EKOLOGIJA. 2007. Vol. 53. No. 1. P. 108–109

*Kronika * Chronicle*

Naujas mokslo istorijos leidinys

Guoda Mackevičienė

„Astakologijos raida Lietuvoje“. Vilnius: UAB „Petro ofsetas“, 2005, 106 p.: il. ISBN 9968-443-29-6

Lietuvos iškilios astakologės dr. Guodos Mackevičienės 2005 m. paskelbtoje knygoje *Astakologijos raida Lietuvoje* istoriškai nagrinėjama astakologijos mokslo raida Lietuvoje. Autorė trumpai aprašo prof. Jakovo Cukerzio ir dr. Jono Šeštoko – pirmųjų astakologijos mokslo Lietuvoje bibliografų sukauptas žinias apie vėžius Lietuvos ežeruose, jų išteklius, gausumą bei kitus vėžininkystei aktualius klausimus. Šie autoriai dviejose bibliografinių rodyklių dalyse pateikė mokslinių ir populiariųjų straipsnių sąrašus, kurie rodo astakologijos raidą nuo senovės iki 1985 m. (Šeštokas, Cukerzis, 1983, 1989). Dr. G. Mackevičienės knygos tikslas – „trumpai nušviesti šios mokslo šakos raidą Lietuvoje ir tęsti astakologinės literatūros šaltinių tyrinėjimo darbą“.

Tačiau tarsi užsibrėžusi gana kuklų tikslą autorė knygos skyriuose – Vėžių tyrimo grupės veikla MA Zoologijos ir parazitologijos institute, Astakologų mokslinė ir taikomoji veikla Karcinologijos laboratorijoje (sektoriuje), Lietuvos vėžių tyrimai Ekologijos instituto Hidroekologijos skyriuje – labai nuosekliai ir kruopščiai aprašė savo kolegų 1986–2002 m. darbus.

Dr. G. Mackevičienė savo knygoje stengėsi astakologų vykdytus darbus susieti istoriškai, todėl pradžioje trumpai aprašė fundamentinių ir mokslinių techninių tyrimų temas, kolegų 1963–1971 m. apgintas disertacijas. 1972 m. susiformavus plataus profilio vėžių tyrinėtojų grupei ir įsteigus Karcinologijos laboratoriją buvo toliau atliekami vietinių ir aklimatizuojamų vėžių rūšių ekologijos, etologijos, fiziologijos, mikrobiologijos tyrimai ir tobulinami akvakultūros metodai (1972–1984). Anot autorės, „šio kolektyvo aktyvi mokslinė veikla pasireiškė sėkmingai apgintomis disertacijomis, leidiniais ir besiplėtojančiais ryšiais su pasaulio astakologais“. Vadovaujant prof. J. Cukerziui buvo parengtos 4 disertacijos įvairiose vėžininkystės tyrimų srityse: ekologijos (J. Šeštokas), trofologijos (E. Tamkevičienė), fiziologijos (G. Mackevičienė), etologijos (J. Dorošenko). Pati autorė ištyrė ir savo darbo rezultatus apibendrino biologijos mokslo kandidato (dabar – daktaro) disertacijoje „Lietuvos vandenų plačiažnyplių ir siauražnyplių vėžių fiziologinės bei biocheminės ypatybės“ (1977). G. Mackevičienė rašo, kad žymaus anglų mokslininko, tarptautinės astakologų asociacijos istoriko, prof. D. Holdicho nuomone, J. Cukerziui vadovaujant, astakologijos srityje nemažai nuveikta ne tik Lietuvoje, bet ir buvusioje Sovietų Sąjungoje. Lietuvos astakologų straipsniai ir tezės jau nuo 1973 m. buvo skelbiami recenzuojamame leidinyje *Freshwater Crayfish*.

1985–1995 m. šiame kolektyve plėtoti tyrimai keliomis kryptimis: etologiniai – skirtingų vėžių rūšių įvairių elgesio formų, fiziologiniai ir biocheminiai vėžių rūšių tyrimai bei darbai virškinamojo trakto mikrobiologijos srityje. Buvo aptikti 3 vėžių rūšių fiziologinių bei biocheminių savybių skirtumai, gauti nauji duomenys apie vėžių hormonų koncentracijų kaitą organizmo ontogenezėje. Išplėtoti vėžių virškinamojo trakto bakteriofloros tyrimai, išskirtos aerobinės ir anerobinės bakterijos, aptikta mokslui nauja bakterijų rūšis, atlikti populiaciniai bakteriofloros tyrimai, įrodytas žymėtųjų vėžių mikrobocenozių kintamumas. Ištirta vėžių geba virškinamajame trakte gaminti laisvąsias aminorūgštis.

Lietuvos astakologai pelnė ir tarptautinį pripažinimą, prof. J. Cukerzis buvo išrinktas tarptautinės astakologų asociacijos vykdomosios tarybos nariu, vėliau vykdomosios tarybos nariu ir koordinatoriumi Baltijos šalims buvo išrinktas dr. A. Burba.

Dešimtojo dešimtmečio pradžioje, po 20 metų pertraukos, Lietuvos astakologai, vadovaujant knygos autorei, atnaujino vėžių akvakultūros metodų diegimo į gamybą bandymus, kurie ir dabar tęsiami, sėkmingai taikant užsienio technologijas. Šių darbų rezultatai buvo pristatyti tarptautinėse konferencijose, paskelbti moksliniuose straipsniuose. Gėlųjų vandenų ekologijos laboratorijoje 1993–2002 m. sukurta duomenų bazė, kurioje sukaupta informacija apie modernias vėžių veisimo ir

auginimo technologijas, taikomas pasaulio šalių veislynuose ir fermose.

