

The Reasons for The Mass Mortality of Siberian Roe Deer in The Wintering Period in Western Siberia



V. B. Yermolik, Yu. D. Schmidt, P. N. Smirnov

Abstract: *The article presents the analysis of the limiting environmental factors that determine the dynamics of the roe deer population in Western Siberia. The regularities of the extreme effect of winter anomalies, in particular, high snow, on the organisms of Siberian roe deer have been determined. The structure of winter nutrition and behavioral reactions of roe deer has been studied in terms of adaptation and maintaining the homeostasis in the conditions of fodder shortage and overcoming the resistance of the snow cover. The reasons for the mass mortality of roe deer in the winter have been found. To solve this problem, post-mortem examinations were made of the roe deer that died from starvation in the wild. Studies have shown that roe deer feeding on raw growing browse in the wintering period results in injuries of the digestive system. This browse has low nutritional value and is unable to ensure the energy balance in the organism of roe deer. It has been found that this process is accompanied by degeneration of the tissues and organs with disruption of their functions, resulting in nutritional depletion, which causes mass mortality of roe deer in the wild.*

Keywords: *Siberian roe deer, population, high snow, adaptation, homeostasis, pathoanatomical examination, feed injuries, the collapse of the digestive system, alimentary depletion.*

I. INTRODUCTION

Siberian roe deer in Western Siberia is the most representative species of wild cloven-hoofed animals. Maintaining the structure of the populations and the number of species of the deer family at the optimal level directly depends on the quality and the year-round availability of the fodder base.

The seasons have different effects on the behavioral patterns of roe deer and play an important role in their life cycle.

In the summer, they find enough food at most feeding points in their habitats [1].

The summer diet of roe deer is quite diversified and consists of 500 plant species. Their everyday preferences are very diverse. These are marsh-and-meadow herbs, in particular, slough grass, marsh rosemary, common horsetail, leaves of

wintergreen, pigweed, and wild vetch. They readily eat cranberry, blueberry, and bilberry leaves and berries. In the forest-steppe zone, roe deer eat burnet, cow parsnip, rosebay, sorrel, calla, acorus, and other plants.

With the onset of the winter, the situation with providing forage resources for roe deer changes dramatically. In Western Siberia, the average duration of the period with stable snow cover is 160 to 180 days. The high-snow season virtually deprives roe deer of the ability to freely move and thus get natural forage under the deep snow. At this period, the feeding opportunities are much worse for roe deer, and they mainly feed on the browse from the lower layer of the trees – shoots of various species of willow, as well as birch and aspen.

The problems of survival, preservation, and changing the population of wild animals, depending on their habitat conditions and on the extreme effect of seasonal factors, were discussed in the works of the following Russian biologists: A. P. Semenov-Tyan-Shansky [2-4]; P. B. Jurgenson [5, 6]; A. A. Nasimovich [7-9]; A. N. Formozov [10]; S. V. Kirikov [11]; V. E. Sokolov, A. A. Danilkin [12], [13]; V. A. Ostanin, V. A. Strekalovskikh [14], A. V. Argunov [15], O. A. Grosheva [16], B. V. Kobelchuk, I. O. Lysenko [17], A. A. Krivoshapkin [18], Y. V. Labutin, M. V. Popov [19], I. A. Lvov [20], P. A. Manteifel [21], N. I. Maltsev [22, 23], N. I. Prostakov [24], and others.

In the winter, during high snow, roe deer are the most vulnerable species in the deer family. The height of the snow cover from 50 cm and more than one meter is a kind of "survival threshold", where roe deer can in rare cases without human help safely make it to the end of the wintering cycle [13, 25, 26]. The onset of each new winter with plenty of snowfalls naturally has biologically serious consequences, i.e., mass death of the animals from starvation. In particular, on the territory of the Novosibirsk region, the winter of 2016 – 2017 by its extreme parameters exceeded all previous winter periods. The height of the snow cover at the lowland parts in separate districts of the region reached one and a half meters, and along the rivers and the contour of the forest, the snow level reached the absolutely abnormal value of over two meters. As a result of the ensuing starvation, the lack of access to natural feed, and the absence of skilled biotechnical support, the population of roe deer in this region suffered serious losses. According to the data of the West-Siberian branch of the All-Russian Research Institute of Hunting and Farming n.a. Prof. B. M. Zhitkov of the Russian Academy of

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Agricultural Sciences, which monitored the wintering cycle and its impact on the populations of the cloven-hoofed animals, the roe deer mass mortality in the region in March 2017 amounted to over 5,000 animals. Concerning this fact, the authors performed research for determining the reason for the mass mortality of the animals.

