The results of Mouflon (Ovis ammon musimon Pal.) and Axis deer (Axis axis Erx.) interaction with cultivated grasslands and the Jerusalem artichoke (Heliunthus tuberosus L.) plantation in the Kalifront ...

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THE RESULTS OF MOUFLON (*OVIS AMMON MUSIMON* PAL.) AND AXIS DEER (*AXIS AXIS* ERX.) INTERACTION WITH CULTIVATED GRASSLANDS AND THE JERUSALEM ARTICHOKE (*HELIANTHUS TUBEROSUS* L.) PLANTATION IN THE KALIFRONT HUNTING GROUND ON THE ISLAND OF RAB

REZULTATI ODNOSA MUFLONA (*OVIS AMMON MUSIMON* PAL.) I JELENA AKSISA (*AXIS AXIS ERX.*) PREMA KULTIVIRANIM TRAVNJACIMA I NASADU ČIČOKE (*HELIANTHUS TUBEROSUS* L.) U LOVIŠTU KALIFRONT NA OTOKU RABU

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The paper deals with the utilisation of cultivated grasslands (two localities) and a plantation of Jerusalem artichoke (*Helianthus tuberosus* L.) by mouflon and axis deer. At the time of research, the game counted 99 heads per hectare of cultivated grasslands, and 365 heads per hectare of Jerusalem artichoke plantation. However, during the count, only 17 heads of game on average were found in the grazing areas. With the absence of hunting, mouflon game formed one large herd of 22 heads and several smaller herds, which were concentrated mainly in one grassland area, while axis deer herds, amounting to 9 heads maximum per herd, used both grasslands. It was observed that mouflon took the food from the storages by themselves, damaging the storages in the process. For this reason, food storages need to be protected with fences. During the research, neither mouflon nor axis deer consumed the provided hey, which means that game animals need not be additionally fed with bulky food in

eu-Mediterranean conditions since there is enough dry food in the nature. Mouflon and axis deer used the Jerusalem artichoke exclusively as forage and did not root for tubers. In dry season (summer), the Jerusalem artichoke is an important forage plant in the hunting ground, with the most intensive grazing occurring in early June, while before June, game shows little interest in this plant species. At the beginning of June, game primarily bites off the terminal parts of the shoots, however, with growing drought, it also eats the leaves.

Key words: mouflon (*Ovis ammon musimon* Pal.), Axis deer (*Axis axis* Erx.), cultivated grasslands, Jerusalem artichoke (*Helianthus tuberosus* L.), biting height, forage, herd size

INTRODUCTION
UVOD

Establishing forage areas as an additional food source for game has been practiced in hunting management for decades. As a rule, grassland areas dominate in the diet during the summer, whereas areas supporting diverse forage cultures are primarily intended for game nutrition during the unfavourable part of the year (winter months). For this purpose the cultures are either left un-harvested or the crops are collected and stored.

In the Mediterranean, and especially in the eu-Mediterranean area, unlike continental (Central European) areas, the unfavourable part of the year for game is not winter but summer, when succulent food or even water is absent. The main problem concerns the provision of fresh food in the dry part of the year so that game pressure on forests is alleviated. Forests in the Mediterranean have a predominantly protective and aesthetic function, and harmful impacts of ruminants on the forest ecosystems in this region are well known.

Although the general factors influencing animal feeding behaviour are known, the specific feeding patterns of individual game species in a given habitat and time are still under research.

In the course of evolution, all animal species, including the ancestors of the present domesticated animals, have developed specific feeding strategies based on the principle of selecting the best quality foods from a large quantity of forage, at the same time avoiding lethal dosages of phytotoxins (Havranek 1998, cit. Launchbauch 1996), which has enabled their survival, growth and development (Havranek 1998, cit. Forbes 1995). In other words, animals have developed feeding strategies involving the intake of large quantities of food in as little time and with as little energy as possible and at a minimal risk of predation (Havranek 1998, cit. Forbes 1995).

Despite the differences in the selective behaviour among different plant-eating groups, as well as among species, some general principles of making dietary choices are very similar, but the ways of their implementation are different. In this respect, all animals can be divided into two groups - *generalists* and *specialists* (Figure 1).

According to the available literature in the field of stockbreeding, agriculture, physiology and animal ecology, there are five different, mutually complementary theories that explain the selection of food (Havranek 1998, cit. Provenza & Balph 1990):

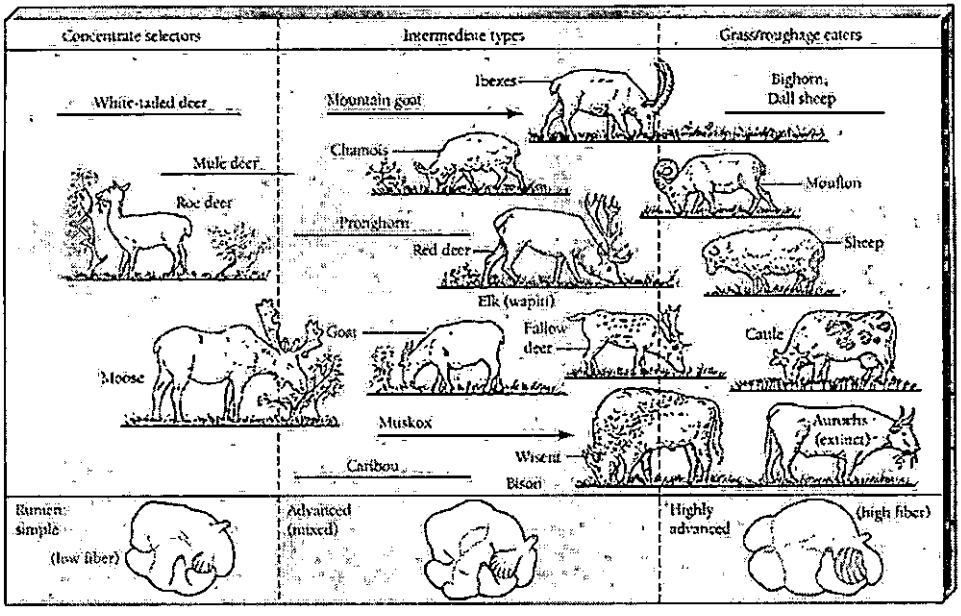


Figure 1. Positions of ruminant species within the system of feeding types
Slika 1. Shematski prikaz prehrambenih strategija različitih vrsta preživača

- Euphagia

This theory is based on the existence of an inherent ability of an organism to select an appropriate nutritious diet

- Hedyphagia

An organism selects food on the principle of palatability with special sensors which have developed during evolution, where nutritious foods become "pleasing" to the senses and toxic or low quality foods become "offensive". It is important to mention that neither euphagia nor hedyphagia take into account the post-ingestive processes.

- Morphophysiology and size of plant and animal

According to this theory, animal intake of foods is based on the differences in the physical and chemical properties of the food. This theory does not explain individual differences within species in consuming identical forage.

- Forage availability

An organism usually selects the food that is available.

- Experience

It is believed that it is much harder and more complicated for ruminants to learn to select

forages due to fermentative nutrient changes in nonglandular stomachs arising from the nutrient ratio in certain foods and the absorbed nutrients.

Taking all these theories into consideration, it can be said that an animal will decide on the selection of a given component in the environment on the basis of the following criteria:

1. Digesta fill
2. Physiology and reproductive condition,
3. Fitness, that is, the condition of body energy and nutrient reserves,
4. Water balance,
5. Nutrient and toxin levels in blood,
6. Experience,
7. Acclimatisation.

Small ruminants use more energy per kilogram of metabolic mass and therefore need a more digestive meal with a high concentration of nutrients. For this reason, small ruminants consume much less cellulose than cattle. Likewise, dry matter dissolves much faster in the rumen of small ruminants than of big ruminants (Havranek 1998, cit. Kleiber 1955, and cit. Van Soest 1994). This research was done on domestic livestock in the savannah, where rearing cattle was of a fully extensive character.

The quantity of consumed forage is also affected by an increase in the volume of abdominal organs, such as the abdominal fat and the uterus with embryo in that they cause a temporary compression of the rumen and a decreased food intake (Havranek 1998, cit. Frame, 1992). Next, at equal size, in obese and heavier animals a correlation between mass and food intake is reversed, while in growing animals it is positive (Havranek 1998, cit. Forbes 1995).

Most scientists today are doubtful about the importance of the senses as it is difficult to define their role (especially the sense of smell and taste, or their interactive relationship), as well as the role of past experience and memory. They claim that the importance of the senses is determined with the methods of their surgical removal, and that it is of little practical value in studying diet selection (Havranek 1998 cit. Lynch *et al.* 1992). However, current insights speak in favour of the importance of the senses in learning to adapt to and consume new foods. Thus, a test with sheep showed that they did not discriminate between the yellow (575 - 600 mn) and green colour (550 - 575 mn) of the same intensity, but could discriminate between colour intensities. It is a known fact that the intensity of the green colour of grass is proportional to the protein content (Havranek 1998, cit. Bazeley & Susan 1989, and cit. Forbes 1995). Other senses are also essential, with the difference that tactile experience is not acquired only with food intake but also with swallowing and chewing food. Together with other sensory properties of a plant, this contributes to the formation of its characteristic sensory picture.

To summarise, animals select the components according to their nutritional value or/and to their organoleptic properties.

The majority of animal studies involved research on their activities over a shorter period (and not over the whole day). This kind of research could not yield definite conclusions on animal behaviour. Observation of animals over longer intervals led to some interesting findings from the standpoint of nutritive strategies. As for feeding itself, it can be seen that animals do not feed only in the sense of continuous food intake, but also that feeding is a complex process

that can further be divided into several mutually related activities, such as:

- Searching for food,
- Catching food,
- Preparing food,
- Eating,
- Moving to a new feeding ground.

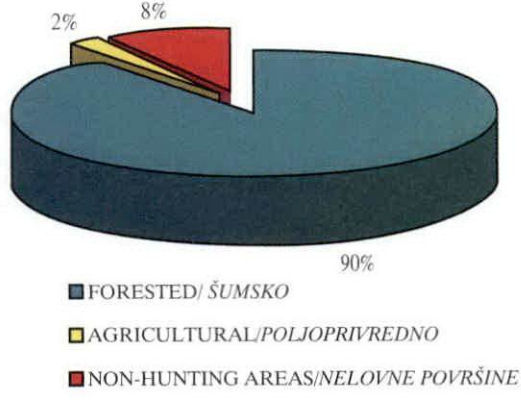
An animal constantly makes decisions on the next step in its behavioural sequences - when to stop with one activity and start with another. To understand these sequences, it is important to study the probability of making a certain decision from the standpoint of optimising a certain factor, such as, for example, the degree of net energy investment.