1994 m. buvo pradėti nagrinėti vėžių chemoadaptacijos klausimai. Tyrinėtas įvairios kilmės cheminio streso poveikis vėžiams, jų virškinamojo trakto mikroflorai, elgesio reakcijoms, skirtingų vėžių rūšių tolerancija ksenobiotikams. Plačiažnyplių vėžių ekotoksikologiniai tyrimai buvo toliau tęsiami ir po laboratorijos reorganizacijos.

Pažymėtina, kad autorė knygoje ne tik aprašo kolegų mokslinius darbus, bet ir pažymi jų visuomeninę veiklą, skaitytas paskaitas, dainavimą Lietuvos mokslų akademijos chore. Knyga parengta su didele šiluma bei meile, ją įdomu skaityti bei žiūrėti, nes ji gausiai iliustruota įvairiomis nuotraukomis. Ji gali praversti biologams, mokslo istorikams bei besidomintiems vėžininkyste Lietuvoje.

Nors Guodos Mackevičienės darbas apibendrina astakologijos mokslo raidą ne nuo jo pradmenų, tačiau yra svarbus įnašas ne tik į biologijos, bet ir apskritai į Lietuvos mokslą ir mokslo istorinės atminties išsaugojimą.

Milda Zita Vosylienė

EKOLOGIJA. 2007. Vol. 53. No. 1. P. 71–79

Wild hoofed animal movement in winter season and possibilities of reducing their mortality in highway environments of Lithuania

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The research on wild hoofed animal vehicle collision was carried out on six major highways of Lithuania in January–March 2003/2004 and 2004/2005. In the highway environment, animal movement activity was documented following the footprints left on the snow. One-time account of hoofed animals was executed and the number of single animals of particular species crossing the highway at day and night in its separate sections was determined.

The number of hoofed animals moving across different sections of highways differs significantly. The obtained findings are presented for the sections of a highway where the highest crossing activity was observed, i. e. in places potentially dangerous for local vehicle collision with wild animals. The highest activity of animals was determined on the Vilnius–Kaunas–Klaipėda highway (A1) at the 259th–264th km, with 7–10 animals per day/km. Roe deers cross the highway most often (up to 68%), wild boars are more rare (25%), red deer comprise 4% and elks up to 3%. The abundance of hoofed animals and movement intensity in winter depend on the size of forest massif (area), specific ecological conditions, on the habitat and other peculiarities of nature. In small grooves the possibility of vehicle and wild hoofed animal collision is less possible than in large massifs of forests.

No statistical data have been published in Lithuania on the number of vehicle collision with wild animals, its seasonal dynamics, etc.

Technical, biotechnical, traffic directing and other measures are suggested for reducing wild hoofed animal mortality rate and for decreasing the number of road accidents.

Key words: highway, hoofed animals, activity in movement, accidents, measures for reducing

INTRODUCTION

Each year collisions of wild animals and particularly hoofed big-game ones with vehicles on the highways cause a great deal of traffic safety problems inevitably resulting in vehicle damage, injuries, severe traumas, human and animal casualties.

Studies on various aspects of the problem regarding vehicle collisions with wild animals were started in Western Europe much earlier than in Lithuania. In Germany, in 1970 was initiated the documenting of wild animals road-killed at motorways (Pauritsch et al., 1985). In the Bitburg region, in 1999 315 cases were recorded, which comprised 13.5% of all the road accidents within the area. In the Rhein region, even 7794 cases of such type were recorded; 149 people suffered and the damage reached 5.67 mill. German marks (Collinger et al., 2000). In the North Rhein–Westfalen where the net of motorways is very dense, in 1996–2000 0.16 – 0.21% (355–473) road accidents were related to wild animals. Annual road-kills in Germany comprise about 200 thous. cases. In 1997, among the wild animal casualties there were 700 red deer, 1200 elks, 1500 wild boars, 110 thous. roe deer, 74 thous. hares, 25 thous. rabbits, 8 thous. pheasants. The total loss for the damaged transport comprised 182.8 mill. marks (Hartwing, 1998).

On the highways of Austria, in 1998 due to collisions with traffic there were 27.7 thous. casualties of roe deers, a great number of hares (Schober, 1996). The risk of collision with wild animals fluctuated depending on the season of the year. The time of the day had also a great influence on the number of collisions. Road-kills of wild

animals are especially numerous when the maximum of their migration activities coincides with huge flows of vehicles during certain periods of day and night (Zwicke, 1998). All these facts indicate that motorways influence the mortality of animals and decrease their population (Maehr et al., 1991; Ferreras et al., 1992), because the network of road infrastructure degrades the quality of animal habitats, separates parts of animal populations, limits seasonal and daytime migration of animals (McLellan, Shackleton, 1988; Trombulak, Frissell, 2000).

In Lithuania, during the last decades the fleet of transport increased significantly (by 32%). The intensity of traffic flows increased notably, and there appeared a great danger for vehicles to come into collision with wild hoofed animals on the major highways of the country. However, no proper attention has been given to this problem. There is not enough information on the sections of highways dangerous for animal crossings, on the species and numbers of wild animals that cross the roads at the places with installed warning road signs.