II. METHODS

A. General Description

To solve the tasks set in the research, pathoanatomical examinations of the bodies of the roe deer starved to death found in the wild on the territory of the Novosibirsk region were performed. The biological material for the subsequent examination was sampled randomly in the format of cluster sampling.

The studies were performed at the base of:

- the office of the Federal Veterinary and Phytosanitary Monitoring Service (Rosselkhoz nadzor) for the Novosibirsk region, Reference Center, Laboratory of Histomorphology (Serebrennikovskiy Str., 5);
- the FSBEI HE Novosibirsk State Agrarian University, Faculty of Veterinary Medicine, Department of Surgery and Internal Noncontagious Diseases, the laboratory-and-clinical building (Dobrolyubov Str. 160).

B. Algorithm

To achieve the goal, the method of complex pathoanatomical examination of the internal organs of roe deer with detailed description and morphometry of the discovered changes was used (Fig. 1)



Fig. 1: Expert autopsy of roe deer, and taking samples for clinical and morphological studies.

External examination of the dead roe deer showed a pronounced exhaustion manifested in the bulging of pelvic bones, ribs, spinous processes of vertebrae; the skin was dry, palpation did not reveal any subcutaneous fat (Figure 2).



Fig. 2: Appearance of a dead roe deer

In the axilla and on the lower part of the thorax, the absence of hair was observed as a result of direct exposure to the high show, which was evidence of disrupted thermoregulation in the animal studied. On the background of fasting, focal alopecia of the skin cover was observed everywhere (Fig. 3).



Fig. 3: Roe deer skin cover alopecia

Opening of the abdominal cavity revealed the total serosanguineous edema of the abdominal cavity organs (Fig. 4) and a pronounced brown atrophy of the liver.

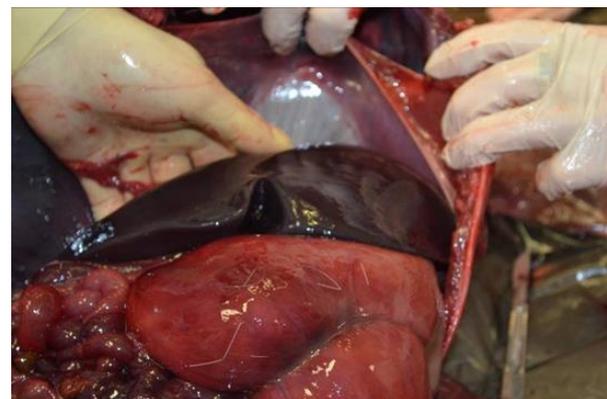


Fig. 4: Serosanguineous edema of the abdominal organs and pronounced brown atrophy of the liver.

III. RESULTS

Examination of the cardiovascular system of Siberian roe deer showed that the macroscopic characteristic of the heart confirmed the high biological load on the animal organism in the absence of metabolic support for the overall energy status on the background of systemic starvation. For instance, the examination revealed the presence of systemic myocardial infarctions, floccular degeneration, acute inflammation of the myocardium, and myocarditis with focal infarction (Fig. 5, 6).



Fig. 5: Myocardial infarctions

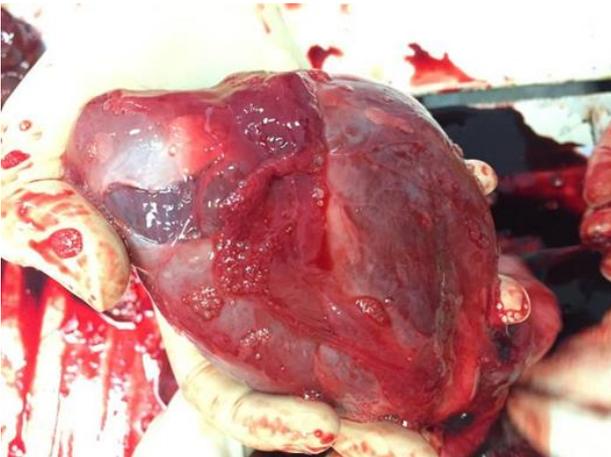


Fig. 6: Myocarditis with focal infarction

Examination of the cross-section of the heart revealed tonogenic dilatation, and a red thrombus in the heart cavity (Fig. 7).