MATERIAL AND METHODS
MATERIJAL I METODE

AREA OF RESEARCH
PODRUČJE ISTRAŽIVANJA

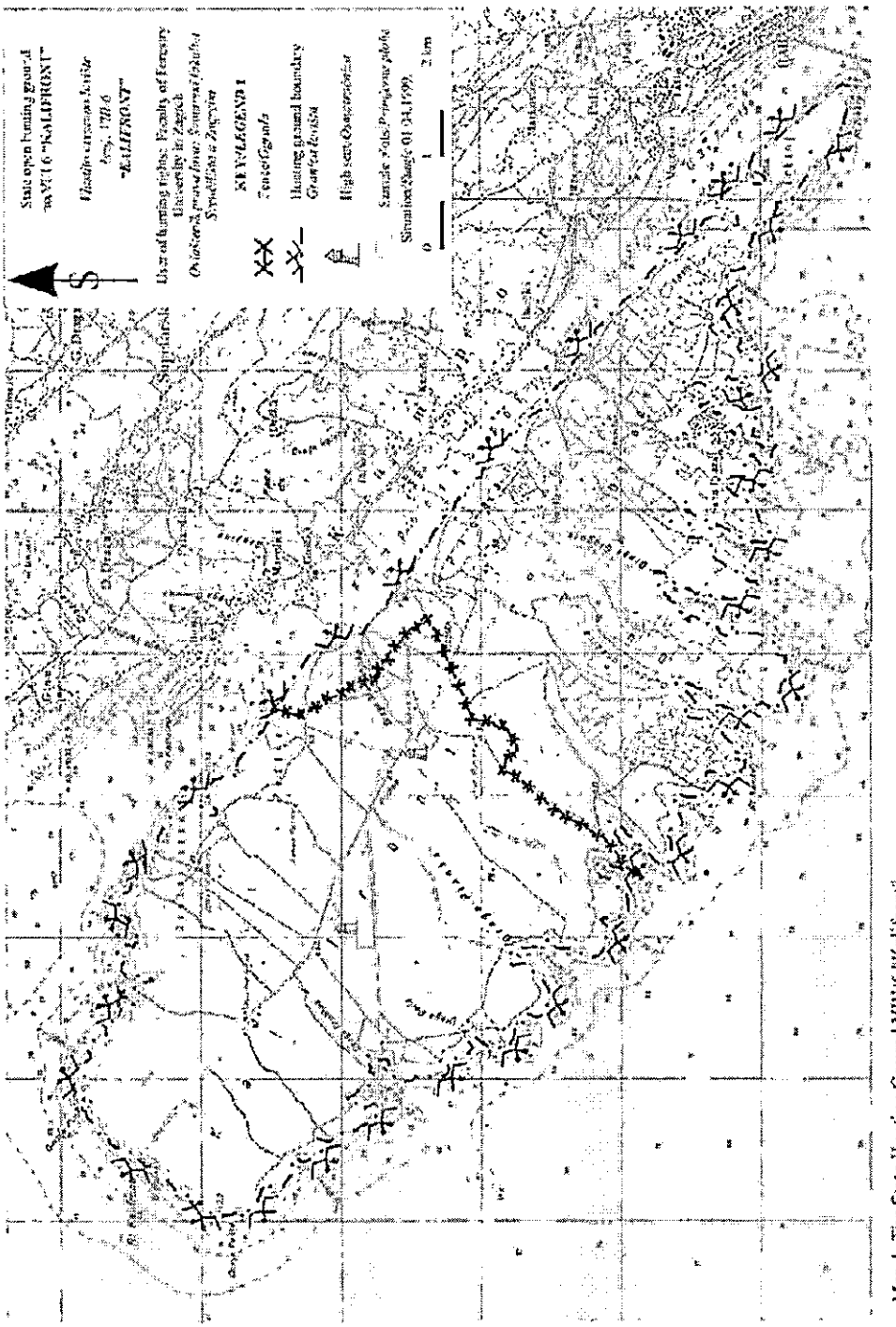
The state hunting ground VIII/6 "Kalifront" (Map 1) is located in the south-west of the island of Rab over a karst plateau of the same name, which is covered with the most valuable forest on the entire island. In relation to the island, Kalifront is a kind of peninsula, since there are two coves stretching deep along Kalifront:

- St. Euphemia in the south-east,
- Kamporska Draga in the north-west.



Graph 1. Percentage share of forested, agricultural and non-hunting areas in the hunting ground "Kalifront"

Grafikon 1. Postotni udio šumskih, poljoprivrednih i nelovnih površina lovišta "Kalifront"



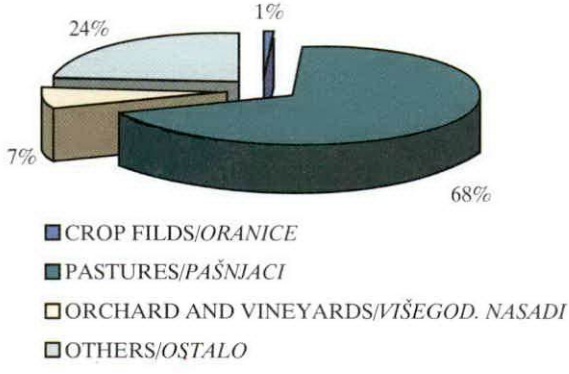
Map 1. The State Hunting Ground VIII/6 "Kalifront"
Karta 1. Državno lovište VIII/6 "Kalifront"

The hunting ground lies in the southeast - northwest direction in the length of 9 km from Frkanj promontory in the south-east to Kalifront promontory in the northwest. Its widest point of 3 km (2,950 m to be precise) is found between Planka promontory and Kamporska Uvala. Territorially, it belongs to the County of Primorje-Gorski Kotar, while from the hunting aspect it belongs to the Adriatic hunting area.

The boundary of the hunting ground begins on the promontory of Kalifront. From there it follows the coast towards the north-east over the Gornja Punta cove, and then south-east along the Kamporska Draga coast, then along the edge of the forest, or Kamporsko Polje, to the cove of St. Euphemia, and on along the coast to end with the starting point on the promontory of Kalifront. Based on the data from the Hunting Ground Foundation Act, the hunting ground covers 1,475 ha, of which 1,319 ha is forestland, 32 ha agricultural land and 124 ha constitutes non-hunting areas (Graph 1).

Graph 1 shows that 90% of the hunting ground is made up of forests, which favours natural rearing of wild even-toad ungulates. The small share of agricultural land in the hunting ground forces the breeder to construct and maintain light strips in the ground in order to provide the wildlife with sufficient quantities of forage.

In terms of the percentage share of agricultural areas by cultures (Graph 2), the share of crop fields is distinctly small. They cannot be used for the production of game food because they are privately owned and cultivated by the local population.



Graph 2. Percentage share of agricultural areas by cultures

Grafikon 2. Postotni udio poljoprivrednih površina po kulturama

Since the entire hunting ground is located on the peninsula, the central part is divided with a partition (3.4 km long). However, the partitioning of the hunting ground has profoundly changed the share of land by categories. Of a total of 840 ha of the enclosed area, about 825 ha (98%) belong to forests and the remaining 15 ha to roads (8.8 ha), light strips (5.9 ha) and grass areas - the nursery Topolje and the nursery A. Petračić (1.5 ha). It was for this reason precisely that forage areas were established for feeding the game in the hunting ground, because it was assumed that the game would not be able to satisfy its nutritional requirements in forest areas only.

In the enclosed part of the hunting ground during collecting the data for this paper, there were

45 heads of mouflon game and 22 heads of axis deer in all. Together, this makes a population density of all big game of 8 heads per 100 ha of the total ground area. According to Table 1, in the year of measurement the game population was suited to the carrying capacity. The enclosed part in which research was done has an area of 840 ha, and the concrete number of heads relates to the count in this part of the hunting ground.

Table 1. Site class, carrying capacity and growing area (GA) for mouflon and axis deer in the hunting ground "Kalifront"[1]

Tablica 1. Bonitet, kapacitet staništa te LPP za muflona i jelena aksisa u lovištu "Kalifront"[1]

Parameters *Parametri*	Mouflon *Muflon*		Axis deer *Jelen aksis*	
	From the working *Plan iz osnove*	Concrete situation *Stvarno stanje*	From the working *Plan iz osnove*	Concrete situation *Stvarno stanje*
GA[1] *LPP*[2]	861 ha	840 ha	930 ha	840 ha
Site class *Bonitet*	First *Prvi*		Second *Drugi*	
Number of heads per 100 ha *Broj grla na 100 ha*	5	5	3	3
Commercial capacity *Gospodarski kapacitet*	43	45	28	22
Hunting capacity *Lovnogosp. kapacitet*	57	51	36	28

[1] 01. April 1999

[2] GA=growing area/*LPP=lovnoproduktivna površina*

THE METHODOLOGY OF DATA COLLECTING
METODOLOGIJA PRIKUPLJANJA PODATAKA

GAME – CULTIVATED GRASSLANDS INTERACTION
INTERAKCIJA DIVLJAČ – KULTIVIRANI TRAVNJACI

During March 1998, the nursery Topolje and the nursery Andrija Petračić were ploughed over and clover grass mixtures of the following species were sown (Šoštarić-Pisačić 1967),

- Cock's foot (*Dactylis glomerata* L.)
- Italian rye-grass (*Lolium italicum* A. Br.)

- Smooth meadow-grass (*Poa pratensis* L.)
- Meadow fescue (*Festuca pratensis* A. Huds.)
- White clover (*Trifolium repens* L.)
- Lucerne (*Medicago sativa* L. 'Elga')

The sowing density is shown in Table 2 (Šoštarić-Pisačić 1967). The concrete sowing norms were obtained in the following way: the quantity of seed was divided with the spatial share each species would cover if it were sown as pure culture.

A total of 1,450 m² of grass mixtures were sown in Topolje, and 3,800 m² of grass mixtures and 2,500 m² of white clover and lucerne mixture were sown in the nursery Andrija Petračić. However, mouflon game concentrated on the nursery Topolje, resulting in all the grass being grazed or trampled in the first year. Of grass species, only cock's foot and Italian rye-grass occurred in both localities. White clover sprouted both in the nursery Topolje and in the nursery A. Petračić, and so did lucerne. In the latter nursery, white clover and lucerne achieved a cover of 90% as early as the first year.

Phytocoenology discriminates between two kinds of plant cover (Rauš & Vukelić 1998):

- Concrete cover - is the cover that a plant achieves after the removal of its above-ground parts and is independent of yearly seasons,
- Projected cover - represents the projection of all above-soil parts of a plant and changes during the vegetation period, but also during the grazing period.

Table 2. The quantity of sown seed by grass species
Tablica 2. Količina zasijanoga sjemena po vrstama travnjačkih biljaka

Species *Vrsta*	Mass *Količina* (kg)	Area *Površina* ha	Concrete norm *Stvarni normativ*	Recommended norm *Preporučljiv normativ*
			(kg/ha)	
Cock's foot *Klupčasta oštrica*	8	0.54	37	30
Italian rye-grass *Talijanski ljulj*	3	0.54	28	25
Smooth meadow-grass *Livadna vlasnjača*	3	0.54	37	32
Meadow fescue *Livadna vlasulja*	5	0.54	37	50
White clover *Bijela djetelina*	2	0.25	40	16
Lucerne 'Elga' *Lucerna 'Elga'*	8	0.25	40	30

The majority of the researchers use the projected cover because it clearly shows natural relationships in a stand in the peak period of its development. Therefore, the projected cover was used here to determine the pasture cover.

For easier cover sampling, the areas in the nursery A. Petračić were divided in three plots as shown in Figure 2, and in the nursery Topolje in two plots (Figure 3). Since the game grazed poorly in the nursery A. Petračić, the grass had to be mowed. During 1999, the same areas were mowed four times in all: once in May, once in July, once in early September and once in early

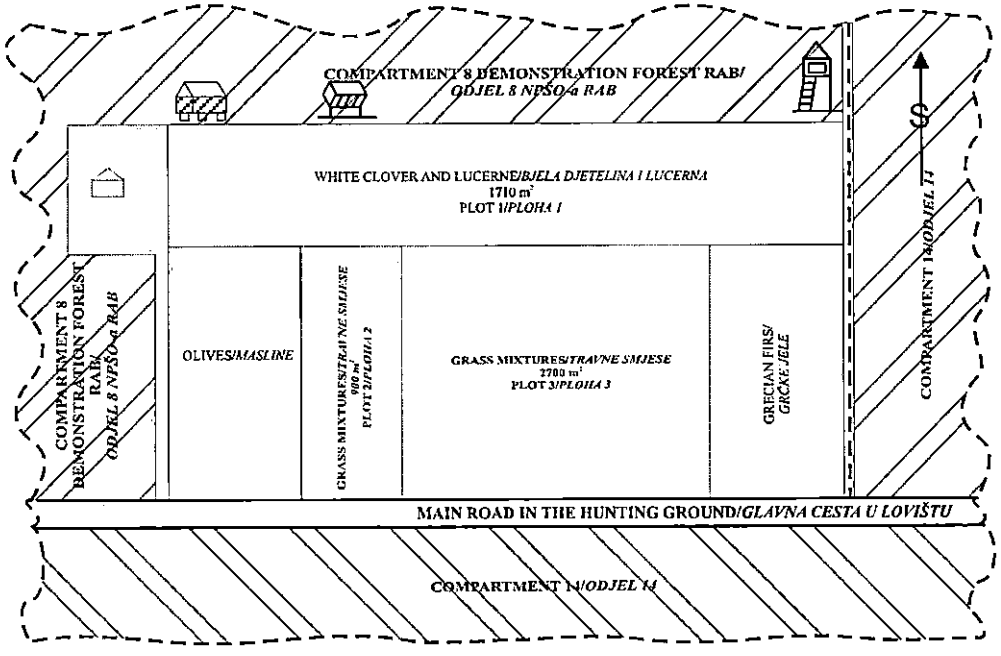


Figure 2. Plan of area distribution in the nursery A. Petračić
Slika 2. Shematski prikaz rasporeda površina u rasadniku A. Petračić

October. The grass areas in the nursery Topolje were never mowed as it was not necessary. The hay from these areas was bundled and offered to game in feeding places - hay racks.

During May 1999, one part of Topolje was ploughed over, and only plot 1 remained covered with grass, so that the grass cover was assessed only in this plot.

The grass cover was assessed in October 1999. At that time of the year, grass vegetation was well developed after summer droughts. To assess the grass cover, a wooden frame (square) with 1 x 1 m sides (1 m²) was constructed. For more accurate reading of the cover, thick thread was used to further divide the square into 100 regular smaller squares sized 1 dm² (Figures 4 and 5). The cover was assessed for each square decimetre. Sample plots were set up at the diagonal transect for each grassy plot. The sampling intensity was 10% for the plot in Topolje (higher variability) and 1% for the plots in the nursery A. Petračić. Table 3 shows plot distribution by cover.

