from less than one-half to over fifty-percent, and averaged eight and seven-tenths percent.

Seeds excreted in an unbroken condition showed high germinating capacity, eight out of ten instances with germination higher than fifty percent. Germination for the whole group averaged seventy percent. Germination for the control seeds was only twenty percent.

In every instance the seeds ingested and excreted by the birds germinated more quickly than the control seeds. This can be explained by the fact that seeds excreted by pheasants had seed coats which had been worn down by abrasive action of the digestive tract. This fact was easily recognizable under ten power binoculars. Ridges on seeds were absent after ingestion and excretion by the pheasants. Digestive juices may also be an important factor.

WILD GRAPE (Vitis spp.)

Grape ranked high as one of the species to be tested because it met the requirements which have been mentioned before. The seed has a hard seed coat, the fruits are available in late winter, the fruits are readily taken by game birds in the wild, and the fruits were available in

Table No. 3

EXTENSIVE EXPERIMENTS WITH POISON SUMACH

Conditions Under Which Seeds Were Fed To Birds	No. Of Seeds Put In Pens	No. Of Seeds Taken By Birds	No. Of Seeds Passed In Whole Condition	Percent Of Seeds Passed In Whole Condition	Percent Of Seeds Germ. Of Those Passed Through	No. Of Days Required To Germ. 10% Of Seeds	Percent Of Seeds Ger. Of Those Ingested
With Mash	400	388	1	.039	100	19	.25
Sumach Alone	3600	3527	218	6.12	52.7	22	32.5
With Corn	400	374	45	12.32	73.3	26	8.0
With Mash	400	345	30	8.69	100	14	7.5
With Corn	600	583	165	28.3	Not Tested		
With Corn	200	189	6	3.18	100	30	3.0
With Corn	400	396	36	9.10	97.0	20	8.4
With Corn	400	261	6	2.3	50.0	35	.75
Corn & No Water	400	396	25	6.31	44.0	21	3.9
Sumach Alone (Starvation)	400	329	50	15.19	60.0	21	1.8

Thirty-eight days were required to germinate ten percent of the seeds in the control experiments.

sufficient quantities to use for experimental purposes. The tangle produced by the vine of the grape also provides excellent winter cover for game birds.

Grape fruits were readily taken by the experimental birds and had the additional quality of being easily distinquishable if picked out of the feeding trays then dropped to the catch screen without being ingested.