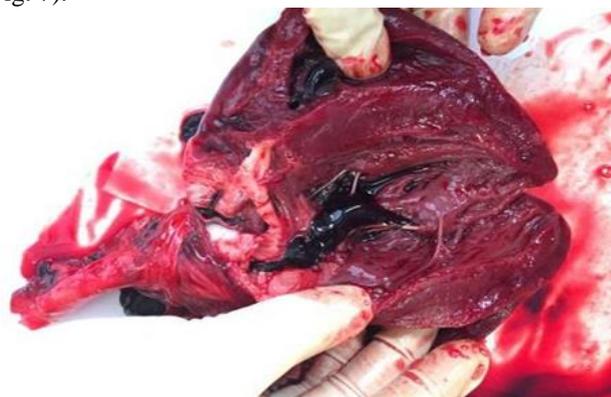


Fig. 7: heart cross-section – tonogenic dilatation

An inflammatory process was noted on the endocardium,

which had resulted in changes in the endocardium structure (Fig. 8).

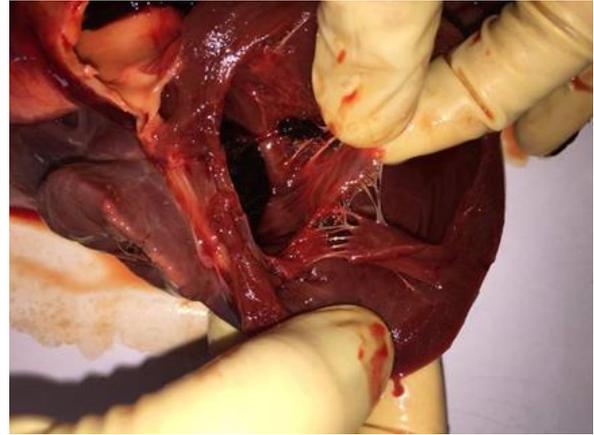


Fig. 8: Valve endocarditis

Fibrinous depositions were found on the endocardium (Fig. 9).

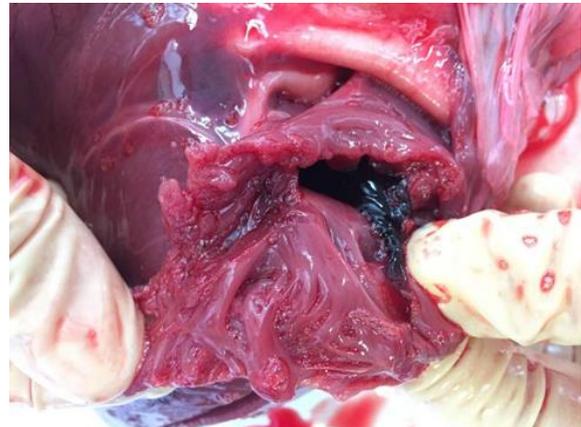


Fig. 9: Fibrinous depositions on the endocardium

Morphological changes of the heart, the presence of degenerative and dystrophic processes, and myocardium atrophy were found (Fig. 10).



Fig. 10: Myocardium atrophy

The examination of the respiratory system revealed hemorrhagic inflammation and pulmonary edema. A pathological increase in the volume of the extravascular fluid in the lungs was observed. The tissues had a firm texture and a deep red color; bloody fluid drained from the surface (Fig. 11).

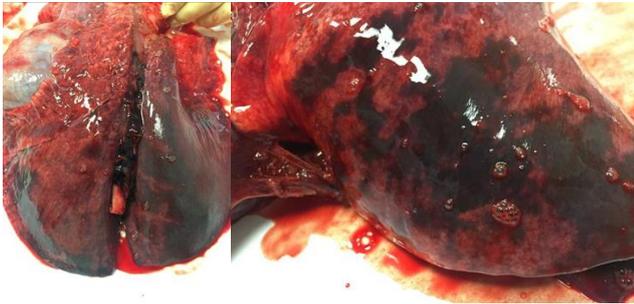


Fig. 11: Brown atrophy of the liver after the prolonged starvation

Examination of the spleen revealed the decreased volume of this organ, which was characterized by brown atrophy, as well as systemic degenerative processes, which were evidence of an extreme degree of cachexy of the examined roe deer (Fig. 12).



Fig. 12: Atrophic splenitis

The expert evaluation of the kidneys showed the complete absence of the adipose capsule; the kidneys were compacted, which was typical for atrophy and nephrosclerosis, the effect of the toxic kidney was observed (Fig. 13, 14).