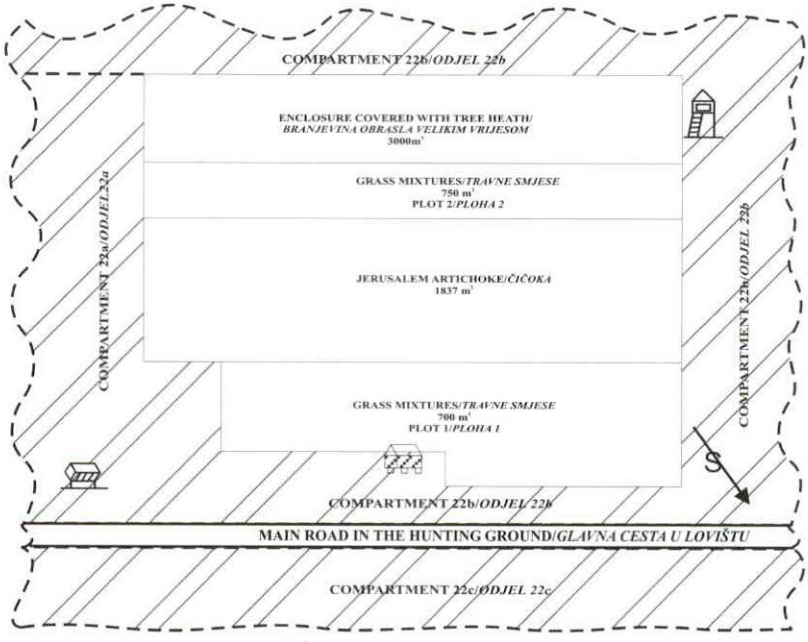


Figure 3. Plan of area distribution in the nursery Topolje
Slika 3. Shematski prikaz rasporeda površina u rasadniku Topolje

Figure 4. The lowest grassland cover in the nursery Topolje
Slika 4. Najmanja pokrovnost travnjaka izmjerena u rasadniku Topolje

Figure 5. The highest grassland cover in the nursery A. Petračić
Slika 5. Najveća pokrovnost travnjaka izmjerena u rasadniku A. Petračić

Table 3. Cover share by plots (1 plot = 1 dm²)
Tablica 3. Prikaz zastupljenosti pokrovnosti po plohama (1 ploha = 1 dm²)

Cover *Pokrovnost*	Plot distribution by cover *Distribucija ploha po pokrovnosti*			
	Plot t *Ploha t*	Plot 1 *Ploha 1*	Plot 2 *Ploha 2*	Plot 3 *Ploha 3*
0 - 10 %	237	10	2	14
10 - 20 %	99	42	22	55
20 - 30 %	65	34	4	75
30 - 40 %	65	43	0	61
40 - 50 %	56	72	50	151
50 - 60 %	69	59	44	300
60 - 70 %	106	84	50	269
70 - 80 %	91	188	103	479
80 - 90 %	98	224	197	742
90 - 100 %	114	1044	428	554
Total *Ukupno*	1000	1800	900	2700

In order to establish the grassland capacity, during 1999 game was monitored from closed observation posts placed in each nursery. In both observation posts, the game was monitored

at the same time one day in the morning and the next day before evening. Monitoring was done every Thursday from 1 April 1999 to 28 October 1999. There were 31 monitoring sessions in all.

GAME - JERUSALEM ARTICHOKE *(HELIANTHUS TUBEROSUS L.)* INTERACTION

INTERAKCIJA DIVLJAČ – ČIČOKA *(HELIANTHUS TUBEROSUS L.)*

According to Grlić (1986), Jerusalem artichoke is a perennial plant achieving a height of up to 2 m. It is related to and resembling the sunflower, with an erect, hirsute stalk, which is bushy at the top and with knobbly tubers on underground stems. The flower heads develop from September to November. It is native to North America. It was introduced to England in 1616, and has become naturalised in the whole of Europe. It is used as livestock food, as a vegetable and as an ornamental plant. It frequently grows in the wild. The tubers are very nutritious and are dug out in late autumn.

Jerusalem artichoke has proved to be an excellent culture for game nutrition. It has very modest soil requirements, is resistant to many diseases, and apart from the tubers, it also forms a large above-ground mass. According to Timarac (2000), wild ruminants like to eat young stems, but before, after and during the blossoming period the stems become hard and the leaves hirsute, so the game avoids it. The same author recommends the stems to be used as silage or dried. It is important to mention that, if there is sufficient food, game avoids Jerusalem artichoke. Table 4 gives the chemical content of different parts of Jerusalem artichoke.

Table 4. Cemical content of Jerusalem artichoke
Tablica 4. Kemijski sastav čičoke

Cemical composition *Kemijski sastav*	Percentage share of individual matter *Postotni udio pojedinih tvari*	
	Stem *Nadzemni dio*	Tubers *Gomolji*
Dry matter *Suha tvar*	16.5	15 - 25
Sugars *Šećeri*	-	13 - 20
Raw protein *Dušične tvari*	1.8 - 2.7	1.7
Raw fibers *Gruba vlakna*	2.0 - 3.9	1.0
Fat *Masnoća*	0.5 - 0.21	0.10 - 0.15
Ash *Pepeo*	2.2 - 7.6	1.0 - 2.0

Source/*Izvor*: Timarac (2000)

According to Table 4, the stem is almost as nutritious as the tubers. The intake of Jerusalem artichoke by game was analysed in the mentioned hunting ground for this reason. Jerusalem artichoke was brought to this ground by some hunters of Rab.

Figure 6. Jerusalem artichoke plantation in September 1998
Slika 6. Nasad čičoke u rujnu 1998. godine

Figure 7. Jerusalem artichoke in June 1999
Slika 7. Biljke čičoke u lipnju 1999. godine

The chronology of Jerusalem artichoke grazing after introducing mouflon game in the hunting ground is as follows:

- The plot of Jerusalem artichoke, covering an area of 1,837 m², was left in the original condition. After introducing the mouflon from the quarantine, the game literally devastated the whole culture (Figure 6). In September 1998, the remains of Jerusalem artichoke stems were as thick as straw and bitten off 15 cm from the ground.
- In May 1999, the field was ploughed over and 25 kg of artificial fertilizers of the 15-15-15 NPK formulation were used. In order to assess the tuber size, hazelnut-size tubers of several plants were dug out. That same year, Jerusalem artichoke developed well (Figure 7).

Two measurements were made in order to see in which period the game grazed on Jerusalem artichoke most. The first was made on 2 June 1999, and the second on 31 July 1999. The measurements were made in sample plots sized 1 m². There were 7 sample plots in all. Both measurements were made in the same plots. The measurements involved counting the leaves and measuring the height from the

ground to the top of a plant. The plants were divided into damaged and undamaged groups. In the leaf count, all undamaged leaves were counted.

RESEARCH RESULTS
REZULTATI ISTRAŽIVANJA

GAME – CULTIVATED GRASSLANDS INTERACTION
INTERAKCIJA DIVLJAČ – KULTIVIRANI TRAVNJACI

The percentage share of grass species (by number) in the nurseries was as follows: Topolje (Plot T, Figure 8) - *Lolium multiflorum* participated with 10% and so did *Dactylis glomerata,* while the rest of the plot was taken by the following plant species: *Cynodon dactylon, Digitaria sanguinalis, Setaria glauca, Setaria viridis, Echinocloa crus-galli, Trifolium repens, Achillea* sp., etc.

Figure 8. The impact of game on the plant cover in the nursery Topolje
Slika 8. Utjecaj divljači na pokrovnost biljaka u rasadniku Topolje

The nursery A. Petračić:

- Plot 1 (Figure 9) - about 80% of the plot was taken by *Agropyron* sp., while about 20% of the plot was taken by *Trifolium repens* and *Medicago sativa*,

Figure 9. Plant cover in Plot 1
Slika 9. Pokrovnost biljaka na plohi 1

- Plot 2 (Figure 10) - about 20% of the plot was taken by *Dactylis glomerata* and *Lolium multiflorum*, and about 80% by other plant species (the same as in Topolje),

Figure 10. Plant cover in Plot 2
Slika 10. Pokrovnost biljaka na plohi 2

• Plot 3 (Figure 11) - about 30% of the plot was taken by *Dactylis glomerata* and *Lolium multiflorum*, 10% was taken by *Artemisia vulgaris*, and the rest of the plot was taken by other plant species (the same as in Topolje),

Figure 11. Plant cover in Plot 3
Slika 11. Pokrovnost biljaka na plohi 3

Table 5. Statistical parameters of grass cover
Tablica 5. Statistički parametri pokrovnosti trava

Parameters *Parametri*	Plot T *Ploha T*	Plot 1 *Ploha 1*	Plot 2 *Ploha 2*	Plot 3 *Ploha 3*
Mean *Arit. sredina*	5	9	9	8
Standard error *Stand. pogreška*	0.10	0.05	0.06	0.04
Median *Median*	5	10	9	8
Mode *Mod*	1	10	10	9
Stand. deviation *Stand. devijacija*	3.3	2.1	1.9	2.0
Sample variance *Varijanca*	10.7	4.5	3.5	4.2
Range *Opseg*	9	9	9	9
Minimum	1	1	1	1
Maximum	10	10	10	10
Sum *Suma*	5076	15630	7799	21081
Count *n*	1000	1800	900	2700

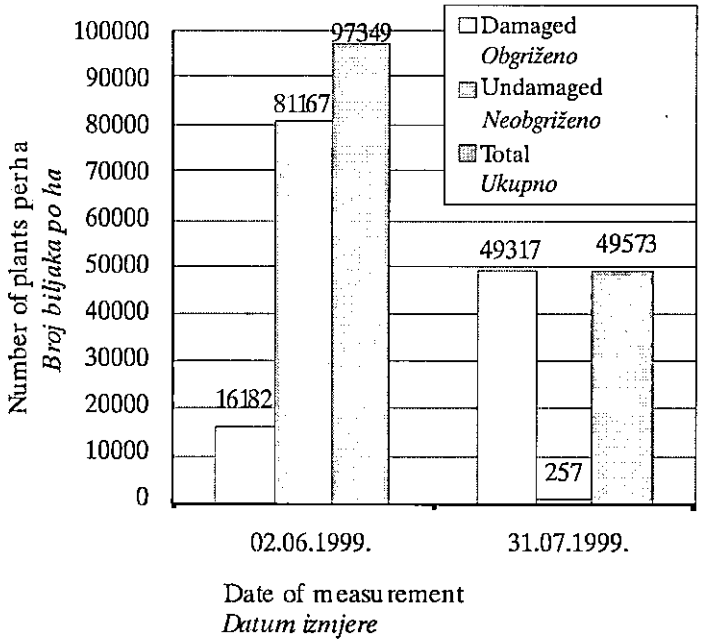
Table 5 shows that the grass area in the nursery Topolje has the lowest cover (40 to 50%), while plots 1 and 2 in the nursery A. Petračić have the highest cover (80 to 90%), and plot 3 in the same nursery has a cover between 70 and 80%.

Apart from the differences in the cover, which is obvious and need not, therefore, be tested with statistical tests, there is also a difference in standard plot cover deviations. The plot in the nursery Topolje displays high variability in the cover ($s_x = 3.3$), unlike the plots in the nursery A. Petračić, where variability is much lower ($s_x = 1.9$ to $s_x = 2.1$). This is supported by Figure 4, taken in the nursery Topolje, which shows that there were even subplots in which the cover was 0% (placed in class 1). Figure 5 shows a much higher cover. In the same plots, higher cover classes were better represented.

GAME - JERUSALEM ARTICHOKE *(HELIANTHUS TUBEROSUS L.)* INTERACTION

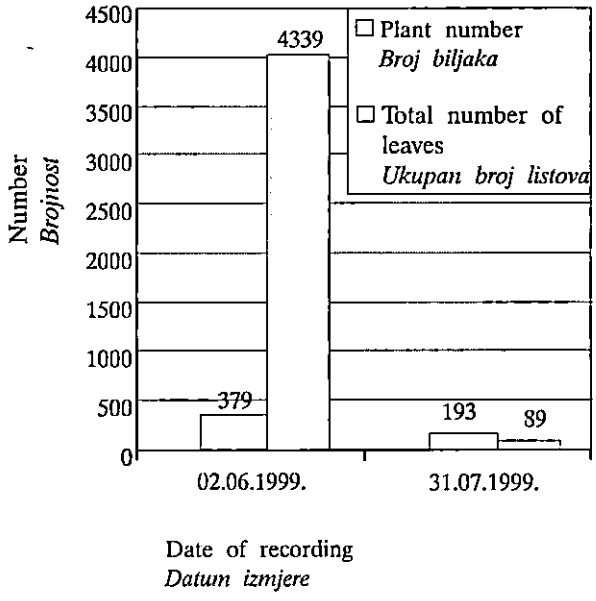
INTERAKCIJA DIVLJAČ – ČIČOKA *(HELIANTHUS TUBEROSUS L.)*

According to Graph 3, of 97,349 plants/ha, 16,182 plants/ha were damaged by game (17%) by the beginning of June. Due to high game pressure on Jerusalem artichoke over a period of two months (June and July), 51% of the plants perished. As a result, 49,573 plants/ha were recorded, of which 49,317 (99%) were damaged.