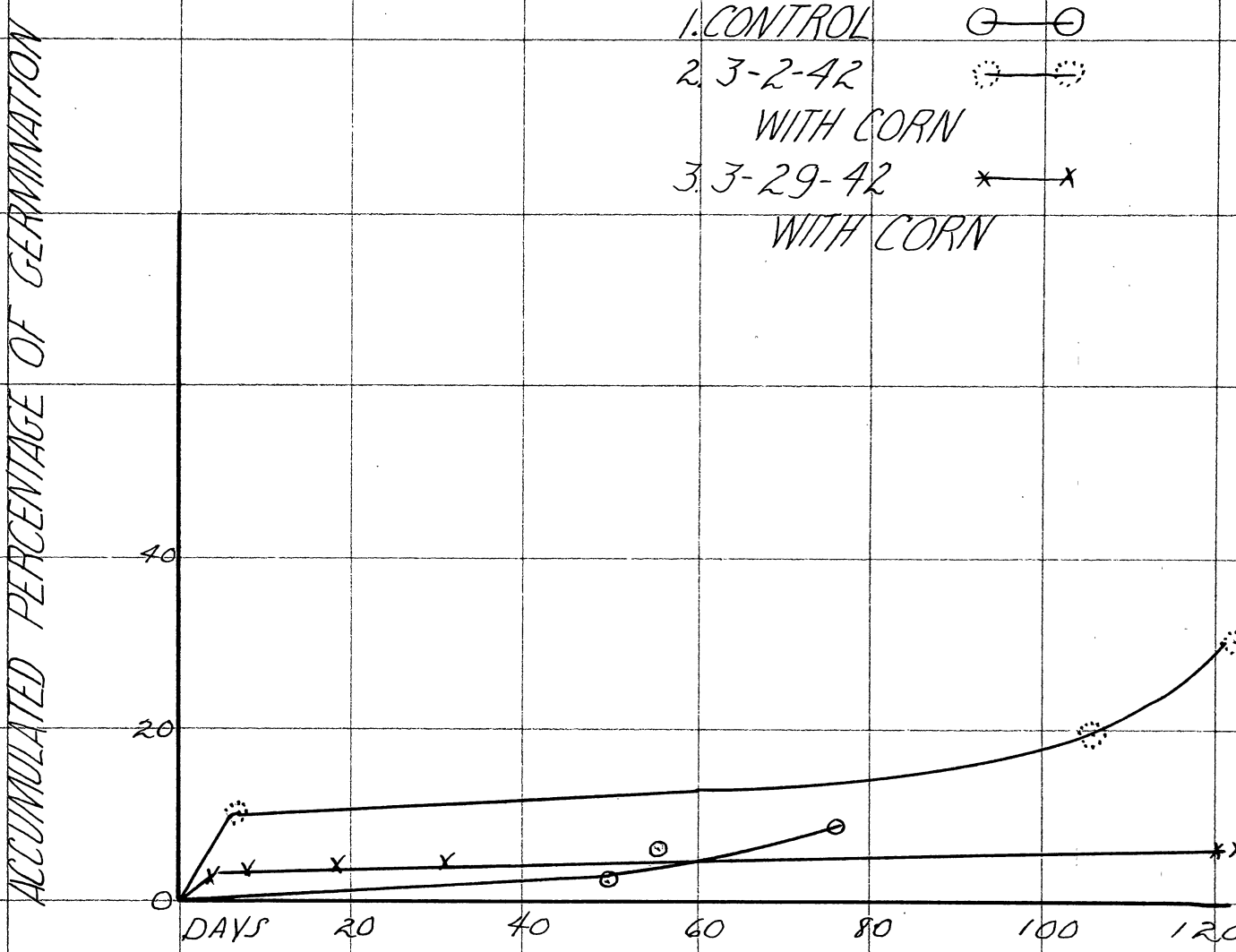
Germination of the seeds passing through the birds, and the control seeds progressed similiarly after twenty days in the germination trays. Total germination of both groups was very close, varying only two percent. The total germination of grape was low, however, it must be remembered that this species is among those showing an inherited dormnant quality.

STAGHORN SUMACH (Rhus hirta)

This species was used in the feeding experiment because it was found in droppings taken from the field, it is a very prevalent species in most Eastern states, and its fruit is available throughout the whole year. Grouse take the fruits of this species readily. The trees of this species are among the first to invade abandoned lands, thereby establishing itself as one of the species to be reckoned with when putting abandoned lands under a wildlife management plan. Sumach was therefore chosen as one of the species to be tested.

Examination of graph (1) will reveal that there was a wide variation in germination of the sumach seeds, and as in other cases the writer found no explanation. This species is not a staple food of pheasants, and it is

GERMINATION OF STAGHORN SUMACH



thought by the writer, and by many wildlife management men, that when consuming the fruit the birds are after grubs which are usually abundant in the seeds, rather than after the fruits alone.

BLACK LOCUST (Robinia pseudoacacia)

This species was tested more for curiosity as to the grinding qualities of the bird's digestive tract than for applicable wildlife management practices. It is, however, a good forest product species, and is among the first of trees to invade abandoned lands. The total germination compares favorably with that of other hard seed coated species.

