

Acta Scientifica Naturalis

Former Annual of Konstantin Preslavsky University – Chemistry, Physics, Biology, Geography

Journal homepage: <http://www.shu.bg>

Received: 30.10.2014

Accepted: 11.03.2015

Dietary specifications reflect the feeding behaviour of the European otter (*Lutra lutra*) in “Strandzha” Natural Park (Bulgaria)**Nikolay Natchev^{1,2}, Zahari Petkov³, Georgi Dashev¹, Ivanka Atanasova¹,
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Abstract: Within the scope of the present study a field survey in the area of “Strandzha” Natural Park in south-east Bulgaria was carried out. The main goal of the investigation was to gain more detailed information on the diet of the European otters (*Lutra lutra*) that inhabit the park. As indicators for the presence of the mustelids a set of standard procedures, such as footprints tracking and inspecting the terrain for otter spraints were used. A total of 204 excrements were found, measured, documented and then disintegrated in water. The food rests in the faeces were investigated and the diet of the local population was documented. On the base of the results we separated the excrements into six groups and analysed the relations between the contents of the spraints and the characteristics of the habitat where they were found. We discovered a clear tendency toward piscivory in the middle and down streams of the studied rivers in the Natural Park. In the upper streams, otters relied almost exclusively on invertebrates like bivalves and crayfish as food source. The fact, that even suboptimal habitats, which offered invariable menu, were exploited by the otters is an indication for the stability of the local population.

Keywords: nutrition, mustelids, spraint analysis, predator, fish farming, population dynamics

Introduction:

Similarly, to most members of the mustelid family, the European otter (*Lutra lutra*) is an actively hunting predator which destroys very large amount of prey animals, as the corps are often left uneaten (at least in closed basins). This fact is the probable reason for the public opinion that otters seriously damage the fisheries (see [1], [2], [3], [4]). In the past, the species was intensively hunted because it

harms the fish reserves and during the 50-s of the 20th century, the European population collapsed to a critical minimum [5]. According to the Bulgarian Red book of endangered species, the number of the adult wild otters had varied dramatically. During the thirties of the 20th century, there were about 4000 otters in Bulgaria, but similar to the European tendency, during the next ten years the population was critically diminished. This resulted in the implementation of measures to mitigate the negative impact on the species in 1962 and since then in Bulgaria the hunt and the skin trade had been regulated by the national legislation. In 1985 the species was included in the Bulgarian Red book of threatened species. Currently the conservation status of the species is as follows: Bulgarian Red Book – vulnerable; Bulgarian Biodiversity low – Anex II and III; IUCN – near threatened; CITES – Anex I; Bern convention – Anex II; Anex I; Habitat directive – Anex I and II. Thanks to the conservation efforts, the population of the species in Europe is showing a trend to recover (for overview see [6], [7]).

The male European otters live solitary and their territory covers the territory of two and more resident females, inhabiting their own smaller areas. These territories vary dramatically in range and can reach huge patches of over 20 km diameter or 40 km on linear objects. According to [8], the otters inhabiting fresh water basins need larger territories than the individuals living on the sea shores.

The females have a polyestros annual cycle and can bear trough the whole year. They live with their offspring for about a year after the birth [9]. These are actually the only social groups which can be found for that species - for the Bulgarian population a socialisation of more otters was never reported as it is for Austrian populations (see [10]).

L. lutra is an opportunistic animal and the range of the territory and breeding behaviour depend on the food and breeding sites resources. There is a clear difference in the habitat preference of the adult animals. The males prefer to inhabit the main streams of the rivers and the females and the subadults prefer small tributaries, ponds, lakes and swamps (see [10], [11]). The subadults which are already separated from their mothers inhabit peripheral areas, but have a temporary access to the resources of the larger water basins when the residential adults are absent (see [7]).

Currently, for the territory of Bulgaria was calculated that there are around 2000 otters, as 1500 of them are adults. The breeding animals are considered to be 1000 (see Bulgarian Red Book).

The “Strandzha” Natural Park is situated in Strandzha Mountain, Southeast Bulgaria. The public materials, issued by the Directorate of “Strandzha” Natural Park stated, that the indicative number of otters in the protected area is about 50 animals. In Bulgaria, the biology and the ethology of the otter were studied in detail [12, 13, 14, 15, 16, 17, 18, 19, 20; 21, 22, 23, 24, 25]. Still, data concerning the feeding behaviour of the species in the region of the “Strandzha” Natural Park are rather scarce and insufficient.