Graph 3. The share of damaged and undamaged plants of Jerusalem artichoke in sample plots

Grafikon 3. Udio oštećenih i neoštećenih biljaka čičoke na primjernim plohama



Graph 4. Leaf and plant number ratio in sample plotss
Grafikon 4. Odnos broja listova i biljaka na primjernim plohama

The sample plots contained plants whose vegetation tops were not bitten off, but whose leaves were damaged. For this reason, the number of leaves for each plant in the sample plot was counted. Graph 4 shows that by the beginning of June, each plant had 11 leaves on average, while during June and July, the number of leaves on a plant dropped to 0.5, or one in two plants in the sample had only one undamaged leaf.

In order to determine the height at which game bites the plants, the measured plants were divided into:

- undamaged - these were the plants whose tops were not damaged (this category also included plants whose leaves were damaged but the vegetation tops were not damaged),
- damaged - this category included plants with bitten stems, that is, those in which the vegetation tops of terminal shoots were bitten off.

Measurements of plant heights from the ground vertically to the vegetation top, that is, to the biting point, showed that the plants with undamaged tops were 38.2 cm tall on average, while the biting height was 47.0 cm on average. In Table 6, animals exhibit deviations in biting heights, since s_x =12.33 on 2 June 1999, or s_x = 17.61 on 31 July 1999.

To get a better insight into plant biting heights, the plants were placed into height classes of 10 cm according to the height and the biting height, as shown in Table 6.

Table 6. Biting height of Jerusalem artichoke
Tablica 6. Visina odgrizanja biljaka čičoke

Statistical parameters *Statistički parametri*	Date of measurement: *Datum izmjere:* 02.06.1999.		Date of measurement: *Datum izmjere:* 31.07.1999.
	Undamaged *Neoštećene*	Damaged *Oštećene*	Damaged *Oštećene*
Mean *Arit. sredina*	38.2	47.0	35.3
Standard error *Stand. pogreška*	1.32	1.55	1.27
Median *Median*	32	50	34
Mode *Mod*	16	28	34
Stand. deviation *Stand. devijacija*	23.50	12.33	17.61
Sample variance *Varijanca*	552.29	152.14	309.93
Range *Opseg*	102	62	96
Minimum	4	10	4
Maximum	106	72	100
Sum *Suma*	12075	2958	6780
Count *n*	316	63	192

Table 6 shows that the average height of damaged plants exceeded that of undamaged plants. It is also clear that the height of damaged plants at the beginning of June exceeded the height of plants measured at the end of July.

To determine the significance of the difference, a U-test was made in order to confirm the above result. The hypotheses are as follows:

- Testing the difference between damaged and undamaged plants (measurement date: 2 June 1999)

$$H_0;\ \bar{h}_N = \bar{h}_O$$
$$H_1;\ \bar{h}_N > \bar{h}_O$$

where

$\overline{h}_N$ = average height of undamaged plants

$\overline{h}_O$ = average height of plants with bitten tops (biting height).

- Testing the difference between damaged plants measured on 2 June 1999 and 31 July 1999 (Table 10).

$$H_0;\ \overline{h}_{O1} = \overline{h}_{O2}$$
$$H_1;\ \overline{h}_{O1} > \overline{h}_{O2}$$

where

$\overline{h}_{O1}$ = average height of damaged plants (2 June 1999)

$\overline{h}_{O2}$ = average height of damaged plants (31 July 1997).

Table 7. Distribution of Jerusalem artichoke by height classes
Tablica 7. Distribucija biljaka čičoke po visinskim razredima

Height classes *Visinski razredi* (cm)	Date: *Datum:* 02.06.1999.		Total *Ukupno*	Date: *Datum:* 31.07.1999.		Total *Ukupno*
	Damaged *Oštećene*	Undamaged *Neoštećene*		Damaged *Oštećene*	Undamaged *Neoštećene*	
0-10	1	16	17	14	0	14
10-20	0	78	78	29	1	30
20-30	7	58	65	31	0	31
30-40	10	41	51	54	0	54
40-50	17	34	51	34	0	34
50-60	20	39	59	15	0	15
60-70	7	20	27	8	0	8
70-80	1	10	11	5	0	5
80-90	0	4	4	1	0	1
90-100	0	13	13	1	0	1
100-110	0	3	3	0	0	0
Total *Ukupno*	63	316	379	192	1	193

The U-test showed (with the significance boundary of 99%) that by 2 June 1999, game preferred to damage higher plants. The test also showed that by the end of July, game significantly lowered the biting height by 11 cm on average.

The intake of different plant parts is essential for knowing the feeding habits of an animal species. For this reason, we wanted to ascertain whether game preferred the shoots and stems of Jerusalem artichoke, or its leaves, and in which period it preferred some of these categories. For this purpose, all plants with undamaged stems and leaves were placed in the category of undamaged plants, while those with damaged stems or leaves were placed in the category of damaged plants.

Table 8. U-test for Jerusalem artichoke height category
Tablica 8. U-test za kategoriju visina biljaka čičoke (cm)

Statistical parameters *Statistički parametri*	Plant height *Visina biljaka* - 02.06.1999.	
	Undamaged *Neoštećene*	Damaged *Oštećene*
Mean *Arit. sredina*	38.2	47.0
Sample variance *Varijanca*	552.29	152.14
Count *n*	316	63
$u_{izr.}$	-4.28	
$u_{tab.}$	2.33	
Statistical parameters *Statistički parametri*	Damaged- plant height *Oštećene -visina biljaka*	
	02.06.1999	31.07.1999
Mean *Arit. sredina*	47.0	35.3
Sample variance *Varijanca*	152.14	309.93
Count *n*	63	192
$u_{izr.}$	5.799	
$u_{tab.}$	2.326	

Table 8 shows that the plants with damaged leaves (2 June 1999) still had a higher number of leaves ($\overline{n}$ = 13.4) than undamaged plants (10.4). Also, damaged plants were taller on average ($\overline{h}_N$ = 38.3) than undamaged plants ($\overline{h}_O$ = 42.3). A U-test was made in order to find out whether there was a significant difference between the leaf number and the heights, or the biting heights in damaged and undamaged plants, and damaged plants at the beginning of June and the end of July. The following hypotheses were made:

* Testing the difference between the number of leaves in damaged and undamaged plants of Jerusalem artichoke damaged by 2 June 1999.

$$H_0;\ \overline{n}_N = \overline{n}_O$$

$$H_1;\ \overline{n}_N > \overline{n}_O,$$

where

$\overline{n}_N$ = average number of leaves on Jerusalem artichoke plants whose leaves were not damaged,

$\overline{n}_O$ = average number of leaves on Jerusalem artichoke plants whose leaves were damaged.

- Testing the difference between the number of leaves of Jerusalem artichoke damaged by 2 June and those damaged by 31 July 1999.

$$H_0,\ \overline{n}_{O1} = \overline{n}_{O2}$$

$$H_1,\ \overline{n}_{O1} > \overline{n}_{O2},$$

where

$\overline{n}_{O1}$ = average number of leaves on Jerusalem artichoke plants whose leaves were damaged (measurement data: 2 June 1999)

$\overline{n}_{O2}$ = average number of leaves on Jerusalem artichoke plants whose leaves were damaged (measurement date: 31 July 1999).

Table 9. Leaf number and heights of damage and undamaged plants of Jerusalem artichoke

Tablica 9. Broj listova i visine biljaka oštećenih i neoštećenih biljaka čičoke

Statistical parameters *Statistički parametri*	Date of measurement: *Datum izmjere:* 02.06.1999.				Date of measurement: *Datum izmjere:* 31.07.1999.	
	Undamaged *Neoštećene*		Damaged *Oštećene*		Damaged *Oštećene*	
	Plant height *Visina biljaka*	Leaf number *Broj listova*	Plant height *Visina biljaka*	Leaf number *Broj listova*	Plant height *Visina biljaka*	Leaf number *Broj listova*
Mean *Arit. sredina*	38.3	10.4	42.3	13.4	35.2	0.5
Standard error *Stand. pogreška*	1.44	0.37	1.86	0.98	1.27	0.05
Median *Median*	35	10	44	9	34	0
Mode *Mod*	16	8	17	7	34	0

Statistical parameters *Statistički parametri*	Date of measurement: *Datum izmjere:* 02.06.1999.				Date of measurement: *Datum izmjere:* 31.07.1999.	
	Undamaged *Neoštećene*		Damaged *Oštećene*		Damaged *Oštećene*	
	Plant height *Visina biljaka*	Leaf number *Broj listova*	Plant height *Visina biljaka*	Leaf number *Broj listova*	Plant height *Visina biljaka*	Leaf number *Broj listova*
Stand. deviation *Stand. deviacija*	22.70	5.84	21.26	11.22	17.63	0.75
Sample variance *Varijanca*	515.43	34.16	451.80	125.78	310.67	0.56
Range *Opseg*	102	46	93	59	96	3
Minimum	4	4	10	4	4	0
Maximum	106	50	103	63	100	3
Sum *Suma*	9494	2584	5539	1755	6794	89
Count *n*	248	248	131	131	193	193

Table 10. U-test for Jerusalem artichoke leaf number

Tablica 10. U-test za kategoriju broj listova na biljkama čičoke

Statistical parameters *Statistički parametri*	Leaf number *Broj listova* 02.06.1999.	
	Undamaged *Neoštećene*	Damaged *Oštećene*
Mean *Arit. sredina*	10.4	13.4
Sample variance *Varijanca*	34.1554133	125.7797
Count *n*	248	131
$u_{izr.}$	-2.84	
$u_{tab.}$	2.33	
Statistical parameters *Statistički parametri*	Leaf number- damaged *Broj listova-oštećeni*	
	02.06.1999	31.07.1999
Mean *Arit. sredina*	13.4	0.5
Sample variance *Varijanca*	125.78	0.56
Count *n*	131	193
$u_{izr.}$	13.18	
$u_{tab.}$	2.33	

The U-test showed (with the significance boundary of 99%) a significant difference in the average number of leaves per plant. This is undoubtedly caused by the fact that damaged plants also had higher heights (42.3 cm) than undamaged plants (38.3 cm). The test also showed that until the end of July game preferred to consume leaves.

DISCUSION
RASPRAVA

In Western and Central Europe, grass areas are mainly established to accommodate small field or possibly roe deer game. Grass areas in this hunting ground are gaining value for the fact that they support a population of brown hare (*Lepus europaeus* Pall.), which has for many years now been at a minimal number (there is a total of 7 tails in the entire area of the hunting ground). Such a condition of the hare population results exclusively from the unfavourable structure of the area, where open spaces fare less than 1% (7.4 ha).

Open spaces are not important only as production areas of game forage (it is assumed that game satisfies its browse requirements in the forest), but they also:

- Provide breeding space,
- Provide denning sites for the young,
- Enable wildlife animals easier drying from rain,
- Ease game stalking and hunting:
- Offer the protective function - namely, the established forage areas in central parts of the hunting ground lure animals there, thus preventing them from wandering to the coastal area for grazing, where they frequently fall prey to poachers who shoot at them from boats at sea.

Only grasses and clovers listed in Table 6 were sown with the purpose of establishing grass areas. However, the nutritive value of grass was enhanced with the addition of some herbaceous plants in the mixture, which, apart from being more palatable for the game, also prolong the grassland vegetation, making it available for a longer period.

During summer until mid-October, the grasslands and Jerusalem artichoke in this hunting ground are dry and make poor forage for the game. This is generally a problem of arid habitats, as there is a shortage of water and fresh food in this period. Yet, not all ruminants are dependent exclusively on water. So, for example, mouflon rarely drink water (Piegert 1999), as they compensate for the water through food. It should be mentioned that as early as the first year after introducing mouflon game in this habitat, it was noted that the bark was stripped from manna ash (*Fraxinus ornus* L.) and holm oak (*Quercus ilex* L.) - the tree species with smooth bark, as well as from broad-leaved phillyrea (*Phillyrea latifolia* L.) and, to a lesser degree, from strawberry tree (*Arbutus unedo* L.). Similar problems were noted by Tschiderer (1974) in Austria, who points out that this occurrence was most probably linked to water shortage.

There is little written data on axis deer. In this game species, the most interesting facts are the size of herd, the social structure and the way of life. In thickets and in grasslands, a herd size correlates with the quantity of precipitation. In terms of precipitation quantity, the correlation is

negative, but in terms of the number of wild fruit trees and leaf litter availability it is positive. In summer, or in dry season, the population density is more than two times higher in forests than in open spaces. If some nutritive components are dispersed, or the habitat is closed, bigger herds are formed (Raman 1997).

