A C T A T H E R I O L O G I C A

VOL. 18, 26: 481—488. BIAŁOWIEŻA December, 1973

STUDIES ON THE EUROPEAN HARE. XXX

Eleonora SZUKIEL

The Effect of Repellents on the Food Preferences of Hares

[With 3 Tables & 1 Fig.]

Studies were made in winter on the food preferences of hares in relation to food consisting of 2- and 3-year old twigs of forest trees and succulent fodder treated with three repellents, in an enclosed area greatly frequented by these animals. Two variants were made of the experiments on hares preferences for different shoots as follows: I — 7 species of trees were planted in 6 separate plots and treated with the same repellent, keeping control plots entirely separate; II trees of only 1 species were planted in each of 5 plots and treated in successive rows with three repellents, leaving the trees in every second row untreated as controls. Oak and robinia were preferred to other species (maple, sycamore, ash and lime) and beets were preferred to carrots. Treating the food with repellents usually discouraged the hares from browsing on shoots, and to a far more effective degree from eating succulent fodder, but even so it did not completely deter them from eating food treated with these preparations. Of the three repellents used (Terpen, Terpak and Morsuvin) the best effects were obtained with Morsuvin.

1. INTRODUCTION

Considerable damage is caused to both orchard and forest trees by hares, which browse on shoots and gnaw the bark of trees and shrubs in certain parts of Europe (Szukiel, 1972b). The damage done to trees and shrubs by hares is not synonymous with grazing, this applying particularly to browsing on the twigs of seedlings in afforested areas, since a considerable part of the shoots are left on the ground near the damaged tree after being bitten off by the hares.

The reasons for the damage caused by hares have not as yet been thoroughly investigated. It is assumed that in addition to grazing, browsing on shoots and gnawing bark is due to the hares' need to wear down their incisors, which grow continually.

The studies so far made show that intensification of hares' browsing on trees does not directly depend on the animals' density, physiographic conditions and food supply in the biotope (Łęski & Szweda, 1958; Turček, 1960; Barneine, 1965; Ueckermann, 1966 and others).

As in the case of tree protection from damage by deer, various methods have been tried to prevent damage by hares, including numerous repellents (*inter alia:* Thomson, 1953; Cardinell, 1958; Łęski & Szweda, 1958; Walters & Soos, 1961; Duffield & Eide, 1962; Armour, 1963).

Studies have shown that hares are less susceptible to the effects of repellents than other herbivorous mammals, *e.g.* deer (Szukiel, 1972b). The chemical preparations used to protect trees from damage by hares usually only partly limit browsing on shoots or bark.

Hares exhibit decided food preferences in relation to the species of trees and shrubs occurring in the given biotope, although the degree of attraction of the various species of plants varies in different natural and geographical habitats (Szukiel, 1972b). Among the forest species on which hares most often browse in Poland are: *Robinia pseudoacacia* L., *Quercus rubra* L., *Q. robur* L., *Q. sessilis* Ehrh., *Fagus silvatica* L., *Acer pseudoplatanus* L., *Fraxinus excelsior* L. and *Tilia cordata* Mill. *Alnus glutinosa* Gaertn. and *A. incana* Willd. as well as *Betula verrucosa* Ehrh. and *B. pubescens* Ehrh. and coniferous species are very rarely browsed (Szukiel, 1972a, b).

The studies were made for the purpose of obtaining preliminary information on the deterrent effect on hares of chemical preparations characterized by specific taste-smell properties.

2. MATERIAL AND METHODS

Three repellents — Morsuvin, Terpen-X and Terpen-T — were used for laboratory experiments. All these preparations are based on the chemical components which had proved to be the most repellent to hares when used on forest tree seedlings (Szukiel, 1972b). Morsuvin has amushy, granular consistency and the specific smell of pyridine compounds. Terpen-X and Terpen-T, made from the waste products of resins dissolved in alcohol ethyl, are of a liquid consistency with a faint specific smell. In addition to resins Terpen-T constains disulphide tetramethylothiuram.