Fig. 13: Kidney (atrophy and dystrophy)



Fig. 14: Kidney cross-section (atrophy and nephrosclerosis)

The analysis of the digestive systems revealed a pronounced atrophy of the mucous layer in the gastrointestinal tract; the contents of the rumen were heterogeneous, undigested vegetable and woody components were found (Fig. 15).



Fig. 15: The contents of the rumen

The examination practically revealed the collapse of the digestive system in the dead roe deer, whereby the atrophy of the omasum and the hemorrhagic inflammation of the mucous membrane of the abomasum were observed with the decomposition of the tissues as a result of the activation of its own enzymes (autolysis) (Fig. 16).



Fig. 16: Omasum atrophy

The mucous membranes of the abomasum and the small intestine were characterized by pronounced necrolysis and acute serosanguineous edema as a manifestation of the terminal stage of the cachexic process in the organism of the animal (Fig. 17, 18, 19).



Fig. 17: Hemorrhagic inflammation of the abomasum mucous membrane



Fig. 18: Autolysis (self-digestion) in the abomasums



Fig. 19: Hemorrhagic enterocolitis

IV. CONCLUSION

As a result of the research and according to the findings of the pathoanatomical examination of the corpses of the roe deer that died of starvation, the authors have come to the conclusion that roe deer feeding on raw growing browse in the winter causes injuries to the digestive system, and results in the atrophy of the mucous layer in the gastrointestinal tract, in necrosis of the mucous membrane in the abomasum and the small intestine, and hemorrhagic inflammation and acute serosanguineous edemas. Such feed has a low nutritional value for roe deer and is poorly digested, which is evidenced by the presence of undigested vegetable and woody components in the gastrointestinal tract. Besides, browse is unable to ensure the energy balance for saturating the roe deer organism with the proper amounts of proteins, fats and

carbohydrates, mineral substances, and vitamins, which are necessary for the survival of this species in high snow conditions. All these factors on the background of long and pronounced malnutrition, starvation, accompanied by degeneration of the tissues and organs with disruption of their functions, result in nutritional dystrophy, which causes mass mortality of roe deer in the wild.

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REFERENCES

1. A.A. Danilkin 'Rossiiskaya programma "Kosulya": itogi, problemy, perspektivy" [The Russian Roe deer program: results, problems, prospects], *Hunting and the hunting economy*, 2, 1995, pp. 14 – 17.
2. A.P. Semenov-Tian-Shansky "Nakanune razgroma poslednikh rezervov prirody" [On the eve of the defeat of the last natural reserves] *Novoe Vremya*, 10 (23), 1911, p. 688.
3. A.P. Semenov-Tian-Shansky "Svobodnaya priroda, kak velikii zhivoi muzei, trebuet neotlozhnykh mer ogradzheniya" [Free Nature As a Great Living Museum Needs Urgent Fencing], *Nature*, 4-6, 1919, pp. 199 – 216.
4. A.P. Semenov-Tian-Shansky "Osnovnye cherty istorii razvitiya alpiiskikh faun" [Main traits in the history of Alpine fauna development], *News of USSR Academy of Sciences. Department of Mathematical and Natural Sciences*, 1937, pp. 1211–1222.
5. P. B. Yurgenson "O rekonstruktsii okhotnichiei fauny" [On the restructuring of the hunting fauna], *Hunter soldier*, 7, 1934.
6. P.B. Yurgenson "Plotnost naseleniya kopytnykh zhivotnykh i ee normirovanie" [The ungulates population density and its regulation] *Reports of the Institute of Forest of the USSR*, 13, M.: 1959, pp. 44 – 50.
7. A.A. Nasimovich "Zima v zhizni kopytnykh Zapadnogo Kavkaza" [Winter in the life of ungulates of the West Caucasus], *Issues of ecology and coenobiology*, 7, L.: 1939, pp. 3–91.
8. A.A. Nasimovich "Opyt izucheniya ekologii mlekopitayushchikh putem zimnikh tropnenii" [The experiment in studying the ecology of mammals through winter tracking], *The Zoologic Journal*, 27 (4), 1948, pp. 371 – 372.
9. A.A. Nasimovich "Rol rezhima snezhnogo pokrova v zhizni kopytnykh zhivotnykh na territorii SSSR" [The role of the snow cover conditions in the life of ungulates on the territory of the USSR], M.: Publishing House of the USSR AS, 1955, p. 404.
10. A.K. Formozov "Snezhnyi pokrov kak faktor sredy, ego znachenie v zhizni mlekopitayushchikh i ptits SSSR" [Snow cover as a factor of the environment, its importance in the life of mammals and birds of the USSR], *Materials for studying the fauna and flora of the USSR*, 5, M.: Publishing House of the Moscow Society of Naturalists, 1946, p. 146.
11. S. V. Kirikov "Promyslovye zhivotnye, prirodnyaya sreda i chelovek" [Commercial animals, natural environment, and the man], M.: Nauka, 1966, p.349.
12. A.E. Sokolov A. A. Danilkin "Sibirskaya kosulya" [Siberian roe deer], M., 1981, p.144.
13. A.A. Danilkin. "Kak upravlyat populyatsiyami kosul" [Roe deer population management], *Hunting and the hunting economy*, 2, 1991, pp. 10–13.
14. A.A. Danilkin, V. A. Ostanin, V. A. Strekalovskikh "Demograficheskie parametry populyatsii sibirskoi kosuli v Zauralie i osnovnye faktory, ikh opredelyayushchie" [Demographic parameters of the Siberian roe deer population in Trans-Urals and basic factors that determine them], *Ecology*, 6, 2000, pp. 432–437.