Telemetric observation of 12 does and 7 bucks of this species in Nepal (Barolia National Park) showed that annual and seasonal home ranges were relatively small, and that males had a bigger action radius than females in the monsoon part of the year and in the hot part of dry season. The area consists of sever types of habitats which are relatively regularly arranged in the form of smaller areas. During hot and dry season, and especially during night, the does preferred grasslands, where *Imperata cylindrica* was the dominant species. During cold and dry season and hot and dry season, the bucks stayed in floodplain forests, and in the monsoon period and partly during a part of cold and dry season in the forests of salty terrains (Moe and Wegge 1994).

Table 11. The number of game in grass areas
Tablica 11. Broj divljači na travnatim površinama

Statistical parameters *Statistički parametri*	Topolje			A. Petračić
	Mouflon *Muflon*		Axis deer *Aksis*	Axis deer *Aksis*
	Morning *Jutro*	Evening *Večer*	Evening *Večer*	Evening *Večer*
Mean *Arit. sredina*	9	2	2	4
Standard error *Stand. pogreška*	1.4	1.0	0.5	0.8
Median *Median*	10	0	1	5
Mode *Mod*	12	0	1	0
Stand. deviation *Stand. deviacija*	5.5	3.8	1.8	3.2
Sample variance *Varijanca*	30.4	14.2	3,3	10.6
Range *Opseg*	22	12	5	9
Minimum	0	0	0	0
Maximum	22	12	5	9
Sum *Suma*	149	26	28	58
Count *n*	16	15	15	15

The interaction between axis deer and forest ecosystems is also interesting. In many regions where axis deer is an autochthonous species, there is a distinct problem of successful forest regeneration. Thus, the impact of this game on the regeneration of mangrove forests was monitored in Bangladesh (the Sundarkans area). Plants (aged 10 months) of the following tree

species were planted: *Heritiera fomes, Xylocarpus mekongensis, Brugiera sexangula, Ceriops decandra, Avicenia officinalis* and *Exoecearia agallocha*. As early as after the first year, damage assessment showed that this game critically damaged all plants in the unfenced area. The survival percentage was nil for the species *Xylocarpus mekongensis, Brugiera sexangula,* and *Avicenia officinalis.* The survival percentage of the three remaining species reached 40% (Siddiqi 1996).

Similar studies of this interaction on Hawaii showed that axis deer made a considerable impact on the success of afforestation with the species *Leucaena diversifolia.* Four-month-old seedlings were planted in the mixture with eucalyptus (*Eucaliptus saligna*). *Leucaena diversifolia* was completely destroyed, whereas axis deer did not damage eucalyptus plants (which is toxic, Krapinec), and so they prospered well. It is important to point out that axis deer in Latin America did not damage plants of *Leucaena diversifolia,* but this tree species is autochthonous there (Brewbaker 1988).

In the grass areas of the hunting ground "Kalifront", axis deer was observed in differently-sized herds. Calves herded by bucks were frequently noted, while one buck with three does was also sometimes observed. With regard to the time of the day, as a rule, axis deer grazed at night (Table 11).

GAME – CULTIVATED GRASSLANDS INTERACTION
INTERAKCIJA DIVLJAČ – KULTIVIRANI TRAVNJACI

To get a better notion of grassland use in the hunting ground in 1999, the game was monitored from two closed high seats, of which one was placed in each nursery.

Table 11 was made to simplify the issue. It should be mentioned that mouflon did not appear in the nursery A. Petračić, but regularly did so in the nursery Topolje. Axis deer foraged only in the evening and remained in the grassland all night. Mouflon usually grazed early in the morning. The hour of grazing changed over the year. According to Table 11, on average 13 heads of game, of which 11 were mouflon and 2 were axis deer, grazed in the nursery Topolje, while 4 heads of axis deer grazed in the nursery A. Petračić on average. This number of game in the nursery Topolje highly correlates with the low cover, because the size of the mouflon herd grazing in the nursery ranged from 3 to 22 heads, and of axis deer from 1 to 5 heads. This significantly reduced the nutritive potential of the grassland, and so they had to be re-ploughed and re-sown with grass mixtures. It should be pointed out that in forage areas, and especially in grasslands, large biomass does not have big importance as the game tramples over most of it, causing the food to perish. Therefore, it is more important to have a smaller quantity of biomass distributed over a larger area. Likewise, the term of the first sowing did not endanger the growth of selected grasses, clovers and lucerne. Their growth was primarily influenced by game activity, which gathered here in larger numbers for several reasons:

- The vicinity of the fence - after the fence - partition was erected in the hunting ground, most game tracks continued to follow the fence itself, which means that the game probably searches for non-existent gates.
- Immediately next to the meadow on the other side of the main road there is a holm oak enclosure, providing excellent shelter for the game, especially for axis deer

(it is almost impenetrable for man), from which game makes nocturnal visits to the nursery.

- South-east from the nursery there is an old quarry, where mouflon has immediately settled and from which it usually goes on forage sprees.
- The stretch of the forest between the nursery Topolje and the road serves as a partition sheltering the game from man. This is the main road in the hunting ground used by cars and tourists (Figure 2 and 3).
- The game was attracted to this plot by the Jerusalem artichoke plantation and the food storage (corn), and it also grazed in the grasslands (Figure 2 and 3).
- The absence of hunting allowed mouflon to form a large herd (consisting of as many as 40 heads already in the first year), always led by the same old ewe. In the hunting sense, in such cases a herd must be broken into several smaller ones by eliminating a herd leader. In our case, the herd size is probably the consequence of transporting the game together, keeping them in the quarantine and introducing them into the new habitat, rather than of poor nutritive conditions in the hunting ground.

Plant composition and grassland cover are influenced by the game in several ways:

- Game grazing and trampling destroys the plant cover,
- Game urine and defecations fertilise the soil, thus improving the conditions for plant growth.

The breaking up of mouflon herds and the formation of more grass areas would relieve the nursery Topolje and decrease game rearing costs, because grass species would need to be regenerated (re-sown) much less frequently (every four or five years). Interestingly, the game did not consume the hay in the feeding points or hay stacks, nor did it lick salt from salt licks (rock salt was offered). This means that during the year animals have enough natural dry food and that no additional bulky food need be ensured for mouflon and axis deer in eu-Mediterranean conditions. The data concerning hay and salt consumption were not measured since these were not consumed. Corn storages need to be enclosed to keep the game away for two reasons:

- the game was noted to extract corn cobs itself, damaging the hunting facility in the process,
- when the game extracts food, the cobs fall on the ground. The animals eat them from the ground, which represents a hazard from the aspect of pathology and health prevention. Around the storages there are animal faeces (non-polluted), but in contact with the food on the ground, may become the breeding ground of vario infections. To prevent this, grain food must be put into troughs.

Of other plant species in the nursery Topolje, game consumed the following: *Setaria viridis, Setaria glauca, Achilea* sp. (only flower heads), *Holcus lanatus, Digitaria sanguinalis, Cynodon dactylon, Echinocloa crus-galli, Erigeron canadensis, Stenactis annua, Polygonum*

lapathifolium, Polygonum aviculare, Solidago serotina, Rumex acetosa, Rumex acetosella, Chenopodium album and *Hypericum veronense*, while the species *Inula viscosa* was not foraged. *Artemis vulgaris* began spreading in the nursery A. Petračić, but the game did not graze it.

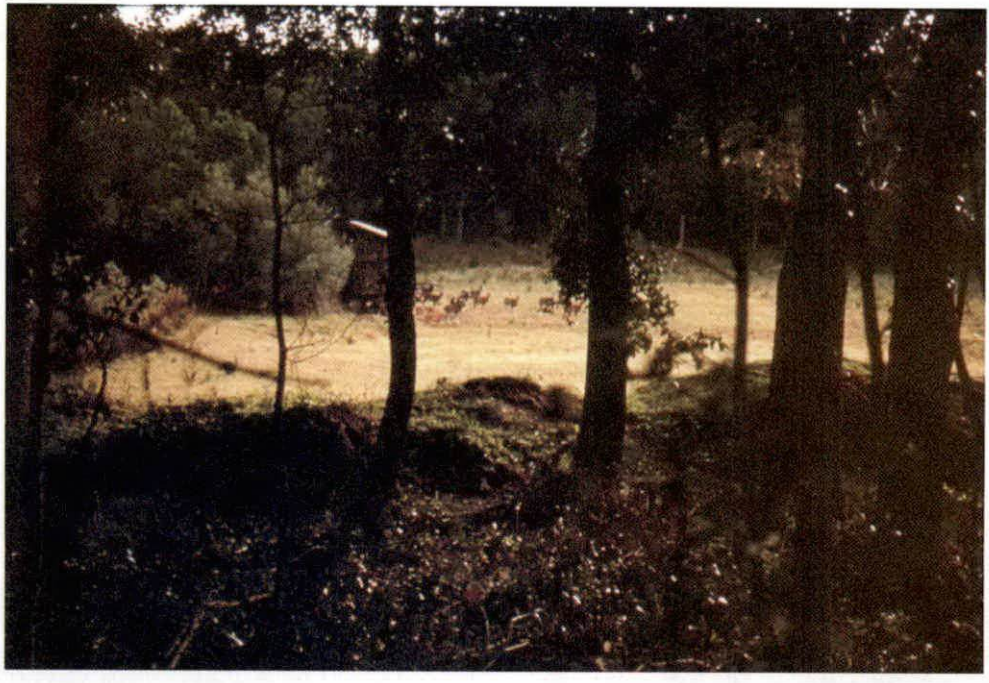


Figure 12. Mouflon distribution in the nursery Topolje
Slika 12. Raspored muflonske divljači pri korištenju rasadnika Topolje

GAME - JERUSALEM ARTICHOKE (*HELIANTHUS TUBEROSUS* L.) INTERACTION
INTERAKCIJA DIVLJAČ – ČIČOKA *(HELIANTHUS TUBEROSUS L.)*

By June, plants of Jerusalem artichoke were well developed, which is shown in Figure 8, however, by the end of July half of the plants were destroyed by game. The destruction was caused by leaf consumption, after which plants became too hard to forage. Table 11 can be used to assess the Jerusalem artichoke plot capacity. The plant was not grazed only by mouflon (11 heads a day on average), but also by axis deer (2 heads a day on average). The use of Jerusalem artichoke as forage is mentioned by Gleich *et al.* (1998) in connection with rearing the fallow deer (*Dama dama* L.) in Eberswald (Germany).

In summer months, Jerusalem artichoke makes forage of very good quality and is for this reason recommended for Mediterranean hunting grounds, especially in view of the fact that

mouflon game is a poor water drinker. It is not necessary to plant thick tubers, because game satisfies its nutritional needs by foraging and not by rooting out and consuming the tubers. Planting a larger number of smaller tubers per unit area may result in Jerusalem artichoke plantations used exclusively as forage. Fertilisation is important. In our case, fertilizing with 125 kg/ha of 15-15-15 NPK fertilizer increased the yield considerably. However, it was seen that the area was not big enough to supply enough game food as total area devastation took place as early as mid-July (Figure 13). Establishing larger plantations of Jerusalem artichoke in several locations would provide more than sufficient food for consumption, which would alleviate the pressure on the stands in the regeneration stage.

Figure 13. Jerusalem artichoke in mid-July 1999

Slika 13. Biljke čičoke sredinom srpnja 1999.

Data from the recording made at the beginning of June show poor grazing on Jerusalem artichoke until early summer, therefore, it is not necessary to enclose the plantations. It is only with the onset of dry conditions and the desiccation of most grasses and herbaceous plants that game begins to forage on Jerusalem artichoke, starting with the tops and the stems and later biting off the leaves rather than the stems.

The biting height of Jerusalem artichoke (47 cm) coincides approximately with the results obtained by Sajfert (2001), who measured the biting height of hawkweed ox-tongue (*Picris hieracioides* L.), reaching 45 cm. In the period of intensive Jerusalem artichoke grazing, the biting height dropped to 35 cm, which means that the game, following worsening living

conditions, started consuming the stalks. The comparison of the heights of damaged and undamaged plants at the beginning of June shows a significant difference, the plants with bitten tops were taller than undamaged plants. This could be explained with the following: the height of 47 cm is optimal for biting because the game not only bites the best quality part of the plant, but also has the maximal field of sight at this height, which enables it to detect a possible predator on time. Although there are no big predators on Rab who would prey on mouflon and axis deer (except for man), this shows that caution in game is instinctive.