Department of Environmental Protection of Vilnius Gediminas Technical University is carrying out integrated studies concerning the effect of transport on various ecosystems (Baltrėnas et al., 1996; Baltrėnas, Vasarevičius, 2003).

The objective of the present research was to determine the moving intensity of wild hoofed animals in the surrounding of separate sections of highways in winter, to investigate potentially dangerous locations of vehicle collisions with wild animals and the influence of the motorway network on hoofed animals, especially within the boundaries of "wild animals" warning road signs where their activity is the greatest, and to recommend measures for reducing the number of animal casualties on the highways.

MATERIALS AND METHODS

The biology of wild animals in certain seasons of the year is closely related with seasonal abiotic changes of factors and their effects on nature. Due to the uneven territorial distribution of animal feed resources, demand for night shelter and places daytime stopovers, animals move to satisfy their requirements for survival.

The research on animal movement activity within the territory of the main highways of Lithuania was initiated in 2003/2004 and 2004/2005 during January–March when the snow cover was no less than 5–7 cm and no thicker than 15–20 cm.

Within seven sectors of highways which crossed forest massifs and had the "wild animals" warning road signs, we investigated the movement tracks of hoofed wild animals such as elks (*Alces alces*), red deer (*Cervus elaphus*), roe deers (*Capreolus capreolus*), wild boars (*Sus scrofa*).

It is known that hoofed animals mostly stay in the same section of the forest no longer than two days (Padaiga, 1996). By changing their places of habitat they frequently tend to cross the highways while migrating. The fateful circumstances have been analyzed and applied when working out the methodology of the research.

The essence of the method employed in our study was to document the intensity of animal movements by their trails left in the snow. In the study sections of roadsides, the previous slots left on the snow were covered. After 3–7 days and nights the newly impressed trails of animals were documented. The recordings were mostly made after the turning up of fresh snow. The footprints were counted on the third-fourth day. By following the indicated route, on the scheme we marked the direction of all fresh footprints of animals by arrows and with the initial letter of animal species names: elk – e, deer – d, roe deer – r, wild boar – b (Fig. 2) (Baleišis et al., 2003).

On the study sites, each section of the highway was investigated verifying the natural surrounding, namely the relief, stiff vegetation (forest stands, age, type, bushes, etc.) as well as its positioning at the roads, etc.

The footmarks were counted in the area where the animals were dispersed. The intensity of wild animal activities was calculated for a particular kilometer of the highway, i. e. the number of animals that crossed the highway. The counted and registered number of animals was divided by days and nights passed after covering the footmarks by snow or cleaning them till the day of counting. The number of animals that crossed the road was calculated from the formula:

$$X = A + B,$$

where A is the number of individuals that crossed the highway from one side, and B is the number of individuals that crossed the highway from the other side.

The footprints were registered no closer than 3 m from the road in places where they were not destroyed by snow.

RESULTS

Wild animal activity in separate sections of highways differs, so the obtained data were analyzed separately for each highway. The results are presented only for highway sections of the most intensive movement of wild animals in the surrounding of the highway and where there might be their potentially dangerous collisions with the traffic.

1. *Vilnius–Kaunas–Klaipėda highway (A1).* The length of the highway is 311.4 km. There are 9 warning road signs "wild animals".

On the section of the road at the 245th–266th km, the road signs comprised a long 21 km portion of validation (four signs; when the validation of one sign expires another sign is installed). There are located the largest massifs of forest through which the main highway of

Lithuania was built. Behind the roadsides of the highway there are ditches and slopes planted with bushes. In the massifs of forests prevail coniferous forest stands (mostly fir-trees) with an insignificant mixture of deciduous trees. In some localities there the areas of broad-leaved woods with sectors of birches. Starting from the 251st km of the highway there are mature pine woods with addition of fir-trees. Close to the highway there are young plantations of fir-trees and pines as well as recently planted forests; there are also small streams, reclamation ditches, clear fellings, open lands. The relief is flat. In some areas of the forests there are areas of soil swamping. In many localities, matured forest stands are being felled. At the section of the highway from the 255th to 259th km, forest stands located at the border of the highway (fir-trees, birches, alders) are very densely sprouted; in some places fir-tree thickets comprise 80% together with separate young plantations of fir trees.

The activity of hoofed wild animals in the rather long section of the highway is quite intensive, although it differs greatly in separate kilometers of the highway. The greatest activity of animals was determined between the 259th and 264th km of the road (Table 1) where the ecological conditions are favourable for animals to populate. There are wild woods with wetlands and open fields, areas for felling where animals find nutrition in winter, as well as there is space enough for hiding. The activity of animals in this location ranges from 5 to 10 animals per day and night. A comparatively low activity of hoofed animals was found at the very beginning and end of the forest massif within the boundaries of road sign validation (1 animal/day) as well as in the middle of the forest massif (1–3 animals/day), possibly because of less feed. On the area of this large forest massif there were recorded four species of hoofed animals moving and migrating across the highway: roes, elks, wild boars and red deer. Most often the highway is crossed by roe deer (68%), not so often by wild boars (25%), red deer (4%) and elks (3%). That proves that the amplitude of hoofed animals and the intensity of their activity in winter depend on the size of forest massifs (area), specific ecological conditions, habitat and other peculiarities of natural environment. The data of the research allow us to state that in the sections of the highway passing not through the large grooves, the probability for vehicles to collide with wild animals is lower than in the large massifs of forests.