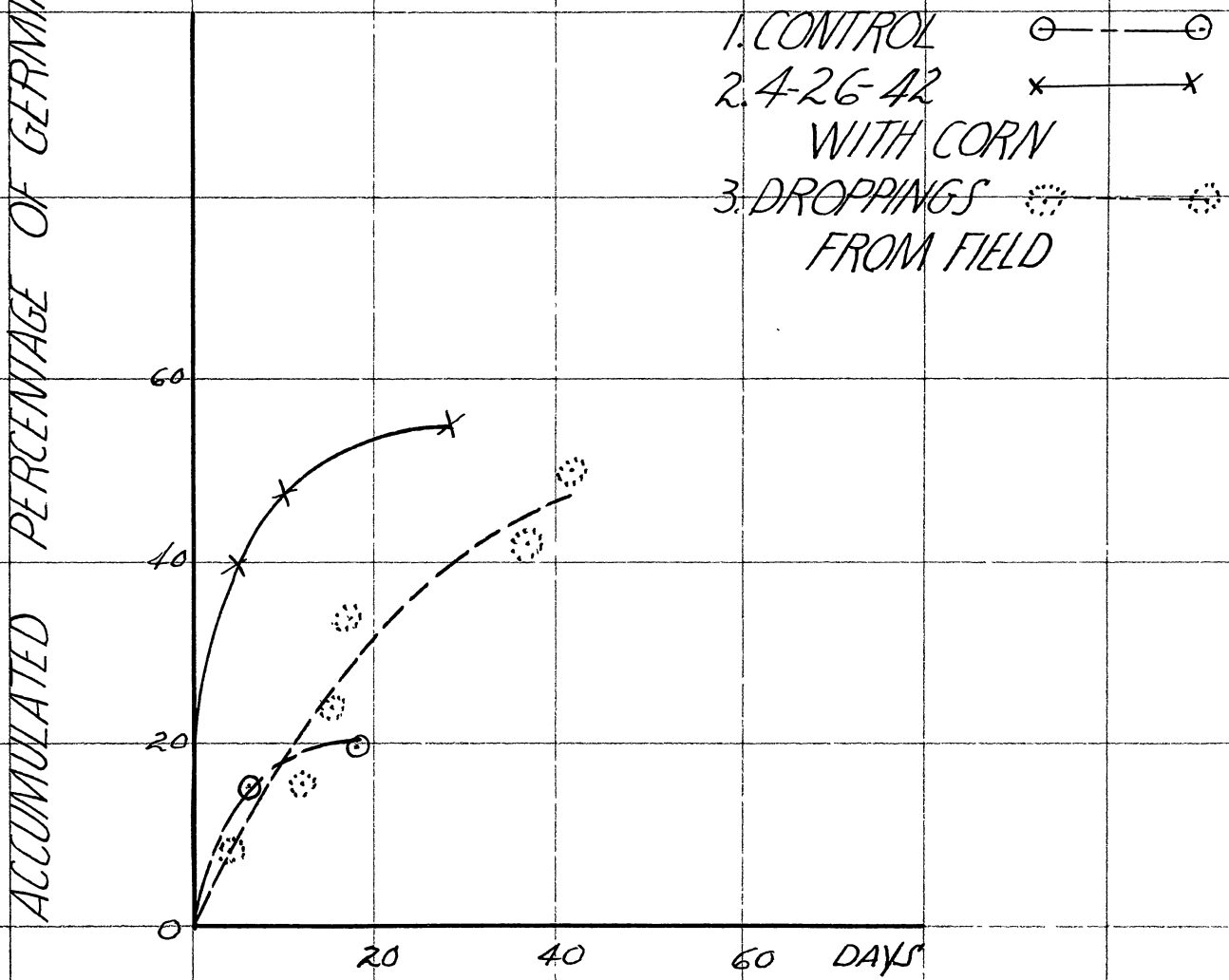
NIGHTSHADE, (Solanum)

Nightshade, one of the favorite foods of pheasants, is found extensively in kettle holes and swamp areas in Southern Michigan. The seeds of this species were found in droppings in the field, therefore, this species was used in the experiment. The percentage of germination for this species was fifty-three, and this fairly high germination figure contributes to the writer's belief that the maize of Solanium bushes that occupy many kettle holes frequently originate from bird droppings.