12. A.V. Argunov "Materialy po chislennosti i plotnosti naseleniya sibirskoi kosuli v Tsentralnoi Yakutii" [Materials on the population and population density of Siberian roe deer in Central Yakutia], *Protection of biological diversity and development of hunting economy in Russia*, Penza: RIO PSAA, 2005, pp. 85–87.
13. O.A. Grosheva "Sokhranenie biologicheskogo raznoobraziya v zapovednikakh stepnoi zony Rossii" [Preservation of the biological diversity in the wildlife reserves in the steppe zone of Russia], *News of the Orenburg State Agricultural University*, 3 (15-1), 2007, pp. 25 – 27.
14. B.V. Kobelchuk, I. O. Lysenko "Analiz sovremennogo sostoyaniya i perspektivy razvitiya osobo okhranyaemykh prirodnykh territorii (OOPP) Stavropolskogo kraya" [Analysis of the current state and development prospects of the natural areas of preferential protection (NAPP) in the Stavropol region], *News of AIC in the Stavropol region*, 1(9), 2013, pp. 100–102.
15. A.A. Krivoshapkin "Chislennost sibirskoi kosuli (Capreolus Pall.) v Tsentralnoi Yakutii i faktory, opredelyayushchie ee dinamiku" [The population of Siberian roe deer (Capreolus Pall.) in Central Yakutia and the factors that determine its dynamics], *News of the YaSU*, 3 (2), 2006, pp. 56 – 62.
16. Y.V. Labutin, M. V. Popov "Izmeneniya chislennosti kosuli na Leno-Kenkeminskom mezhdurechie kak sledstvie vliyaniya antropogennogo faktora i pogodnykh uslovii" [Changes in the population of roe deer in the Lena-Kenkeme interfluvium area due to the anthropogenic factors and weather conditions], *The Nature of Yakutia and its preservation*, Yakutsk, 1972, pp. 72–82
17. I.A. Lvov Dikaya priroda: grani upravleniya [Wildlife: management aspects], *Bioengineering Essays*, M.: Mysl, 1984, p.191.
18. P.A. Manteifel "O rekonstruktsii okhotnichie-promyslovoi fauny mlekopitayushchikh SSSR" [On the reconstruction of the mammals hunting and commercial fauna of the USSR], *Socialist reconstruction and science*, 2, 1934.
19. N.I. Maltsev "Vesennie migratsii kosuli [Spring migrations of roe deer], *Hunting and the hunting economy*, 5, 2002, pp. 8–10.
20. N.I. Maltsev "Ekologicheskie osnovy ratsionalnogo ispolzovaniya resursov i sibirskoi kosuli Srednei Sibiri" [Ecological bases for the rational use of natural resources and the Siberian roe deer in Central Siberia], Abstract of Dissertation...Candidate of Biological Sciences 03.00.32 / Nikolai Ivanovich Maltsev, Krasnoyarsk, 2004, p.30.
21. N.I. Prostakov "Ekologiya i sotsialnaya zhizn evropeiskoi kosuli" [Ecology and the social life of the European roe deer], Voronezh, 1996, p. 375.
22. A.A. Danilkin "Zimnyaya podkormka kopytnykh: biologicheskii aspekt problem" [Ungulates winter feeding: the biological aspect of the problem], *Hunting and the hunting economy*, 4, 1996, pp. 12–14.
23. A.A. Danilkin, V. A. Ostanin "Mass mortality of roe deer", *Hunting and the hunting economy*, 7, 1998, pp. 6–8.