Field studies were made on the experimental areas of the Polish Hunting Union Research Station at Czempin, on which there were about 50 hares within an enclosed area of approx. 15 ha. This area forms part of a forest group (about 8 ha) consisting mainly of coniferous species; the only tree species attractive to hares there were *Prunus cerasifera* var. *divaricata* Ehrh. and *Sorbus aucuparia* L. The enclosed area also included 1.3 ha of meadow and 5 ha of cultivated land, on which the experimental plots were situated.

Two and 3-year old seedlings of deciduous tree species most often browsed by hares in Poland were chosen for the experiments, i.e. oak, robinia, sycamore, maple, ash and lime (Szukiel, 1972b). The experiments were made in early spring (March—April 1969), when hares browse intensively on the shoots.

Seedlings either treated with repellents or untreated were planted on the plots, and observations made every few days, keeping a detailed list of damaged tree seedlings.

Two variants of the experiment were carried out: Variant I. 6 experimental plots were laid out, measuring about 6 ares, and on each of them 50 seedlings were planted in 7 successive rows, each row consisting of seedlings of a different species. This gave a total of 350 seedlings planted per plot. All seedlings on plot no. 1 were treated with Morsuvin, on no. 3 with Terpen-T, on no. 5 — with Terpen-X. Plots nos. 2, 4, 6 formed controls. There were two plots: an experimental and control on one site. Variant II. 5 plots were laid out but located seperately, and 60 seedlings of one species only planted on each of them. There were 10 seedlings in a row, those in rows 1, 3 and 5 being treated with chemicals, but a different repellent to each row, while trees in rows 2, 4 and 6 formed controls (Fig. 1).

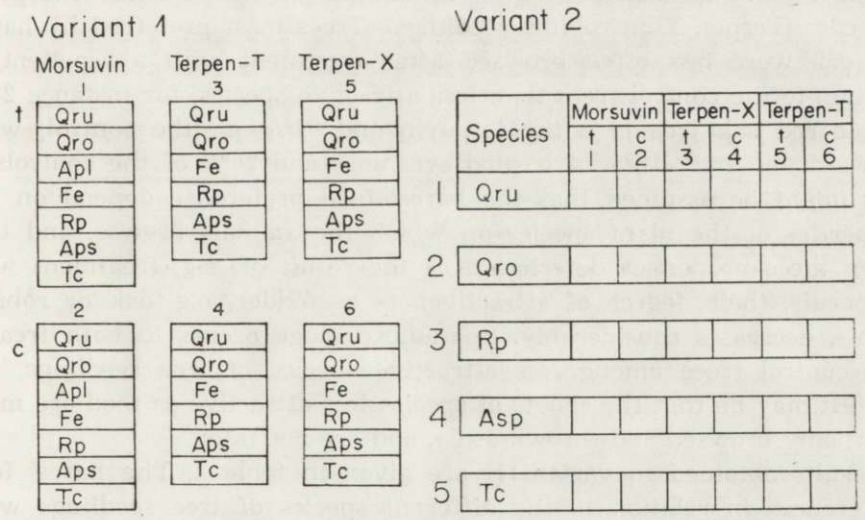

Fig. 1. Schedule of the experimental area. t — tree seedlings treated with the repellents, c — control. Qru — *Quercus rubra*, Qro — *Quercus robur*, Apl — *Acer platanoides*, Fe — *Fraxinus exclesior*, Rp — *Robinia pseudoacacia*, Aps — *Acer pseudoplatanus*, Tc — *Tilia cordata*.

Records of damage done were kept by noting every few days, i.e. on the 2nd, 5th, 7th and 12th day of the experiment (except that in two of the plots inspection was made on the 3rd, 5th and 9th day of the experiment) the number of seedlings on which the leading shoot had been gnawed (the seedlings planted had few branches and the majority possessed a leading shoot only).

In addition succulent fodder (beets, carrots) were treated with the above repellents and differences observed in the food preferences exhibited by hares for untreated and treated food. The amount of fodder eaten was assessed in percentages on the 1st, 4th and 7th day after it had been put out for the hares.

3. RESULTS

The results of experiments from variant I are given in table 1. The experiment showed that hares prefer to browse on oak seedlings shoots. About 80% of the untreated oak seedlings had been browsed on the second day after planting, whereas only about 13% of the treated seedlings were damaged. Robinia comes second in order of attractiveness, then far less often and later the hares browsed on maple, sycamore and ash, and least and latest on lime, which remained untouched for the first few days.