Table 1. **The highest movement activity of wild hoofed animals in winter at the Vilnius–Kaunas–Klaipėda highway section 245–266 km**

Kilometer (section)	Number of animals				Total (animals/day)
245–266	Wild boar	Roe deer	Elk	Deer	**67**
245–246	–	1	–	–	1
246–247	–	1	–	–	1
247–248	1	2	–	–	3
248–249	–	2	–	–	2
249–250	–	2	–	–	2
250–251	2	3	–	–	5
251–252	–	2	–	–	2
252–253	–	1	–	–	1
253–254	–	1	–	–	1
254–255	1	2	–	–	3
255–256	–	1	–	–	1
256–257	–	1	–	–	1
257–258	1	1	–	–	2
258–259	–	3	–	–	3
259–260	2	5	–	–	7
260–261	–	5	–	–	5
261–262	2	3	–	2	7
262–263	2	4	–	–	6
263–264	4	5	2	1	10
264–265	2	1	–	–	3
265–266	–	1	–	–	1

2. Klaipėda–Liepaja highway (A13). The length of the highway is 45.15 km to the border with the Republic of Latvia. There are installed three preventive signs; the total section of the highway guided by a road sign is 10 km.

The highway runs through the pines typical of the landscapes of seacoast plains. These are mostly medium-aged and mature pines with fir-tree underwoods, undergrowths of young fir-trees, junipers, birches, rowans, bird cherries. In some areas there are dense woods with 50% of fir trees and 50% of pine stands. Young plantations of pines grow at separate sections of the highway. The forests are dried up, the relief is even. There is no clear felling. The roadsides of the highway within the portion of 4–5 m are mostly forests without stiffened vegetation; there are not enough satisfactory places for animal feed and habitat in the vicinity of this highway.

Hoofed animals move most actively at the section of the 37th–38th km and 43rd–44th km (Table 2). The most frequent and the most active in migrating across the

Table 2. **The highest activity of wild hoofed animals in winter on the Klaipėda–Liepaja highway section 34–44 km**

Kilometer (section)	Number of animals				Total (animals/day)
34–44	Wild boar	Roe deer	Elk	Deer	**43**
34–35	–	1	–	–	1
35–36	1	3	–	–	4
36–37	–	1	–	–	1
37–38	–	7	1	–	7
38–39	2	4	–	–	6
39–40	–	1	–	–	1
40–41	1	4	–	–	5
41–42	2	4	–	–	6
42–43	1	4	–	–	5
43–44	–	7	–	–	7

road were roe deer (82.1%). The activity of wild boars was lower (15.7%), and only single elks (2.2%) were registered.

3. Vilnius–Prienai–Marijampolė highway (A16). The length of the highway is 137.51 km. The highway has five warning road signs.

The maximum activity of wild animals was determined within the boundaries of the 5th warning road sign validation. The road passes through coniferous woods, nurseries are becoming mature and ripening. There are pure pines and fir-tree areas; fir-trees prevail in the underwoods. The undergrowth is comprised of nutwoods, sorbs, bird-cherries, birches. The wood is thick and in some places boggy, there are no large upland bogs and intermediate type of swamps. In those areas the ecological conditions (feed, places for hiding) ensure a rather wide population of hoofed animals at certain sections of the highway. The relief in the forest is uneven: there are hills, hollows, ditches.

Table 3. **The highest movement activity of wild hoofed animals in winter on the Vilnius–Prienai–Marijampolė highway section 98–104 km**

Kilometer (section)	Number of animals				Total (animals/day)
98–104	Wild boar	Roe deer	Elk	Deer	**40**
98–99	–	2	–	–	2
99–100	1	4	–	–	5
100–101	2	6	–	–	8
101–102	3	4	–	3	10
102–103	–	7	2	1	10
103–104	–	5	–	–	5

Table 4. **The highest activity of wild hoofed animals in winter on the Kaunas–Zarasai highway section 20–23 km**

Kilometer (section)	Number of animals				Total (animals/day)
20–23	Wild boar	Roe deer	Elk	Deer	**25**
20–21	5	8	3	–	16
21–22	1	4		–	5
22–23	–	4	–	–	4

Table 5. **The highest movement activity of wild hoofed animals in winter on the Šiauliai–Palanga highway section 74–79 km**

Kilometer (section)	Number of animals				Total (animals/day)
74–79	Wild boar	Roe deer	Elk	Deer	**50**
74–75	5	6	2	–	13
75–76	4	7	–	–	11
76–77	4	6	–	–	10
77–78	–	13	–	1	13
78–79	–	3	–	–	3

The activity of movement of hoofed wild animals on this section of the highway is rather intensive. It is a bit lower within the boundaries of sign validation (1 km from the total of 98 km), the most intensive being the 100th–103rd km (8–10 animals/day) (Table 3). Within that section of the highway, four species of hoofed animals were recorded to cross the highway: roe deer, wild boar, elk and red deer. Roe deer used to cross the highway within the boundaries of sign validation (68.2%), wild boars, elks making respectively 15.9% and 10.2% and elks only 5.7%. The intensity of animal migration is influenced by the particular ecological conditions of the area and the forested section located at the boundaries of the highway.

4. Kaunas–Zarasai highway (A6). The length of the highway is 185.4 km, it reaches the boundaries of the Republic of Latvia. There are installed 11 warning road signs on the highway.