In the range of the present study we performed field survey to inspect the diet and the feeding behaviour of the otters living on the territory of “Strandzha” National Park. Important aspect of our work was to determine whether there was a shift in the food preferences when the animals inhabit different types of water basins. On the base of interviews face to face we were able to judge on the image of the otter by the local people, the hunters and the personnel of the fisher farm in the Natural Park.

Material and methods:

The European otter is the largest mustelid in Bulgaria. This species shows sexual dimorphisms as the males are larger than the females and can reach about 15 kg of weight [26]. Normally the weight of a male otter is in the range of 11 – 12 kg, while the females weight about 8 kg. The body length is about 90 cm and the tail is 40 cm long. The species inhabits aquatic habitats of different kind like rivers with different stream debit, small tributaries, lakes, artificial dams, brackish waters, sea shores etc. [27].

For the purpose of our work, we classified the water basins on the territory of the natural park dependent on their specific characteristics. We selected presumably suitable otter habitats along: rivers which are wide over 20 m; sections along smaller rivers between 2 and 10 m bright; sections along rivers under 2 m bright; tributary with temporary character. Additionally, in attempt to gain more information concerning the conflict between the predator and the fish farmers we monitored two fish farms – one of them completely fenced (between Mladezhko and Evrenozovo villages) and one that is not fenced (near Brushljan village). We interviewed the personnel of the fisher farms in addition to our field investigation.

Because of the relatively small territory of the “Strandzha” Natural Park, we did not follow standard procedures concerning the transect lengths and our tracks were longer than the standard of 600 m. We did not concentrate our efforts only around river bridges (see [28]).

Generally, the field surveys were conducted in the summer and autumn months (six days pro month in June, July, August, September and October) of 2014. During the investigations, we found that the most detailed information can be gathered when the track is performed along the longitudinal axis of the rivers. By walking or swimming in the middle of the smaller rivers and tributaries, we were able to observe shores, as well as the stones and trunks for faeces. For transects in the estuary of the Veleka river we used a boat.

As indicators for the presence of *L. lutra* we surveyed for the classical indicating signals described in the literature (for overview see [24], [28], [29], [30]). To gain information concerning the diet of the local otter, the found faeces were measured and then disintegrate in water for content investigations. Special attention was paid to the remnants of chitin or shell rests, bones, scales or other epidermal skin derivates. The characteristics of the spraints were documented by using Canon EOS 300D digital camera with a Canon Tele Zoom Lens 75-300 mm II (Canon Inc., Tokyo, Japan) and via underwater camera Kodak ZX 5. We used a small fisher net to obtain data on the potential prey of the European otter in the Natural Park. We were also able to catch by hand and identify the crayfish at the visited sites.

The number of spraints including only chitin rests and spraints including predominantly fish rests were compared (together with their occurrence in the different sections of the Strandzha rivers) using Fisher exact probability test.

Results:

During the field surveys we were able to find and investigate a total of 204 faeces of European otters. We had split the found faeces in the following groups:

1. Spraints including only chitin rests (121 faeces);
2. Spraints including chitin and bivalvia shell rests (19 faeces);
3. Spraints including chitin, bivalvia shell rests, as well as fish bones and scales (26 faeces);
4. Spraints including predominantly fish bones and scales (36 faeces);

5. Spraints including avian rests (1 faeces);
6. Spraints including squamate rests (1 faeces);

	East	Middle	West
Group 1	86.13%	5.66%	
Group 2	8.76%	13.21%	
Group 3	4.38%	32.07%	100%
Group 4		47.17%	
Group 5		1.89%	
Group 6	0.73%		

Table 1. Percentage of the spraints belonging to the six groups found in the three sections of the “Strandzha” Natural Park;

Surprisingly, our results indicated that spraints (see Table 1) including only chitin rests were significantly more abundant than spraints including predominantly fish bones and scales ($p < 0.0001$). These facts are explicitly discussed below. The chitin spraints were significantly more abundant in the eastern part of the Strandzha Mountain, while fish containing spraints significantly predominated in the middle and western section of the mountain ($p < 0.0001$). No spraints were found on the tracks along the temporary tributaries of the two main rivers in the park.