ALFALFA, MILLET, FLAX, RED CLOVER

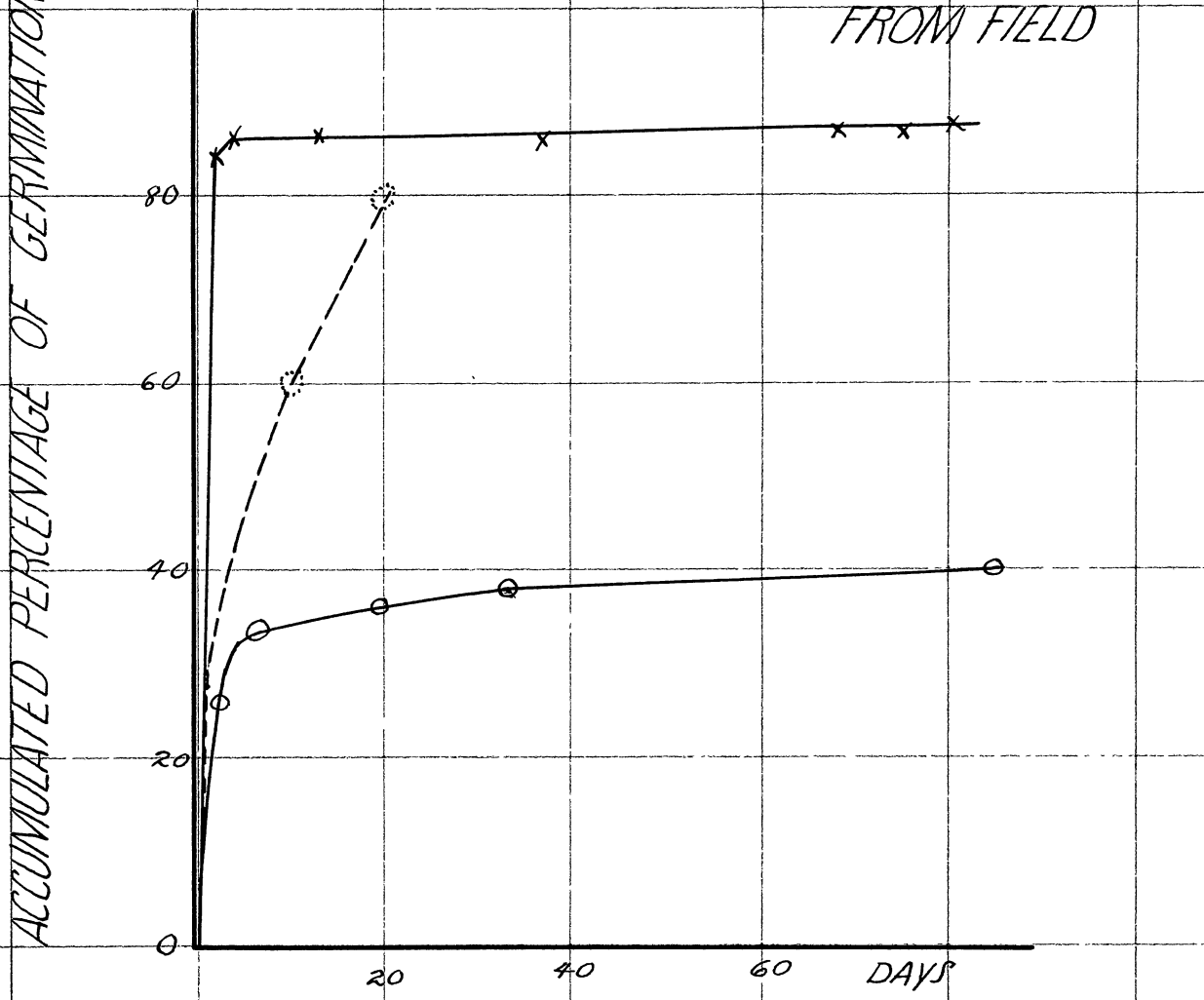
These cultivated species were fed to the birds for various reasons. Many food plots established by wildlife technicians on game lands contain some of these species, and if it can be proven that birds crack these seeds amd utilize the contents, the value of these species as a game food can be ascertained. The possibilities of

GERMINATION OF NIGHTSHADE



GERMINATION OF CLOVER

1. CONTROL
2. 5-11-42 WITH CORN
3. DROPPINGS FROM FIELD



dispersal of a valuable food species is another point to be considered. From the experiments it was found that germination was high for those seeds passed, reaching one hundred percent in flax, and ninety-three percent in alfalfa. Utilization was also high, clover being the lowest, as 25 whole seeds were excreted out of 500 seeds fed to the birds. Millet was highest in utilization, as only forty-eight seeds, or three percent, were excreted; and this was closely followed by alfalfa with forty-seven seeds, or five percent; and flax with forty-eight, or five percent.

VIRGINIA CREEPER (Psedera quinquefolia)

This species is found in considerable quantities along fence rows in Southern Michigan. The fruits remain on the vines well into late winter, offering a good emergency ration for wildlife. It was placed on the list to test the percentage of utilization by the birds as well as the viability of the seed after ingestion. In all tests with this species a relative low percentage of seeds were found to pass through the birds in a viable condition. Upon one occasion no whole seeds were found out of 748 ingested. It was found, however, that a relatively high percentage of those seeds coming through in a whole condition were viable. (64%). Fifty-eight percent of the seeds germinated in the control experiment.