The most intensive activity of the animals was recorded within the zone of validation of the second warning road sign; the validation is 3 km. The highway passes through leafy and mixed forest stands. There prevail middle-aged alders, in some areas ripening birches, fir-trees. In the undergrowths there are sorbs, nut-woods, bird-cherries, black alders. In some places the forest is wet, the relief is even, with reclamation ditches. The afforestation on separate sections of the highway approaches the highway itself. The most intensive animal migration was recorded at the 20th km (16 animals/day) (Table 4). In that area the roe deer cross the highway most intensively (68.8%), wild boars comprising (18.7%) and deer (12.5%) of the total number of migrating hoofed animals. The activity of animals on the other sections of the highway is significantly lower – 4–5 animals/day, but roe deer prevail.

5. Šiauliai–Palanga highway (A11). The length of the highway is 146.85 km. On that section of the highway there are no preventive road signs informing on the possible collision with wild animals. On counting the footprints, we proposed to install the signs at the potentially dangerous sites, namely on the 74th–79th km.

The highway passes through a forest massif with prevailing mature stands of leafy woods in some places (birches, black alders); there are felling sites as well as young plantations. The forest is wet, in some areas waterlogged. The relief is hilly, there are reclamation ditches, hollows. The afforestation in some areas is very close to the highway. In the massif of this forest on both sides of the highway there were recorded four species of hoofed animals (roe deer, red deer, elks and wild boars).

The higher intensity of wild hoofed animals was determined at the 74th and 77th kilometers – 13 animals/day (Table 5). The areas of crossing the highway for

specific animals are influenced by the ecological conditions. Namely, wild boars cross the highway mostly at the 74th–76th km, in locations with thick fir-tree forests situated close to the highway, where they comprise up to 46% of the total number of animals crossing the highway. Roe deer usually inhabit the outskirts of forests, so they cross the highway at the 78th km. The 5 km long highway section with the potentially increased majority of fatal accidents it is mainly crossed by single elks and red deer.

6. Vilnius–Varėna–Gardin highway (A4). The length of the highway is 135.46 km. It reaches the borders of Belarus. The highway has no warning road signs installed. Our research has shown that on the highway A4 the first warning sign should be installed at the 40th km with a 5 km validation zone due to the high activity of animals in that section of the highway.

The 40th km was crossed by six hoofed wild animals within day and night, namely 1 elk and 5 roe deer, showing a low activity of animals in that part of the highway. At the 40th–41st km, on both sides there are situated areas of maturing forest stands. Birches, black alders, fir-trees prevail there; at the end of the section there are young plantations of pines. At the 41st km, 19 wild animals/day were found to cross the highway, of them 13 roe deer and 6 wild boars. There is a mixed forest on both sides of the highway, in some areas covered with coniferous (mostly pine) stands, with the underwood at rare intervals. At the roadsides the relief is even, sand soil prevails. At the 42nd km, the total number of wild animals that crossed the road reached 18 animals per day (roe deer). On both sides of the highway there is a mixed forest, with numerous areas of larger and smaller middle-aged pine and fir-tree stands. At the 43rd km the highway is crossed only by roe deer (22 animals/day). This kilometer of the highway on both sides has coniferous (mostly pine) young plantations with an insignificant mixture (10–15%) of birches. In the underwood there prevail fir-trees, in some areas junipers. At the 44th km, only roe deer cross the highway (12 animals/day). The activity of animals at this kilometer is medium. At the roadsides prevail nearly mature pine forests with the underwood of broadleaves. The relief is even, sandy soils prevail. The movement of wild animals across the highway is most intensive at the 41st–43rd km (Table 6).

Table 6. **The highest movement activity of wild hoofed animals in winter on the Vilnius–Varėna–Gardin highway 40–45 km section**

Kilometer (section)	Number of animals				Total (animals/day)
40–45	Wild boar	Roe deer	Elk	Deer	**77**
40–41	–	5	1	–	6
41–42	6	13	–	–	19
42–43	–	18	–	–	18
43–44	–	22	–	–	22
44–45	–	12	–	–	12

Table 7. **The highest movement activity of wild hoofed animals in winter on the highway Riga–Šiauliai–Tauragė–Kaliningrad section 146–152 km**

Kilometer (section)	Number of animals				Total (animals/day)
146–152	Wild boar	Roe deer	Elk	Deer	**62**
146–147	–	2	2	–	4
147–148	–	5	–	–	5
148–149	–	–	–	15	15
149–150	4	2	–	12	18
150–151	–	5	4	6	15
151–152	3	2	–	–	5

7. Riga–Šiauliai–Tauragė–Kaliningrad highway (A12). The length of the highway in the territory of the Republic of Lithuania is 186.09 km. On this length, three warning road signs are installed.

The most intensive movement of wild animals was determined at the 3rd road sign validation zone which is 5 km long. At the 146th km the highway was crossed by four hoofed animals during the day, 2 elks and 2 roe deer per day, indicating a low intensity of the movement. The road at the 146th km passes through even area, through a mature mixed forest massif. The forest in some places is wet, there are sites of felling, glades, forest roads. At the 146.8–147th km section, on the left side of the highway an arable land area is located, where roe deer use to come to the winter crops.