In 2014 the Mladezhka river did not went dry. The ichthyofauna and the batrachofauna along the river were very poor. Still, other species which could be a potential food source for *L. lutra* were found: the potamon crayfish (*Potamon ibericum*), the marsh frogs (*Pelophilax ridibundus*), the common toad (*Bufo bufo*), the green toad (*Bufo viridis*), the agile frog (*Rana dalmatina*), the European pond turtle (*Emys orbicularis*) and the grass snake (*Natrix natrix*). No skinned frogs were registered. All spraints found were from 1.7 to 2.1 cm in diameter and had different contents belonging to groups 1, 2 and 4 (see Figure 1).



Figure 1. European otter spraints from groups 2 and 4 found on stones in Mladezhka river;

A small tributary, with similar debit as Mladezhka river, which was selected for investigation, was the river in the region of „St. Mary“ Chapel near Malko Turnovo town. The water here was always cold (11° to 15°C). No green frogs or larger fishes were registered. On the river rocks were found abundant rests of potamon exoskeletons as well as spraints from group 1.

Near the waterfalls of Stoilovo village were found abundant rests of crayfish exoskeletons. The otter excrements were from groups 2 and 5. The spraint from group 5 was positioned on a stone in the middle of the river bed 36 cm above the water level and included bones and skin epidermal derivates (leg scales ,beak and claws) from a strigiform bird (see Figure 2).

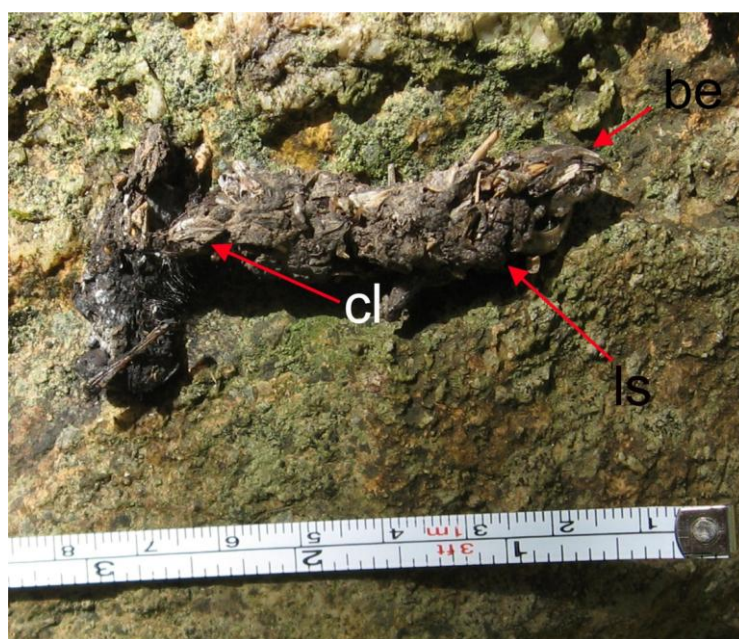


Figure 2. European otter spraint from group 5 including rests of a strigiform bird; be, rest of the beak; cl, rest of claws; ls, rests of leg skin;

We visited the midsection of Veleka River in the regions of Brodilovo and Kosti villages. The water stream was very strong and the river bed was full with dragged logs. The otters marked both stones in the water, as well as trunks which jut out of the water with spraints of groups 2, 3 and 4.

In the upper stream of Rezovska River at the locality “Vulchanov most” near Malko turnovo town, the river bed was stony and the water stream was strong. No green or brown frogs were observed and we were not able to catch any fish - the ichthyofauna and the batrachofauna in 2014 were poor. We found several groups of marking sites of *L. lutra* in a linear distance of around 400m (700 m on the track). The numerous spraints differ in their diameter and condition. Some excrements were old and dry, but others were very fresh and had characteristic smell. All spraints were from group 1 (see Figure 3), with one exception from group 6 (see Figure 4). The snake rests were from a grass or dice snake (*Natrix sp.*). Additionally to the faeces, we found numerous chitin exoskeletons of potamon crayfish, which were crashed by the otters and left on the river rocks. Some rests indicated that the crayfishes were killed and then left uneaten (see Figure 5).