An important phenomenon detected in the hunting ground in 1998 and 1999 involves the escape of axis deer from the enclosed part of the hunting ground. It was found that axis deer swam from the enclosed part into the open part of the ground and vice versa. This corroborates the fact that mouflon game is much more aggressive, which forces axis deer to search for other habitats. Partitioning the hunting ground to suit the mouflon feeding strategy cannot be viewed any more within the theory of optimal feeding, because this deprives this game of the possibility of migrating to other, food-richer habitats in case the resources in the present hunting ground are exhausted. Axis deer does not have this problem since water does not pose any serious barrier to it. In order to increase game capacity, more attention should be paid to increasing the nutritive potentials of the habitat in the future, although they are currently still undisturbed.

CONCLUSIONS
ZAKLJUČCI

The following conclusions can be drawn from the analyses:

1. The area of cultivated grasslands amounting to 6,760 m² is sufficient to satisfy the grazing requirements of the game. However, excessive game in the nursery Topolje has seriously disturbed grassland productivity, reducing the cover to 50%.

2. To reduce the number of game in the nursery Topolje, several smaller forage areas (Jerusalem artichoke, oat, forage kale, corn and similar) should be dispersed over the hunting ground. This would reduce the number of heads in a herd and lower the costs of regenerating grass areas.

3. The game must be prevented from extracting food from feeding storages for several reasons: consuming food from the ground, the danger of damaging antlers in the process of extracting food from feeding places, and unnecessary herding in forage areas in which food storages are placed. This can be successfully prevented with enclosing the food storages.

4. Additional nutrition with bulky foods is not necessary in eu-Mediterranean conditions because there is sufficient food in the hunting ground.

5. Mouflon and axis deer use Jerusalem artichoke exclusively as forage and do not root out tubers. In the dry period (summer), Jerusalem artichoke represents an important forage plant in the hunting ground. The most intensive foraging takes place at the beginning of June, whereas before June game shows very little interest in this plant. In early June, game starts with biting off the terminal parts of the shoots, to transfer to the leaves as the drought increases.

6. The quantity of Jerusalem artichoke in the plot of 1,837 m² (10 plants/m²) was not sufficient to satisfy the nutritive requirements of 45 heads of mouflon and 22 heads of axis deer. For this reason, in the dry eu-Mediterranean period it is necessary to establish several smaller forage areas dispersed over the hunting ground, where game may satisfy their needs for fresh food. These areas should be enclosed by the beginning of summer. This procedure would reduce the pressure on the stands in the stage of regeneration, as the crops of woody species represent the only source of fresh food in dry periods.

REFERENCES
LITERATURA

Adamič, M., 1990: Prehranske značilnosti kot element načrtovanja varstva, gojitve in lova parkljaste divjadi s odudarkom na jelenjadi (*Cervus elaphus* L.). Universa Edvarda Kardelja v Ljubljani – VDO Biotehniška fakulteta, Institut za gozdno in lesno gospodarstvo VTOZD za gozdarstvo, Strokovna in znanstvena dela 105, Doktorska disertacija na Univerzi v Beogradu, Ljubljana, 203 pp.

Alcock, J., 1998: Animal Behavior: An Evolutionary Approach. Sixt Edition, Sinauer Associates, Inc. Publishers Sunderland, Massachusetts, 718 pp.

Andrašić, D., 1982: Objekti tehničkog uređenja lovišta i uzgajališta divljači. Lovački savez Hrvatske, Zagreb, 106 pp.

Andrašić, D., 1984: Zoologija divljači i lovna tehnologija. Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 392 pp.

Bart, J., M. A. Fligner & W. I. Notz, 1998: Sampling and Statistical methods for Behavioral Ecologist. Cambridge University Press, Cambridge, 330 pp.

Blondel, J., & J. Aronson, 1999: Biology and Wildlife of the Mediterranean Region. Oxford University Press, New York, 328 pp.

Bouchner, M., 1990: Animal Tracks. Aventinum Nakladatelstvi, Prague, 264 pp.

Brewbaker, J. L., 1988: Deer palatability of *Leucaena diversifolia*. Leucaena Research Reports., 9: 113–114.

Čeović, I., 1953: Lovstvo. Lovačka knjiga, Zagreb, 733 pp.

Danell, K., & R. Bergström, 1987: Studies on Interactions Between Moose and Two Species of Birch in Sweden. A Rewiew, Proceedings-Symposium on Plant – Herbivore Interactions, Snowbird, Utah, August 7–9, 1985, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Ogden, Utah, pp. 48–57.

Denffer, D., & H. Ziegler, 1991: Udžbenik botanike za visoke škole, Morfologija i fiziologija. Školska knjiga, Zagreb, 595 pp.

Forenbacher, S., 1998: Otrovne biljke i biljna otrovanja životinja. Školska knjiga, Zagreb, 436 pp.

Garms, H., & L. Borm, 1981: Fauna Europe. Mladinska knjiga, Ljubljana, 550 pp.

Gleich, E., R. Kätzel & L. Reichelt, 1998: Unterzuchungen von Nahrungspräferenzen der Wildart Damwild an Topinambur in einem Forschungsgatter. Z. Jagdwiss. 44, Berlin, pp. 57–65.

Grajdl, M., 1993: Analiza kvaliteta trofeja muflona u ograđenom uzgajalištu "Garjevica" Kutina. Diplomski rad, Šumarski fakultet, Zagreb, 35 pp.

Grlić, Lj., 1986: Enciklopedija samoniklog jestivog bilja. August Cesarec, Zagreb, pp. 328–329.

Grubešić, M., 1996: Utjecaj prirodnih i gospodarskih čimbenika na kvalitetu stojbine divljači. Disertacija, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 157 pp.

Grupa autora, 1967: Lovački priručnik. Lovačka knjiga, Zagreb, 704 pp.

Hadjisterkostis, E., 1996: Ernahrungsgewonheiten des Zyprischen Mufflons Ovis gmelini ophion. Z. Jagdwiss. 42, Berlin, pp. 256–263.

Havranek, D., 1998: Istraživanje palatabilnosti nekih vrsta trava ispašom ovaca. Disertacija, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 97 pp.

Horvatić, S., 1938: Pregled vegetacije otoka Raba sa gledišta biljne sociologije. Znanstvene rasprave Botaničkog instituta Universe Kralja Aleksandra v Ljubljani, Ljubljana, 96 pp.

Jávorka, S., & V. Csapody, 1975: Iconographia florae partis austro-orientalis Europae centralis. Akadémiai Kiado, Budapest, 555. tab.

Knežević, M., 1989: Istraživanje selektivne ispaše četiri vrste trava. Sveučilište u Zagrebu, Disertacija, Zagreb, 66 pp.

Kovačević, J., 1963: Fitocenologija travnjaka. Zagreb, 232 pp.

Kovačević, J., 1979: Poljoprivredna fitocenologija. SNL, Zagreb, 269 pp.

Krapinec, K., J. Vukelić & M. Grubešić, 2000: Prilog poznavanju brštenja širokolisne zelenike (*Phillyrea latifolia* L.) divljih preživača na otoku Rabu. Šumarski list, CXXIV (5–6): 285–292.

Krebs, C. J., 1989: Ecological Metodology. Harper & Row, Publishers, New York, 654 pp.

Krejči, V., & V. Viličić, 1993: Obnova sastojina hrasta lužnjaka oštećenih od srneće divljači. Radovi, Šumarski institut Jastrebarsko, 28(1–2): 207–214.

Krejči, V., V. Viličić, T. Dubravac, 1997: Prilog obnovi lužnjakove sastojine koju oštećuje srneća divljač. Radovi, Šumarski institut Jastrebarsko, 32(2): 27–35.

Manning, A., M. S. Dawkins, 1998: An Introduction to Animal Behavior. Cambridge unoversity Press, Cambridge, 450 pp.

Medvedović, J., 1989: Metoda utvrđivanja prehrambenih potencijala za divljač. Radovi, Šumarski institut Jastrebarsko, 80: 29–36.

Medvedović, J., 1994: Prehrambeni potencijali za divljači u šumama hrasta lužnjaka i graba sjeverne Hrvatske. Radovi, Šumarski institut Jastrebarsko, 29(1): 123–136.

Medvedović, J., & J. Knepr, 1996: Prehrambeni potencijal za divljač u lovištima "Žabljački lug-Česma" i "Pisanička Bilogora". In: B. Mayer (ed.), Unapređenje proizvodnje biomase šumskih ekosustava, Šumarski fakultet Sveučilišta u Zagrebu & Šumarski institut, Jastrebarsko, Zagreb, pp. 209–216.

Moe, S. R., & P. Wegge, 1994: Spacing behaviour and habitat use of axis deer *(Axis axis)* in lowland Nepal. Canadian Journal of Zoology, 72: 10, 1735–1744 pp.

Pavlović, R., 1998: Utjecaj divljači na obnovu sastojina u GJ "Bolčansko-Žabljački lug". Diplomski rad, Zagreb, 62 pp.

Piegert, H., 1999: Muffelwild – Von Korzika zum Oberhartz. Wild und hund Eksklusiv, Paul Parey Zeitscriftverlag GmbH & Co. KG, Singhofen, 14: 8–57.

Pranjić, A., 1990: Šumarska biometrika. Sveučilišna naklada Liber, Zagreb, 204 pp.

Pribičević, S., & B. Bogović, 1966: Prilog poznavanju ishrane beljskog jelena. Jelen –bilten Lovno-šumskog gazdinstva – Beograd, posebno izdanje Operativno-naučnog centra – Bilje, broj 4, Beograd, 7–14 pp.

Prpić, B., 1986: Odnos hrasta crnike i nekih njegovih pratilaca prema vodi i svjetlu. Glasnik za šumske

pokuse, posebno izdanje, 2. dio, Zagreb, pp. 69–77.

Raguž, D., A. Alegro, A. Frković & M. Tompak, 1994: Stručna podloga za bonitiranje i utvrđivanje lovnoproduktivnih površina u lovištima Republike Hrvatske. Zagreb, 29 pp.

Raguž, D., & M. Grubešić, 1996: Istraživanja mogućnosti gospodarenja na prostoru Mediterana. In: B. Mayer (ed.), Unapređenje proizvodnje biomase šumskih ekosustava, Šumarski fakultet Sveučilišta u Zagrebu & Šumarski institut, Jastrebarsko, Zagreb, pp. 187–193.

Raguž, D., & M. Grubešić, 1997: Revizija lovnogospodarske osnove za Državno lovište VIII/6 "Kalifront" za razdoblje 1997–2005. Zagreb, 90 pp.

Raman, T. R. S., 1997: Factors influencing seasonal and monthly changes in the group size of chital or axis deer in southern India. Journal of Biosciens, 22 (2): 203–218.

Rauš, Đ., & S. Matić, 1986: Prevođenje makija i panjača hrasta crnike u sastojine višeg uzgojnog oblika. Glasnik za šumske pokuse, posebno izdanje, 2. dio, Zagreb, pp. 79–86.

Risehoover, K. L., 1987: Intraspecific Variation in Moose Preference for Willows. Proceedings-Symposium on Plant – Herbivore Interactions, Snowbird, Utah, August 7–9, 1985, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Ogden, Utah, pp. 48–57.

Sajfert, R., 2001: Analiza načina odgrizanja runjikastog jagušca (*Picris hieracioides* L.) od divljači u lovištu "Kalifront". Diplomski rad, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 43 pp.

Scalet, C. G., L. D. Flake & D. W. Willis, 1996: Introduction to Wildlife and Fisheries: An Integrated Approach. W.H. Freeman and Company, New York, 512 pp.

Siddiqi, N. A., 1996: Influence on the artificial regeneration of the mangrove of Sundarbans, Bangladesh. Special issue: wildlife management. Indian-Forester, 122(10): 937–942.

Siddiqi, N. A., & K. Z. Husain, 1994: The impact of deer on natural regeneration in the Sundarbans mangrove forest of Bangladesh. Bangladesh Journal of Zoology, 22(2): 223–234.

Šoštarić-Pisačić, K., 1967: Krmne kulture na oranicama. Poljoprivredna enciklopedija, knj. 2, JLZ, Zagreb, pp. 1–13 pp.

Šoštarić-Pisačić, K., & J. Kovačević, 1968: Travnjačka flora i njena poljoprivredna vrijednost. Nakladni zavod Znanje, Zagreb, 443 pp.

Šoštarić-Pisačić, K., & J. Kovačević, 1974: Kompleksna metoda za utvrđivanje kvalitete i sumarne vrijednosti travnjaka i djetelišta. Poljoprivredna znanstvena smotra, Naučne edicije Poljoprivrednog fakulteta Sveučilišta u Zagrebu, Zagreb, 102 pp.

Španjol, Ž., 1995: Prirodna obilježja otoka Raba. Rab–Zagreb, 440 pp.

Timarac, Z., 2000: Čičoka – hrana iznad i ispod zemlje. Lovački vjesnik, 109(4): 4.