At the 147th km, activity of wild hoofed animals was also low because only five roe deer were recorded to cross the highway. At that kilometer of the highway prevail broadleaf mature forest with fir-tree admixture, in some places with some large areas of only coniferous (fir-tree) or broadleaf (black alders, birches) forest stands. The surrounding of the highway is similar to that one at the 146th km.

Meanwhile at the 148th km the highway was crossed by 15 wild animals per day (red deer). At that section, movement activity of deer was most intensive as compared with the other sections of the highway. The highway at the 148th km passes through an even area grown with forests. At the roadsides there prevail broadleaf stands (mostly alders), with larger or smaller areas of mature mixed forests. The forest has a good network of roads. Forest management here is intensive, there are sites of felling.

The activity of wild animals at the 149th km was of the maximum intensity (Table 7). During the day the highway was crossed by 18 wild animals – 12 red deer, 2 roe deer, 4 wild boars. At this kilometer, on both sides of the highway there lies an area of mature, in some places ripen forest; there are areas of broadleaves (mostly black alders) and are felling sites. The forest has been reclaimed and so there are very many ditches.

At the 150th km, the road was daily crossed by on average 15 animals (4 elks, 6 deer and 5 roe deer). The 150th km passes through broadleaf (alder) stands, areas of mixed forests and felling sites. At the road sides the relief is rather even.

The activity of hoofed animals at the 151st km was low, with only five animals (2 roe deer and 3 wild boars) crossing the highway per day. On both sides of the highway there is a mixed forest which approaches the suburbs of the Tauragė town at the 152nd km. There are areas of mature fir trees, felling sites, forest sites. The underwood in some places is thick. The ecological conditions are favorable for the reproduction of elk population due to the very good conditions of nutrition.

DISCUSSION

The number of casualties of wild animals after collisions with vehicles on the highways was found to relate to the number of their population in particular areas and with different intensity of traffic at separate sections of the highways. Damage caused by transport to separate species of animals may be significant. Nearly 30 years ago in Lithuania there were animal casualties of car and railway collisions that involved annually about 10.5% of elk population (Балейшис, 1972). What is the present situation?

At the Public Road Surveillance Services of the Public Police of Lithuania there are statistical data on traffic accidents in relation with animals. The data are concerned mostly with the statistics regarding collisions with wild massive domestic animals; data on collisions with wild animals were not registered as a separate item, so they are rather approximate. For example, for eight months (January–August) of 2004 there were recorded 321 and from May to the beginning of September 169 such cases. There is no doubt that the number of vehicle collisions with wild animals on highways is significantly influenced by the higher speed of vehicles and intensity of traffic in comparison with country roads.

According to the data of road traffic surveillance, on May 8, 2005 on the Vilnius–Klaipėda highway at the 262nd km an elk crashed with a car. During the accident the driver and the animal were killed, two passengers were wounded. The Vilnius–Kaunas–Klaipėda highway from the 254th to 263rd km passes through a forest. The highway is not protected from forest animals by screens; the drivers are informed to be careful by the installed road signs. In 2004, animals that appeared unexpectedly on the road caused eight accidents. Three people were wounded, one elk was killed. At this section of the road there were two accidents during 2006.

In October 2005, on the Vilnius–Kaunas–Klaipėda highway a red deer caused a great accident. Two vehicles driving on the opposite sides were smashed, one of them irreparably. This severe collision was held at the same place as on May 8, 2005.

The greatest number (42.8%) of accidents connected with wild animals occur to be on the major country highway Vilnius–Kaunas–Klaipėda.

In accordance with the registered data, the greatest number of accidents due to the collisions with hoofed animals occurs on the Vilnius–Kaunas–Klaipėda highway (A1). The preventive road signs "wild animals" are installed at the 245th–253rd km and 254th–262nd km (after three collisions registered). Similar accidents were registered on the highway A1 at the section 80th–85th km (two cases registered). Thus, our data on animal movement activity on this highway coincide with the statistical data on road accidents recorded by the Traffic Surveillance Service.

No statistical data on vehicle collision with hoofed animals were recorded by the Traffic Surveillance Service on the other highways.

Analysis of the data of our research has shown that the movement activity of wild hoofed animals in winter on the Klaipėda–Liepaja highway at the 34th–44th km is 1.0 to 7.0 animal/day. The highest activity was noted at the 37th–39th and the 41st–44th km where the most active migrants are roe deer (82.1%), followed by wild boar (15.7%), and separate elks comprise 2.2% of all the animals crossing the road.

On the Vilnius–Prienai–Marijampolė highway, the greatest movement activity among hoofed animals was registered within the validation boundaries of the 5th road sign (the 98th–104th km) where the highway was crossed by hoofed animals of four species: roe deer, elks, wild boars and red deer. The highway was crossed most intensively by roe deer (68.2%), followed by wild boars (15.9%), red deer (10.2%), elks (5.7%). The greatest activity is 8–10 animals/day. Both on this major highway and on the Klaipėda–Liepaja highway the most cactive migrants are roe deer. The reason is the highway sections located close to the sites of felling and on the mature mixed forest stands, forest areas with abundance of underwoods and subshrub undergrowths. The number of accidents depends not only on the ecological environmental conditions in the highway area, but also on the size of massif forests, the abundance of specific habitats suitable for animals, etc.

On the Šiauliai–Palanga and Vilnius–Varėna–Gardin highways there are no warning "wild animals" road signs, and potentially dangerous places for vehicles to collide with wild hoofed animals have been unknown. The research documented existence of dangerous sections on those highways (Figs. 1, 2) where wild animals might cause accidents.