Figure 3. European otter spraint of group 1 from the upper stream of Rezovska River;

We received permission from the Bulgarian border police to enter the border zone at the downstream of the Rezovska River. Along the riverbed we found a swamp with abundant vegetation on the banks (Figure 6). In the downstream of the Rezovska River we found otter excrements from group 3 (see Figure 7), but in the downstream of Veleka River we were not able to detect any spraints. Both rivers are rich of fish, crayfish and frogs in these sections, still the registered spraints were scarce.

In our visits at the fish farm near Mladezhko village we found that the trophic base for the European otter was very rich. The artificial water basins were stocked with carps (*Cyprinus caprio*), silver carp (*Hypophthalmichthys molitrix*) and also inhabited by mullet (*Leociscus cephalus*) and carucian (*Carassius gibelio*). Besides the rich fish resource, we found that the region was inhabited by a dense population of green frogs (*P. ridibundus*). Other species, which can be used as a food source by the otters in the region, were the European pond turtle, the European green lizard (*Lacerta viridis*) and the grass snake.

During the field surveys no indication of otter activities were recognised. The manager of the fish farm stated that in the past the region was inhabited by numerous European otters. The mustelids had inflicted severe damage on the fish resources. Therefore, in 2011 the farm was fenced, but the otters were still able to undermine the nets and enter the farm. After the fences were buried into the substrate, the otter incursions were stopped. On the base of our investigation, we may conclude that the area around this particular fish farm was not a resident territory of *L. lutra*, because the food resources were currently inaccessible for the predators and the local river dries out very often.

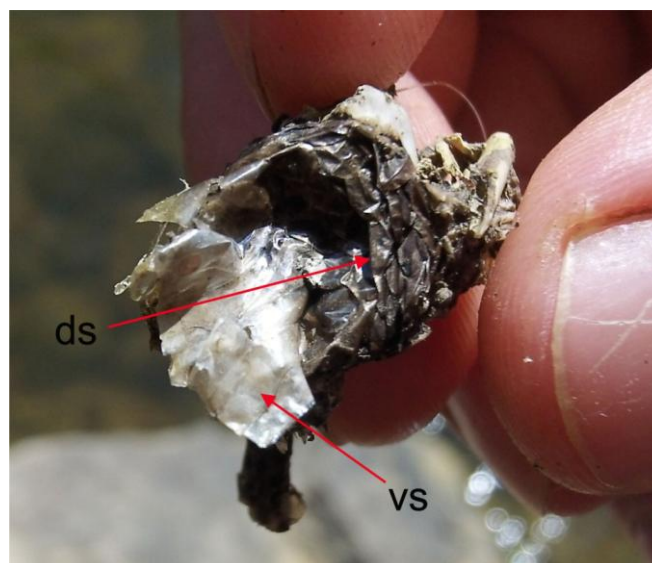


Figure 4. European otter spraint from group 6 including rests of a Colubrid snake; ds- dorsal scales, vs- ventral scales;

The other fish farm which we visited is the largest in the “Strandzha” Natural Park. It is positioned in the region of Brushlyan village (north of the village and east from road E87) on the upper stream of Veleka River. This farm is specialized in breeding of rainbow trout (*Oncorhynchus mykiss*) and accipenser hybrids. These fishes inhabit concrete channels 70 m in length and 3m bright. The channels are 1.5 m deep and have fixed feeding installations. Near the channels there is a dam with a diameter of 60 m for breeding of carp. The river bed surrounds the complex from east and has a rich fish resource. No anuran species were registered. During the field surveys, we found otter spraints in four permanent marking spots on river stones with a height of approximately 40 cm above water level. Two of the marking positions were on the north-east site of the farm (about 150 m from the centre of the complex) and two were on about 100 m south-west from the complex. All spraints had a diameter between 2.1 and 3.6 cm. The faeces differ in their contents and included fish rests, chitin rests and bivalvia shell fragments – spraints of groups 2 and 3.

According to the data gained by interview of the ichthyologist of the complex, the region is inhabited by two resident female animals and is included in the territory of a very large male. The fish farm could not be effectively guarded from the otters and they regularly inflict heavy damages on the fish resources. The complex lacks a fence and is guarded by men and dogs. The guard system is not fully effective - regularly the ichthyologists find dozens of dead fishes on the shores of the water basins.