Trinajstić, I., 1986: Fitogeografsko raščlanjenje šumske vegetacije istočnojadranskog sredozemnog područja – polazna osnovica. Glasnik za šumske pokuse, posebno izdanje, 2. dio, Zagreb, pp. 53–65.

Tschiderer, K., 1974: Muffelwild- (*Ovis ammon musimon*) Studie. Z. Jagdwiss. 20, Hamburg und Berlin, pp. 185–192.

Vančina, N., 1994: Razvoj populacije muflona u lovištu "Petehovac" Delnice od unašanja do danas. Diplomski rad, Šumarski fakultet Sveučilišta u Zagrebu, Zagreb, 55 pp.

Viličić, V., 1992: Metoda istraživanja utjecaja divljači na prirodnu obnovu šuma. Radovi, Šumarski institut Jastrebarsko, 27(2): 167–174.

Viličić, V., V. Krejči & T. Dubravac, 1996: Razvoj lužnjakovih sastojina nakon oplodne sječe dostupnih

krupnoj divljači. In: B. Mayer (ed.), Unapređenje proizvodnje biomase šumskih ekosustava, Šumarski fakultet Sveučilišta u Zagrebu & Šumarski institut, Jastrebarsko, Zagreb, pp. 195–208.

Viličić, V., V. Krejči & T. Dubravac, 1997: Stanje lužnjakovih sastojina dostupnoj krupnoj divljači dvije godine nakon oplodne sječe. Radovi, Šumarski institut Jastrebarsko, 32(1): 107–114.

Viličić, V., V. Krejči, M. Grubešić & T. Dubravac, 1998: Razvoj pomlatka hrasta crnike (*Quercus ilex* L.) izvrgnutog utjecaju krupne divljači. Radovi, Šumarski institut Jastrebarsko, 33(2): 103–116.

Vukelić, J., & Đ. Rauš, 1998: Šumarska fitocenologija i Šumske zajednice u Hrvatskoj. Zagreb, 310 pp.

REZULTATI ODNOSA MUFLONA (OVIS AMMON MUSIMON PAL.) I JELENA AKSISA *(AXIS AXIS ERX.)* PREMA KULTIVIRANIM TRAVNJACIMA I NASADU ČIČOKE *(HELIANTHUS TUBEROSUS L.)* U LOVIŠTU KALIFRONT NA OTOKU RABU

SAŽETAK

Osnivanje krmnih površina kao dopune prirodne hrane za divljač u lovnom se gospodarstvu primjenjuje već desetljećima. Dok travnjačke površine u načelu služe za prehranu divljači ljeti, površine pod različitim krmnim kulturama namijenjene su ponajprije prehrani divljači u zimskim mjesecima koji su za divljač nepovoljni, i to tako da se kulture ostavljaju neubrane ili da se s njih plodovi skupe i uskladište.

U sredozemnim područjima, a napose u eumediteranskim, za razliku od kontinentalnih (srednjoeuropskih), za divljač je nepovoljni dio godine upravo ljeto jer tada pati od nedostatka sočne hrane ili čak vode. Zbog toga je glavni problem osiguranje sočne hrane kako bi se smanjio pritisak divljači na šumu koja u sredozemnim krajevima ima ponajprije zaštitnu i estetsku funkciju.

Travnjačke površine u zapadnoj i srednjoj Europi uglavnom se osnivaju za sitnu poljsku ili eventualno za srneću divljač. Zbog toga te površine u ovom lovištu dobivaju na vrijednosti za održavanje populacije običnoga zeca (*Lepus europaeus* Pall.), čija je brojnost ovdje već dulji niz godina minimalna (na cijeloj površini lovišta ima ukupno 7 repova). Takvo je stanje zečje populacije isključivo proizvod nepovoljne strukture površina jer otvorenih ima manje od 1 % (7,4 ha).

Državno lovište VIII/6 "Kalifront" prostire se na jugozapadnom dijelu otoka Raba na istoimenoj krškoj zaravni, koja je obrasla najvrjednijom šumom cijeloga otoka. Kalifront je svojevrsni poluotok, ako gledamo cjelinu otoka Raba, jer se uz Kalifront u dubinu uvlače dvije uvale: s jugoistoka Uvala svete Eufemije i sa sjeverozapada Kamporska draga.

Na temelju podataka iz akta o ustanovljenju lovišta ukupna površina lovišta iznosi 1475 ha, a odnos površina po kulturama vidljiv je iz grafikona 1. Iz njega je vidljivo da 90 % lovišta čine šume, što pogoduje prirodnom uzgoju divljih dvopapkara. Zbog maloga udjela poljoprivrednih

površina u lovištu uzgajivač će biti prisiljen praviti i održavati svijetle pruge u lovištu kako bi se divljači osigurala paša u dovoljnoj količini.

Promatrajući postotni udio poljoprivrednih površina po kulturi (grafikon 2), uočljiv je malen udio oranica, osim toga nije ih moguće iskoristiti za proizvodnju hrane za divljač jer su u privatnom vlasništvu, a stanovništvo ih obrađuje.

S obzirom na to da se radi o lovištu koje je u cijelosti smješteno na poluotoku, ono je pregrađeno u duljini 3,4 km. Međutim, pregrađivanjem se lovišta iz korijena promijenio udio zemljišta po kategorijama. Od ukupno 840 ha ograđene površine oko 825 ha (98 %) otpada na šume, a ostalih 15 ha na putove (8,8 ha), svijetle pruge (5,9 ha) i travnjačke površine – rasadnik Topolje i rasadnik "A. Petračić" (1,5 ha). Upravo je stoga bilo nužno osnovati krmne površine za prehranu divljači u lovištu jer se pretpostavljalo da divljač neće moći zadovoljiti dovoljne hranidbene potrebe isključivo na šumskim površinama.

U ograđenom dijelu lovišta tijekom uzimanja podataka za ovaj rad ukupno je bilo 45 grla muflonske divljači i 22 grla jelena aksisa. To čini gustoću populacije sve krupne divljači od 8 grla na 100 ha ukupne površine lovišta. Iz tablice 1 je vidljivo da je u godini izmjere populacija divljači bila u skladu s kapacitetima staništa. Razlika u lovnoproduktivnoj površini nastala je pregrađivanjem lovišta ogradom na dva dijela. Pregrađeni dio u kojem se istraživalo ima površinu od 840 ha, a stvarni se broj grla odnosi na prebrojavanje u tome dijelu lovišta.

Tijekom ožujka 1998. godine preorani su rasadnik Topolje te rasadnik "Andrija Petračić" i na njima zasijane djetelinsko-travne smjese. Gustoća sjetve prikazana je u tablici 6 (Šoštarić-Pisačić 1967). Stvarni normativi sjetve dobiveni su tako da se količina sjemena podijelila površinskim udjelom svake vrste koji bi zauzimala kada bi se zasijala u čistoj kulturi.

Na Topolju je zasijano1450 m^2 travnih smjesa, a u rasadniku "Andrija Petračić" je zasijano 3800 m^2 travnih smjesa te 2500 m^2 smjese bijele djeteline i lucerne. Međutim, muflonska se divljač koncentrirala na rasadnik Topolje tako da je prve godine sva trava bila popasena ili izgažena. Od travnih vrsta iznikle su na oba lokaliteta samo klupčasta oštrica i talijanski ljulj. Bijela djetelina i lucerna iznikle su i na Topolju i u rasadniku "A. Petračić". U rasadniku "A. Petračić" bijela djetelina i lucerna su već prve godine imale pokrovnost od 90 %. Prilikom prikaza pokrovnosti korištena je prividna ili projekcijska pokrovnost jer ju većina istraživača upotrebljava zato što ona jasno izražava prirodne odnose u sastojini u doba njezina najboljega razvitka.

Radi lakšega uzimanja uzorka pokrovnosti površine u rasadniku "A. Petračić" podjeljene su na tri plohe kako je prikazano na slici 3, a u rasadniku Topolje na dvije plohe (slika 4). Budući da se divljač slabo napasala u rasadniku "A. Petračić", trebalo ga je kositi. Tijekom 1999. godine iste su površine pokošene ukupno *četiri* puta, i to jednom u *svibnju*, jednom u *srpnju*, početkom *rujna* i početkom *listopada*. U rasadniku Topolje travne površine nikada nisu košene zbog toga jer nije bilo potrebno.

Tijekom svibnja 1999. godine preoran je jedan dio Topolja te je od travnih površina ostala samo ploha 1 tako da je pokrovnost trava mjerena samo na njoj.

U listopadu 1999. godine izmjerena je pokrovnost travnih površina. U to je doba godine trava dobro razvijena nakon ljetne suše. Za izmjeru pokrovnosti načinjen je drveni okvir (kvadrat) stranica 1 x 1 m (1 m^2). Radi preciznijega očitavanja pokrovnosti kvadrat je debelim

koncem podijeljen na 100 pravilnih manjih kvadrata ploštine 1 dm^2 (slika 4 i 5 – očitavanje površine). Pokrovnost je očitana za svaki kvadratni decimetar. Primjerne su plohe postavljene dijagonalno za svaku travnu plohu. Intenzitet uzorkovanja bio je 10 % za plohu na Topolju (veća varijabilnost) te 1 % za plohe u rasadniku „A. Petračić". U tablici 7 dan je prikaz distribucije ploha po pokrovnosti.

Radi određivanja kapaciteta travnjaka praćena je divljač tijekom 1999. godine iz zatvorenih osmatračnica, od kojih je svaka bila na jednom rasadniku. Divljač je praćena jedan dan ujutro, a drugi predvečer na obje osmatračnice u isto vrijeme. Motrilo se od 1. 4. 1999. do 28. 10. 1999. godine, i to svaki četvrtak. Ukupno je bilo 31 praćenje.

Kronologija pasenja čičoke nakon puštanja u lovište muflonske divljači je sljedeća:

- Ploha čičoke ostavljena je u zatečenom stanju i zauzimala je ploštinu od 1837 m^2. Nakon puštanja muflonske divljači iz karantene ona je doslovce opustošila kompletnu kulturu (slika 6). U rujnu 1998. godine ostaci stabljika čičoke bili su debljine žitne slame i odgrizeni na visini od 15 cm od tla.
- U svibnju 1999. godine polje je preorano i na polje je bačeno 25 kg umjetnoga gnojiva NPK formulacije 15-15-15. Da bi se vidjela veličina gomolja, iskopani su gomolji nekoliko biljaka, koji su bili veličine lješnjaka. Iste se godine čičoka dobro razvila (slika 7).

Kako bi se utvrdilo u kojem razdoblju divljač najviše pase čičoku, napravljene su dvije izmjere. Prva je izmjera napravljena 2. lipnja 1999. godine, a druga 31. srpnja 1999. godine. Izmjere su načinjene na primjernim plohama veličine 1 m^2. Ukupno je bilo načinjeno 7 primjernih ploha. Obje su izmjere obavljene na istim plohama. Na biljkama su prebrojeni listovi, izmjerena visina od tla do vrha biljke te biljke razvrstane na oštećene i neoštećene. Pri prebrojavanju listova brojeni su svi neoštećeni listovi.

Postotni udio travnih vrsta (po brojnosti) na površini rasadnika bio je sljedeći:

Topolje (ploha T, slika 8) – udio *Lolium multiflorum* bio je 10 %, a *Dactylis glomerata* isto 10 %, ostatak plohe su zauzimale ove biljne vrste: *Cynodon dactylon, Digitaria sanguinalis, Setaria glauca, Setaria viridis, Echinocloa crus-galli, Trifolium repens, Achillea* sp. itd.

Rasadnik "A. Petračić"

- Ploha 1 (slika 9) – oko 80 % plohe zauzimao je *Agropyron* sp., dok su oko 20 % plohe zauzimale *Trifolium repens* i *Medicago sativa*
- Ploha 2 (slika 10) – oko 20 % plohe zauzimale su *Dactylis glomerata* i *Lolium multiflorum*, a 80 % su zauzimale ostale biljne vrste (iste kao i na Topolju)
- Ploha 3 (slika 11) – oko 30 % plohe zauzimale su *Dactylis glomerata* i *Lolium multiflorum*, 10 % je zauzimala *Artemisia vulgaris*, a ostatak plohe su zauzimale ostale biljne vrste (kao i na Topolju).

Iz tablice 5 vidljivo je da najmanju pokrovnost ima travnjak u rasadniku Topolje (40 do 50 %), dok najveću pokrovnost imaju plohe 1 i 2 (80 do 90 %) u rasadniku "A. Petračić", a ploha 3 u istom rasadniku ima pokrovnost od 70 do 80 %.

Osim što postoji vidljiva razlika u pokrovnosti te je stoga nije potrebno ispitivati statističkim testovima, postoji razlika i u standardnim devijacijama pokrovnosti ploha. Ploha u rasadniku Topolje pokazuje veliku varijabilnost u pokrovnosti (s_x= 3,3), dok je na plohama rasadnika "A. Petračić" varijabilnost mnogo manja (s_x=1,9 do s_x=2,1). U prilog tomu govori i slika 12 snimljena u rasadniku Topolje na kojoj je vidljivo da je čak bilo potploha na kojima je pokrovnost bila 0 % (svrstane su u razred 1).