WILD ROSE (Rosa spp.)

Wild Rose seeds are hard and small, and in most cases

pheasants in the field seemed to prefer the pulpy fruit around the seeds, leaving the seeds on the ground near the plants. The caged birds ate both fruit and seeds. Rose was therefore used to determine if the seeds were digestable to the pheasant and to determine if ingestion would have a tendency to break the dormnancy of the rose seeds.

Many wild rose seeds were found in droppings collected from the field, and, as in the experimental feedings, none of these seeds were found to germinate. The birds utilize a high percentage of the seeds, in one case 99.3% and in another 89.8%. These figures should be interesting from the standpoint of rose seeds as a game bird food when collaborated with Barske's (1943) findings.

BARBERRY

Barberry was tested to obtain some idea of the percentage of utiliaztion of this species by the ringneck. The high percentage of utilization correlated with the findings of Barske, (1943), prove that this plant has great food value as well as being an excellent cover plant for use in wildlife management.

RELATION OF FINDINGS AS APPLIED IN WILDLIFE MANAGEMENT

Wildlife managers in the United States consider food and cover the most important factors controlling game populations. In many Eastern and Midwestern states regular farm-game programs have been carefully planned and are now being carried out. One of the most important of these programs is the establishment of food plots which contain grains readily utilized by game birds.

The writer believes that among the plants in a food plot there should be some species which are not completely utilized by the birds. The food plots would then serve as a dispersal point, and birds as a dispersal agency for certain species of plants. The seed of the plants to be dispersed should be small, for small seeds pass through the digestive tract in greater quantities than large seeds. The seed coat should be hard for this also contributes to the percentage of seeds passed.

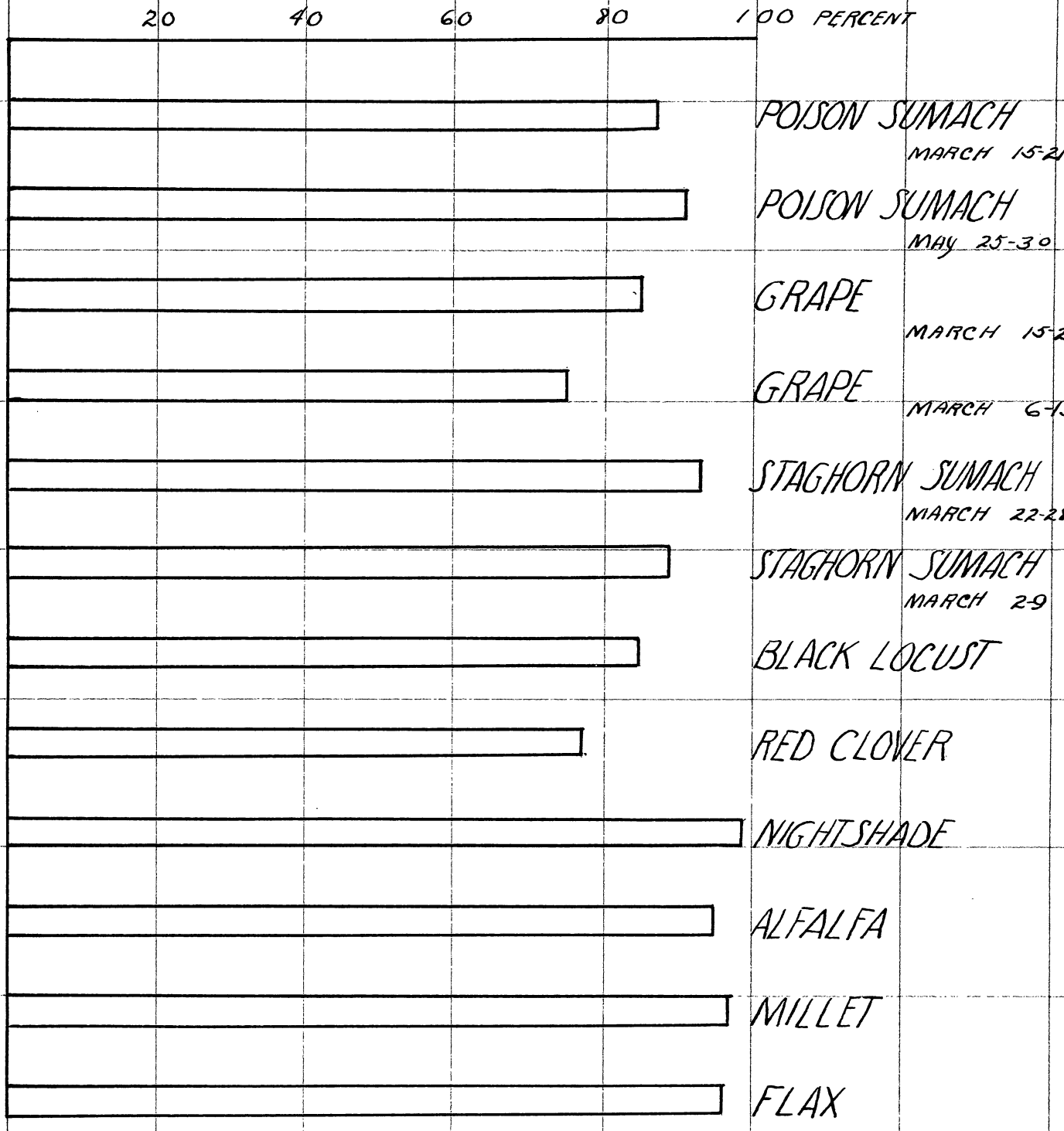
There is no doubt that birds distribute in a viable condition seeds of plants such as grape, virginia creeper, black locust, poison sumach and others of the hard seed variety. Of the seeds of these species ingested by pheasants, approximately six percent are passed in a viable condition. From this source of supply a good crop of both feed and cover is established, and once established, plants of these species produce a good annual food crop without any replanting. The writer is convinced that more