Discussion:

The diet of the European otter may vary in large ranges and the ratio of the different items can dramatically change between the populations. According to [31], the otters inhabiting the Scandinavian Peninsula have a fish based diet (over 80%). Other scientists reported that in Asia *L. lutra* preys predominantly on crayfish [32], [33] and amphibians [34], with fish playing a very minor role in the diet.



Figure 5. Rests of the chitin exoskeleton of *Potamon ibericum* left by an otter on a river stone at the upper flow of Rezovska River;

As part of the diet of the European otters were recorded invertebrates (insects and crayfish) as well as amphibians, cold and warm blooded amniotes - squamates, birds and mammals (for overview see [7]). Concerning the striking misbalanced in presence or absence of spraint types described in our results, we have to stress that these finding should not be an object of direct and simplistic comparisons. It is obvious that the spraints from the group 1 were predominant and one can draw the misleading conclusion, that the local otters prefer to feed on crayfish. This conclusion would be completely inadequate, as where fish was available the diet of the otters was for sure more balanced than in regions where large fish was lacking (see result). In the down streams of the rivers, where the ichthyofauna was rich, the regions are under stronger anthropogenic pressure. For sure this is a reason for alternations in the marking behaviour of the otters. Furthermore, the down streams of the rivers of the “Strandzha” Natural Park are inhabited by the European pond turtle and the Caspian pond turtle (*Mauremys rivuleta*). These turtles are basking species and use stones, rocks, logs and stem on the banks and in the river bed to temperate their bodies (see [35], [36]). These are exactly the favourite object on which the otters leave spraints to mark their territories. It is logical that the otters do not leave marks which may be removed by the basking turtles and this is the reason that we found low number of excrements including fish remnants (groups 3 and 4). This is also the main reason for the relatively low number of our samples. Concerning the low number of spraints including snake and bird rests (groups 5 and 6), we propose that the percentage of these excrements reflects the actual feeding behaviour of the otter in the region.



Figure 6. Swamp beyond the border fence of Bulgaria near Resovo village represents an optimal otter habitat;

For the territory of Bulgaria, data on the diet of the European otter are provided in the Red list of protected species, as well as in the manuscripts of local scientists (see [16], [17], [18], [21], [25]). Despite the large amount of information on the feeding ethology of the species, data from the region of Strandzha Mountain are rather scarce. In this context the analysis of the dietary specifications of the otter population inhabiting the “Strandzha” Natural Park is very intriguing.



Figure 7. European otter spraint from group 3 found in the area of the swamp represented on Figure 6;

On the territory of the Natural Park were found habitats with very different specifications. There are upper streams of rivers with fast water streams, where the water is cold and the food resources are limited in diversity and abundance. On the other hand, at the down streams of Rezovska and Veleka rivers, where the water is warm, the ichthyofauna and the batrachofauna were rich. Despite these controversial habitat characteristics, the European otters inhabit the whole area around the rivers and the larger tributaries on the territory of the park. Even in the small rivers Mladezhka and Silistar were found food rests and the specific marking spraints indicating the presence of *L. lutra*. The local otters inhabit both the optimally suited habitats as the rich on fish reserves downstream of Rezovska and Veleka rivers, as well as small but permanent tributaries.

In particular sections of the rivers, object of our monitoring, the content of the otters excrements indicated that the individuals are on a very limited diet of invertebrates – molluscs and crayfish. This fact indicates that in certain periods of their life cycles, the otters can survive despite the lack of fish in their menu. The species showed an extraordinary plasticity toward the utilization of the trophic resources of the habitat. The fact that even adult animals inhabited sections of the river (mainly the upper river streams), where they rely predominantly on crayfish and mussels as food source, indicated that the population density of the otters in the “Strandzha” Natural Park was high in 2014.

Aknowlegements:

We would like to thank to mag. Nina Stoilova for her help during the field surveys. The personnel of the fish farm “Ribarnik” is acknowledged for the helpful information provided. Dr Nikolay Tzankov from NHM-Sofia, made useful comments on the structure of the manuscript and confirmed the identification of the snake rests. The team of the “Strandzha” Natural Park had supported our research.

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