Na slici 13 vidi se da je pokrovnost mnogo veća. Na istim plohama zastupljeniji su bili viši razredi pokrovnosti.

Iz grafikona 3 vidljivo je da je do početka lipnja od 97 349 biljaka/ha bilo oštećeno od divljači njih 16 182/ha (17 %). Zbog velikoga pritiska divljači na čičoku u roku od dva mjeseca, odnosno tijekom lipnja i srpnja, 51 % biljaka čičoke se osušio. Zbog toga su bile zabilježene 49 573 biljke/ha, od kojih je oštećeno bilo njih 49 317/ha (99 %).

Na primjernim je plohama bilo biljaka kod kojih vegetacijski vrh nije odgrizen, ali su bili oštećeni listovi. Zbog toga je pobrojeno lišće za svaku biljku na primjernoj plohi. Iz grafikona 4 vidljivo je da je do početka lipnja svaka biljka u prosjeku imala 11 listova, dok je tijekom lipnja i srpnja broj listova na biljci smanjen na 0,5, odnosno svaka je druga biljka u uzorku imala samo jedan neoštećen list.

Promatrajući tablicu 8 vidljivo je da su biljke s oštećenim listovima (2. 6. 1999) još uvijek imale veći broj listova (=13,4) nego neoštećene biljke (10,4), a isto tako da su oštećene biljke imale u prosjeku veće visine (=38,3 cm) nego neoštećene (=42,3). U-test je pokazao (uz granicu signifikantnosti 99 %) signifikantnu razliku u prosječnom broju listova po biljci. Uzrok tomu nedvojbeno je i to što su oštećene biljke imale i veće visine (42,3 cm) od neoštećenih (38,3 cm). Isto je tako test pokazao da je divljač, do kraja mjeseca srpnja, radije konzimirala listove.

Važnost otvorenih površina nije samo u proizvodnji paše za divljač (pretpostavlja se da divljač potrebe za brstom zadovoljava u šumi), nego je ovdje riječ o sljedećim funkcijama:

- Prostor za parenje
- Prostor za koćenje (leženje) mladunčadi
- Prostor na kojem se divljač može brže osušiti nakon kiše
- Olakšavanje osmatranja i odstrela
- Zaštitna funkcija – naime osnivanjem krmnih površina u središnjim dijelovima lovišta divljač se primamljuje na njih te puno manje izlazi na obalni prostor na koji dolazi na pašu gdje najčešće postaje meta zvjerokradica i krivolovaca koji na nju pucaju iz barki, odnosno s pučine.

Prilikom osnivanja travnjaka sijane su isključivo trave i djeteline navedene u tablici 6. Međutim, za divljač je mnogo povoljnije da na travnjacima bude u smjesi i nešto zeljanica jer neke imaju bolju hranidbenu vrijednost od trava, a osim toga produljuju vegetaciju travnjaka te on dulje vrijeme stoji na raspolaganju divljači.

Radi boljega uvida u korištenje travnjaka u lovištu tijekom 1999. godine praćena je divljač iz dviju zatvorenih osmatračnica, od kojih je svaka bila smještena u jednom rasadniku (tablica 11). Pri tome se mora napomenuti da mufloni nisu izlazili u rasadnik "A. Petračić", ali su redovito izlazili u rasadnik Topolje. Jelen aksis na pašu izlazi samo navečer i drži se travnjaka

tijekom cijele noći. Mufloni obično izlaze na pašu rano ujutro. Sat izlaska na pašu tijekom godine se mijenja. Iz tablice 11 može se vidjeti da je u rasadnik Topolje prosječno izlazilo na pašu 13 grla divljači, od toga 11 grla muflonske divljači i 2 grla jelena aksisa, dok su u rasadniku "A. Petračić" pasla prosječno 4 grla jelena aksisa. S tim u svezi može se reći da je ovaj broj divljači u rasadniku Topolje u visokoj korelaciji s malom pokrovnošću jer se broj muflonskoga krda koje je paslo u rasadniku kretao od 3 do 22 grla, a kod jelena aksisa od 1 do 5 grla. Pri tome je jedan od razloga za intenzivnije korištenje rasadnika Topolje bilo spremište za kukuruz koje se nalazi u njemu. Time su se prehrambeni potencijali travnjaka znatno smanjili te se moralo pribjeći novom preoravanju travnih površina i ponovnom zasijavanju travnim smjesama. Dakle, ne može se reći da je termin prvotne sjetve bitno ugrozio rast selekcioniranih trava, djeteline i lucerne. Na njihov razvoj u prvome je redu utjecala divljač svojim djelovanjem koja se ovdje nagomilala iz više razloga:

- Blizina ograde – nakon podizanja ograde-pregrade u lovištu se još uočava da glavnina tragova divljači vodi uz samu ogradu. Vjerojatno divljač traži moguće prijelaze kojih nema.
- Odmah pored livade s druge strane glavne ceste nalazi se branjevina hrasta crnike te tako divljač (osobito jelen aksis) u njoj nalazi prvoklasan zaklon (gotovo je neprohodna za čovjeka), a na večer izlazi na pašu u rasadnik.
- Jugoistočno od rasadnika nalazi se stari kamenolom na koji se odmah smjestila muflonska divljač te odatle obično kreće na pašu.
- Trasa šume između rasadnika Topolje i ceste služi divljači kao paravan kojim je zakrita od čovjeka. Naime, ovom cestom, koja je glavna u lovištu, dosta prolaze automobili i turisti.
- Nasad čičoke privukao je divljač na ovu plohu pa se divljač hranila i na travnjacima.
- Izostanak odstrela pridonio je grupiranju muflonske divljači u veliko krdo (koje je već prve godine znalo brojiti 40 grla), koje je predvodila uvijek jedna te ista stara ovca. Naime, poznato je da u takvim slučajevima treba razbiti krdo na više manjih odstreljivanjem vođe krda. Ovdje je nužno pretpostaviti kako je veličina krda vjerojatno posljedica zajedničke dopreme, držanja u karanteni i ispuštanja u novo stanište, a ne posljedica loših hranidbenih uvjeta u lovištu.

Na biljni sastav i pokrovnost travnjaka divljač utječe na više načina:

- Pašom i gaženjem uništava biljni pokrov.
- Uriniranjem i defekacijom gnoji tlo čime se poboljšavaju uvjeti za rast biljaka.

Razbijanjem krda muflonske divljači formiranjem više travnih površina rasteretio bi se rasadnik Topolje, a time bi se smanjili troškovi uzgoja divljači jer bi travne vrste (nadosijavanje) trebale obnavljati mnogo rjeđe (svake četvrte ili pete godine). Zanimljivo je da divljač nije uzimala sijeno s hranilica i iz stogova, te nije htjela lizati sol na soliištima (izlagala se kamena sol). To pokazuje da divljač tijekom godine ima dovoljno prirodne suhe hrane te u eumediteranskim uvjetim nije potrebno predviđati prihranu kabastom hranom za muflonsku divljač i jelena aksisa. Te podatke nije bilo potrebno mjeriti jer uzimanja sijena i soli nije bilo. Isto je tako nužno zbog divljači ograditi spremišta za kukuruz iz dvaju razloga:

- Uočeno je da divljač iz njih sama vadi klipove te pri tom oštećuje lovni objekt.
- Pri vađenju klipova oni padaju na tlo te ih životinje jedu s tla, što nije dobro s gledišta patologije, odnosno zdravstvene preventive. Oko spremišta se nalaze fecesi životinja koji se doduše čiste, ali na tlu hrana dolazi u doticaj s izmetom te se prenose različite zaraze. Zbog toga se zrnata hrana mora izlagati u koritima.

Od ostalih biljnih vrsta u rasadniku Topolje divljač je konzumirala sljedeće: *Setaria viridis, Setaria glauca, Achilea* sp. (samo cvatne glavice), *Holcus lanatus, Digitaria sanguinalis, Cynodon dactylon, Echinocloa crus-galli, Erigeron canadensis, Stenactis annua, Polygonum lapathifolium, Polygonum aviculare, Solidago serotina, Rumex acetosa, Rumex acetosella, Chenopodium album* i *Hypericum veronense,* dok vrstu *Inula viscosa* divljač nije pasla. U rasadniku "A. Petračić" počela se širiti *Artemisia vulgaris*, ali divljač ju nije pasla.

Iako su se biljke čičoke do lipnja dobro razvile, o čemu svjedoči slika 8, divljač je do kraja srpnja uništila polovinu biljaka. Uzrok je tomu konzumiranje listova, nakon što je stabljika postala pretvrda za pašu. Za određivanje kapaciteta plohe čičoke može se upotrijebiti tablica 11. Čičoku nisu brstili samo mufloni (prosječno 11 grla dnevno), nego i jelen aksis (u prosjeku 2 grla dnevno). Čičoka zbog svoje sočnosti u ljetnim mjesecima pruža vrlo dorbu pašu. Zbog toga ju je preporučljivo saditi u sredozemnim lovištima, pogotovo kada se zna da muflonska divljač slabo uzima vodu s pojilišta. Nije potrebno saditi krupne gomolje jer se divljač zadovoljava i njihovom pašom, ne iskopavajući i ne jedući gomolje. Zbog toga je dovoljno saditi sitnije gomolje, ali veći broj po jedinici površine, te formirati polja čičoke isključivo za potrebe paše. Pri tome značajnu ulogu ima gnojenje. U ovom slučaju gnojenjem se (125 kg gnojiva NPK 15-15-15/ha) dobio znatan prirast. Međutim, pokazalo se da navedena površina nije bila dovoljna za prehranu divljači jer je u potpunosti opustošena već sredinom srpnja (slika 28). Vjerojatno je to jedan od razloga zašto je divljač tijekom ljeta intenzivnije brstila. Ako bi se u lovištu osnovale veće površine čičoke na više lokacija, tada bi je bilo više nego dovljno za prehranu te bi se smanjio pritisak na sastojine u fazi obnove.

Podaci dobiveni snimkom početkom lipnja upućuju na to da divljač slabije pase čičoku do početka ljeta, te ju nije potrebno ograđivati. Tek kada nastupe sušni uvjeti, a većina trava i zeljanica se osuši, divljač počinje s pašom čičoke, u prvom redu odgrizanjem vrhova, odnosno stabljika, a poslije više odgrizanjem listova, a manje odgrizanjem stabljike.

Visina odgrizanja biljaka čičoke (47 cm) približno se podudara s rezultatima koje je dobio Sajfert (2001) mjereći visinu odgrizanja runjikastoga jagušca (*Picris hieracioides* L.), a koja je iznosila 45 cm. Tijekom intenzivne paše čičoke visina odgrizanja ja pala na 35 cm, što znači da je divljač, razmjerno pogoršanjem životnih uvjeta, posegnula za jačim iskorištavanjem stabljika čičoke. Uspoređujući visine oštećenih i neoštećenih biljaka početkom lipnja, uočljiva je signifikantna razlika, odnosno biljke s obgrizenim vrhom imale su veće visine od onih neoštećenih. To bi se moglo objasniti sljedećim: visina od 47 cm optimalna je za odgrizanje jer divljač time ne samo što odgriza najkvalitetniji dio biljke nego je pri toj visini osigurano maksimalno vidno polje koje divljači omogućuje dobar pregled terena i pravodobno uočavanje predatora. Iako na Rabu nema velikih predatora koji bi se mogli hraniti muflonom i jelenom aksisom (osim čovjeka), to pokazuje da je divljač oprezna instinktivno.

Tijekom 1998. i 1999. godine u lovištu je uočeno bježanje jelena aksisa iz ograđenoga dijela

lovišta. Naime, uočeno je da jelen aksis pliva iz ograđenoga u neograđen dio lovišta i obratno. To je u skladu s činjenicom da je muflonska divljač mnogo agresivnija te da je jelen aksis prisiljen tražiti druga staništa. Pregrađivanjem lovišta na prehrambenu strategiju muflonske divljači ne može se više gledati u okvirima teorije optimalnoga hranjenja jer im je isključena mogućnost migracije u druga hranidbeno bogatija staništa, ako se resursi u sadašnjem lovištu iscrpe. Jelen aksis nema tih problema jer mu vodena površina nije značajnija prepreka. Zbog toga bi se trebala veća pozornost posvetiti podizanju hranidbenih potencijala staništa (koji doduše još nisu narušeni), ako bi se kapacitet divljači želio povećati.

Ključne riječi: muflon (*Ovis ammon musimon* Pal.), jelen aksis (*Axis axis* Erx.), čičoka (*Helianthus tuberosus* L.)