Matuszewski (1966), on the basis of studies on hares' food preferences for branches of trees and shrubs laid out for the animals, considered that species such as oak, robinia, ash and lime were browsed on to a medium degree.

The repellents used proved to be similar in effectiveness except in one case (Terpen-T on robinia seedlings). Trees most preferred by hares, e.g. oak were less often browsed after treatment with a repellent in relation to the control trees than less attractive species, for instance 28% of the red oak treated with Morsuvin and 94% of the control, were browsed, but only 16% of treated sycamore and 20% of the controls.

It might be assumed that the hares' food preference depend on the properties of the plant species on which the animals browse, and that when these properties deteriorate as the result of, e.g. treatment with chemicals, their degree of attractiveness as fodder, e.g. oak or robinia shoots, decreases considerably. Sporadic damage occurs to both treated and control trees among less attractive species of tree seedlings, *e.g.* lime. It may be that the shoots of species less attractive as food are more often only browsed and thrown aside, and are not eaten.

Results obtained in variant II are given in table 2. The hares' food preferences in relation to the different species of tree seedlings were similarly distributed; the following species were most often browsed red oak and robinia. The effectiveness of the same repellents was lesser in variant II than in I, when all seedlings in the given area were treated. Maximum effectiveness was found for repellents on plot no. 2.

No distinct differences were found in the degree to which the various repellents acted as deterrents to hares.

It would seem that such alternating treatment of seedlings (variant II) deters hares from browsing to a lesser degree than when all individual trees of attractive species are chemically protected. If a hare entering the area continually encounters treated shoots (of a species for which it has a decided preference) it probably becomes more quickly discouraged from further browsing and visits to the area. Similar results were

Table 1

Numbers of browsed tree seedlings previously treated with repellents — results from variant I of the experiments.

Repellent	Succesive day of observations	Plot	Treated							Plot	Not treated						
			Qru	Qro	Apl	Fe	Rp	Aps	Tc		Qru	Qro	Apl	Fe	Rp	Aps	Tc
Morsuvin	2	1	3	3	0	3	0	2	0	2	46	36	9	3	15	8	0
	5		7	9	2	3	2	2	0		46	36	9	3	15	10	0
	7		13	19	2	9	7	7	0		46	37	13	3	16	10	1
	12		14	21	3	9	7	8	1		47	37	17	8	16	10	3
	Not browsed		36	29	47	41	43	42	49		3	13	33	42	34	40	47
Terpen-X	2	3	14	3	—	2	3	0	0	4	38	36	—	7	15	4	0
	5		15	7	—	2	6	1	2		41	47	—	9	21	5	1
	7		18	12	—	2	8	2	4		41	47	—	13	24	14	2
	12		22	12	—	4	8	2	5		42	47	—	15	27	14	3
	Not browsed		28	38	—	46	42	48	45		8	3	—	35	23	36	47
Terpen-T	2	5	16	*	—	0	20	4	0	6	41	*	—	5	19	4	0
	5		16	1	—	2	27	4	0		42	5	—	5	23	7	0
	7		22	5	—	4	33	9	0		42	11	—	11	27	13	6
	12		22	7	—	8	39	13	3		47	15	—	16	32	13	8
	Not browsed		28	43	—	42	11	37	47		3	35	—	34	18	37	42

Notes: Qru — *Quercus rubra*, Qro — *Quercus robur*, Apl — *Acer platanoides*, Fe — *Fraxinus excelsior*, Rp — *Robina pseudoacacia*, Aps — *Acer pseudoplatanus*, Tc — *Tilia cordata*.
Dash means that species was not tested. * — tested beginning with day four.

Table 2

Number of browsed tree seedlings previously treated with repelents — results from variant II of the experiments.