seeds of the afore mentioned species should be placed in food plot mixtures distributed by conservation agencys.

Utilization of food by game is considered when making plantings on game areas, and from tests conducted by the writer, nightshade, (Solanium spp.) showed the greatest percentage of utilization. Millet, alfalfa, flax, staghorn sumach, and poison sumach also showed high utilization. Grape and red clover were the lowest in utilization. The seeds of every species tested showed at least seventy-five percent utilization.

Barske, (1943), found that staghorn sumach, poison sumach, wild grape and nightshade seeds were highly nutritive foods for pheasants when ground into a mash form. The findings of this study established a high percentage of utilization of seeds by the birds. In conjunction with the findings of Barske, it proves that these wild fruits and the enclosed seeds are very good foods for pheasants.

The method used by the writer in establishing the percentage of utilization of seeds by pheasants could be used for other species of birds and plants. This would provide a basis from which to select plants for the establishment of food plots upon areas to be put under wildlife management.



PERCENTAGE OF SEEDS
UTILIZED BY THE PHEASANTS

SUMMARY

This thesis is concerned with determining utilization of seeds by the Ringneck pheasant, and germination of those seeds voided by this bird. Droppings were collected in the field and whole seeds found within were germinated. Seeds of two species enclosed in the droppings, Nightshade and Staghorn sumach, were found to germinate earlier in the season than seeds of these species normally do.

Droppings collected from Bob-white quail, when compared with droppings from Ringnecks, tend to show that the smaller bird passes fewer whole seeds. Laboratory tests also show that smaller seeds pass through the digestive tract of pheasants in greater quantities than large seeds.

In all tests conducted it was found that seeds passing through the digestive tract of the Ringneck germinate more quickly than those seeds not undergoing such treatment. Total germination and rapidity of germination varied within the same species of seeds. No controlling factor was established.

Soft seeded species such as Alfalfa, Nightshade, Millet and Flax passed through the birds in small quantities, therefore utilization of these species was high, (95-99%). Wild grape, a seed with a very hard coat, and red clover, a small seed, showed the greatest resist-

ance to breakage by the digestive tract of the birds.

It is recommended by the writer that both seeds which are easily utilized by game birds, and seeds which show resistance to utilization, be included in food plot mixtures distributed by conservation agencies. Seeds easily utilized are of great food value immediately upon maturity, while seeds that resist utilization somewhat are distributed over the area by birds. These seeds so distributed in a viable condition germinate over a wide area, thereby establishing plants which will bear food for game over a long period of time.

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