The number of vehicle collisions with wild hoofed animals and the number of their casualties on the highways should be reduced, especially on the most dangerous sites, by applying biotechnical, technical, road traffic control measures.

Biotechnical measures are considered to be the measures provided and applied for to improve the visibility of the closest surrounding of the highways. That

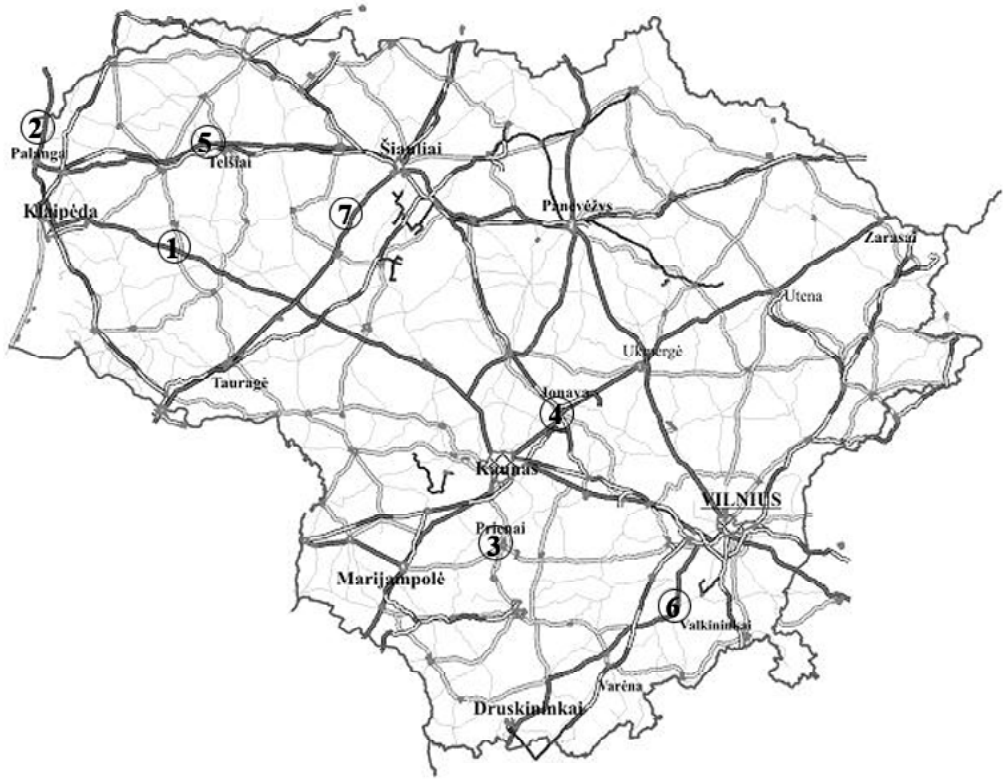

Fig. 1. Main highways of Lithuania with indicated places of highest activity of wild hoofed animals in the surrounding of the highways: *1* – Vilnius–Kaunas–Klaipėda, section 245–266 km, *2* – Klaipėda–Liepaja, section 34–44 km, *3* – Vilnius–Prienai–Marijampolė, section 98–104 km, *4* – Kaunas–Zarasai, section 20–23 km, *5* – Šiauliai–Palanga, section 74–79 km, *6* – Vilnius–Varėna–Gardin, section 40–45 km, *7* – Riga–Šiauliai–Tauragė–Kaliningrad, section 146–152 km.

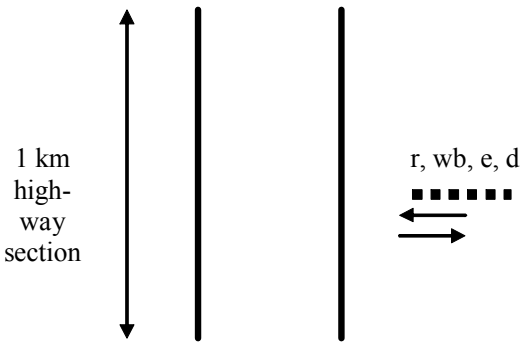

Fig. 2. Scheme of determining wild animal movement activity in highways surroundings (wb – wild boar, r – roe, e – elk, d – deer)

is why it is necessary to fell the bushes and shrubs grown at the road sides, young trees at a distance of 10–15 m (depending on the relief of the locality) from the asphalt cover of the highway. Participants of the traffic shall have to take safety measures such as to reduce the speed, stop a car, etc. after having noticed a wild animal at the road side.

Technical measures. They are considered to be various equipments and their components, sets preventing against wild animal appearance on the carriage way of the highways and reducing the likelihood of accidents. One of the most often used technical means is a safety protective fence on the highway sections grown with forests. To make the fence one can use wooden, reinforced or plastic poles with a different diameter of wire mesh net fixed between the wired, metal, or other wire fence elements. The height of the recommended fence is 2 m, and the width is 2.5 m. The fence type is chosen in accordance with the local peculiarities with bends of 600–800–1200 m, with passes of 100 m. The gates have to be made for exit into the forest.