Plot	Tree species	Succesive day of observations	Morsuvin t	Morsuvin c	Terpen-X t	Terpen-X c	Terpen-T t	Terpen-T c
1	*Quercus rubra*	2	3	8	6	7	6	9
		5	3	9	7	7	7	9
		7	5	9	8	7	7	9
		12	6	9	8	8	7	10
		Not browsed	4	1	2	2	3	0
2	*Acer platanoides*	2	0	5	2	8	1	8
		5	0	8	2	8	2	10
		7	3	8	4	9	5	10
		12	4	9	4	9	5	10
		Not browsed	6	1	6	1	5	0
3	*Robinia pseudoacacia*	2	4	6	8	8	7	8
		5	5	6	9	10	7	8
		7	6	7	9	10	7	8
		12	6	8	9	10	8	10
		Not browsed	4	2	1	0	2	0
4	*Quercus robur*	3	—	—	2	0	0	8
		5	—	—	2	3	2	9
		9	—	—	3	5	5	9
		Not browsed	—	—	7	5	5	1
5	*Tilia cordata*	3	—	—	0	0	0	0
		5	—	—	0	1	0	0
		9	—	—	1	2	0	2
		Not browsed	—	—	9	8	10	8

t — treated; c — control.
Dash means that *Tilia cordata* and *Quercus robur* introduced into the plots on third day of experiment: in addition these species were not treated with Morsuvin.

Table 3

Hares' food preferences in relation to succulent food treated with repellents.

Repellent	Per cent of food eaten in relation to amount laid out — Beets			Carrots		
	1[1])	4	7	1	4	7
Morsuvin	—	—	—	—	—	—
Terpen-X	—	>25	>25	—	—	>25
Terpen-T	>25	25	25	—	>25	>25
Control	25	75	100	—	25	100

[1]) Day after food was laid out.

obtained in studies on open areas in afforested tracts of land (Szukiel, 1973).

Hares' preferences for the succulent fodder laid out for them.

Results of observations of hares' feeding on beets and carrots untreated and treated with chemicals are given in table 3.

Morsuvin proved 100% effective in repelling hares from the fodder laid out for them, while the other two repellents were less effective, although more than 25% of the fodder laid out remained uneaten up to the end of the observations (whether beets or carrots). On the other hand 100% of untreated fodder was eaten, hares preferring beets to carrots, as in the case of fodder treated with Terpen-X and Terpen-T.

4. CONCLUSIONS

Of the species of forest trees used for this study oak and robinia were most readily browsed on by hares, and to a far lesser degree maple, ash and sycamore, and least lime.

The hares were somewhat reluctant to eat food treated with repellents, despite the fact that there were only limited opportunities of finding food of another kind in the biotope.

Of the foods treated by repellents it the shoots (not always consumed) which are browsed to a greater degree by hares than succulent food.

Of the three preparations used, Morsuvin proved to have the greatest repellent properties in relation to hares.

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Accepted, May 15, 1973.

Forestry Research Institute,
02-362 Warszawa, ul. Wery Kostrzewy 3

Eleonora SZUKIEL

WPŁYW REPELENTÓW NA PREFERENCJE ŻEROWE ZAJĘCY

Streszczenie

Badania nad preferencją żerową zajęcy w stosunku do pokarmu traktowanego repelentami, przeprowadzono w okresie zimy, na powierzchni ogrodzonej, silnie penetrowanej przez zające.

Pędy 2- i 3-letnich drzewek leśnych oraz karmę soczystą traktowano trzema repelentami:

Doświadczenia nad preferencją zajęcy w odniesieniu do żeru pędowego, założono w dwu wariantach: w I — na 6 oddzielnych działkach posadzono drzewka 7 gatunków i potraktowano je tym samym repelentem, a działki kontrolne zlokalizowano oddzielnie; w II — na każdej działce (5) posadzono tylko jeden gatunek drzewek, traktując je, w kolejnych rzędach trzema repelentami przy czym, drzewka w co drugim rzędzie zostawiono jako kontrolę.

Wyniki z wariantu I podano w tab. 1, z II — w tab. 2, a wyniki doświadczeń nad preferencją żerową w stosunku do karmy soczystej traktowanej i kontrolnej w tab. 3.

Dąb i robinia były chętniej zgryzane niż pozostałe badane gatunki (klon, jawor, jesion i lipa), a z karmy soczystej — buraki chętniej niż marchew.

Traktowanie pokarmu repelentami, na ogół zniechęcało zające do zgryzania pędów, a znacznie skuteczniej — do zjadania karmy soczystej; jednakże nie odstraszało ich zupełnie od pobierania skażonego pokarmu.

Z badanych repelentów (Terpen, Terpak i Morsuvin) najlepsze efekty dał Morsuvin.