The other measures widely applied lately are reflectors which have to be installed at the sites of animal gathering at the forests, meadows, in the forests or similar places of wild animal habitat to serve as an optical barrier. The final installation of reflectors is carried out taking into consideration the width of the shoulder of the highway, metal screens mounted, roadside vegetation, waste water ditches, dams and other peculiarities of the relief. The bands of reflectors are not necessarily located within the same distance from the reservation line or within the same distance from the highway edge. They are usually arranged in chess-board order. The mounted reflectors are not allowed to be positioned opposite each other, i. e. not at the right angle to each other but at the right angle to the highway. A reflector is mounted at the height of over 24–30 cm above the highway. If at the roadside there is a steep slope, more reflectors should be mounted because wild animals are not able to notice them from the other side of the road (Dale, 1996).

Underground tunnels could also be prescribed as the technical measures (Singer et al., 1999) as well as "green viaducts/overpasses" which are installed above the highways and are meant for animal crossing. Under the highways, in places where the activity of animals is great (e. g., on the Vilnius–Kaunas–Klaipėda highway at the 263rd km (Table 1), on the Riga–Šiauliai–Tauragė–Kaliningrad highway at the 149th km (Table 7)), it is advisable to install a tunnel prefabricated from separate metal sheets. The height of the pass should be 4.0 m and the width 5.0 m. The walls of the tunnel are recommended to be painted in the dark green or grey colour for animals not to be scared of vivid metal brightness. The bed of the tunnel should be covered by a 20–30 cm ground cover. On both sides of the tunnel we advise to install a fence 100–250 m long on each side in accordance with the geographical conditions of the locality and 2.0 m in height, made of metal wire mesh that could stop animals from crossing the road and direct them towards the underground tunnel.

"Green viaducts" are very popular for protecting animals crossing the highways in Canada, USA, West Europe (Germany, Switzerland) where highways are built across the mountains (Singer, Doherty, 1995). In Lithuania, the installation is hindered by unfavorable geographical conditions.

Other technical measures applied are additional lightning of highways in the places of high wild animal activity (Schober, 1996), installation of ultrasonic whistles on vehicles, installation of metal screens at the roadsides (Dale, 1996).

Measures for directing traffic. The warning road signs "wild animals" are installed in the newly appeared places of wild animal intensive activity movements or previously undiscovered movements across the highways. Another traffic safety ensuring measure is the usage of speed limiting signs. They should be installed at the fences, passes. On the highways at the passes the speed should be limited to 80–90 km/h. Besides that, we recommend together with the warning signs "wild animals" to install speed limiting signs (up to 90 km/h) (Schober, 1996; Hartwing, 1998).

Other measures are recommended to make amendments while designing, when building roads and after having noticed intensive wild animal movements at the road building sites to transfer or move out the roads from places of animal migration.

To attract the attention of wild animals away from highways but towards feeding sites and by installing them (Schober, 1996) could be one more measure.

The implementation of these measures could reduce the casualties of wild animals as well as the number of accidents on the highways.

Received 1 March 2006
Accepted 10 January 2007

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LAUKINIŲ KANOPINIŲ GYVŪNŲ AKTYVUMO ŽIEMOS METU IR JŲ ŽŪČIŲ SUMAŽINIMO GALIMYBIŲ TYRIMAI LIETUVOS MAGISTRALINIŲ KELIŲ APLINKOJE

Santrauka

Laukinių kanopinių gyvūnų susidūrimų su autotransporto priemonėmis tyrimai atlikti šešiuose Lietuvos automagistraliniuose keliuose 2003/2004 ir 2004/2005 m. sausį–kovą. Gyvūnų aktyvumas kelio aplinkoje registruotas pagal sniege jų paliktus pėdsakus. Atliktos vienkartinės kanopinių gyvūnų apskaitos, nustatyta, kiek tam tikrų rūšių individų perbėgo kelią jo atkarpose per parą.

Kanopinių gyvūnų aktyvumas magistralinių kelių įvairiuose ruožuose ryškiai skyrėsi. Gauti tyrimų rezultatai pateikti tiems kelių ruožams, kuriuose buvo nustatytas didžiausias gyvūnų aktyvumas, t. y. kuriuose yra potencialiai pavojingos vietos autotransporto susidūrimams su laukiniais gyvūnais. Didžiausias žvėrių aktyvumas nustatytas magistralinio kelio Vilnius–Kaunas–Klaipėda (A1) 259–264 kilometruose, 7–10 ind. per parą/km. Dažniausiai per kelią perbėga stirnos – iki 68%, rečiausiai šernai – 25%, taurieji elniai – 4% ir briedžiai – iki 3%. Nustatyta, kad kanopinių žvėrių gausumas ir aktyvumo intensyvumas žiemą priklauso nuo miško masyvo dydžio (ploto), specifinių ekologinių sąlygų, tinkamų buveinių gausos ir kitų gamtinės aplinkos ypatumų. Tyrimų duomenys taip pat leidžia teigti, kad kelio atkarpose, einančiose per miškelius, tikimybė automobiliams susidurti su laukiniais kanopiniais žvėrimis yra mažesnė nei dideliuose miškuose.

Lietuvoje skelbtų statistikos duomenų apie autotransporto susidūrimų su laukiniais gyvūnais skaičių, sezoninę dinamiką ir pan. nėra.

Pasiūlytos techninės, biotechninės, eismą reguliuojančios ir kitos priemonės laukinių kanopinių žvėrių žūčių ir autoįvykių keliuose skaičiui sumažinti.

Raktažodžiai: magistralinis kelias, kanopiniai žvėrys, aktyvumas, autoįvykiai, sumažinimo priemonės