MSC THESIS

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MSc in Wildlife Management Engineering

OCCURRENCE, MORPHOLOGICAL AND REPRODUCTIVE CHARACTERISTICS OF THE INVASIVE NUTRIA *(MYOCASTOR COYPUS)* IN CENTRAL EUROPE

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1. Introduction and objectives

1.1. Introduction

The Earth goes through in countless changes, whiches prints are spectecularly visible in the nature and wildlife. These changes happen in bigger volumen and more and more often. A happening like this can occur, when in a given area, a totally new, non-indigenous animal appears. The invasive species are creatures being non-native in the given environment, what more, their impact is negative, and it can lead to harmful consequences in the nature, animal healthcare and in economy. Behind the introduction of these species there are direct or indirect human activites (Beck et al 2008).

The nutria or coypu *(Myocastor coypus)* is included in the list of invasive species (http 1). Nowadays this mammalian species can be found in several points of the world, and its spread became faster. Due to these facts this animal is also presented in Hungary and, in some of the neighbouring countries, like Slovakia (http 2). The appearance of nutria carries countless, newer types of problem, due to the fact, that this rodent is able to cause several sort of damages. These damages of nutria, in the case of water management, nature conservation, wildlife management and in agriculture are well known in several European countries (Bertolino et al. 2012). These problems mean significant tangible (sometimes in millions) and intangible harms, which problems need to have a solution (Panzacchi et al. 2007). In order be able to find a solution to rollback this alien, invasive species, we have to get to know this animal and get more knowledge about its biology and ecological habits.

During the researches we wanted to get to know more about the occurence of nutria in Hungary, and we sought to get as much knowledge about the nutria as possible, what more we tried to collect as many hunting samples as we could, in order to be able to create a broader image about this animal. During the works we could collect and analyse 53 animals as samples from the areas of two Slovakian hunting clubs, whiches were diverse, regarding the ages and sexes of the animal. The hunting experiences also decreased the lacking information, what more, we could realize the actuality of the problem in first hand. Then we analyzed the collected samples in laboratory to get more information. Here we implemented the investigation of the organs and measurements of the different types of body sizes.

1.2. Objectives

During our research we targeted to collect ecological data about nutria, which is an invasive, alien species in Europe, and which has been appeared in Slovakia not long time ago and more detection is documented in Hungary. One of our further goals to expand the available data by newer information and write them down in a research. There is few literature about nutria in Hungary and in Central Europe and we wanted raise the number of them. Based on the data which were collected during the researches, we aimed to make conclusions related to the occurrence, anatomy, reproductive biology of the species. These can be important information, because we are highlighting an invasive species, by which we want to strengthen the works to stop the expansion of this animal.

The investigated questions were the followings:

- What is the occurrence of nutria in Hungary?
- How much the hunting (especially trapping) of the nutria can be effective?
- Are the individuals in good condition in the wild?
- What are the body sizes of male and female nutrias?
- Could the reproduction of nutria in the wild be proven by the observation of genital organs?
- How much the nutria is a fastly reproducing species based on the condition of the genital organs and the number and sizes of the embryos?
- How long period can be covered by reproduction during the year based on the development of the nutria embryos in different seasons?

2. Literature review

2.1. The general characteristics of nutria *(Myocastor coypus)*

2.1.1. The taxonomy of nutria

Animals *(Animalia)*
Chordates *(Chordata)*
Vertebrates *(Vertebrata)*
Mammals *(Mammalia)*
Therians *(Theria)*

Eutheria
Placentals *(Placentalia)*
Rodents *(Rodentia)*
Hystricomorphids *(Hystricomorpha)*

Myocastorids *(Myocastoridae)*
Ameghino, 1904
Myocastor
Kerr, 1792
M. coypus
(http 3)

Picture 1: *Nutria (Kozmér, Gy., 2021)*

2.1.2. The habitat and distribution of nutria

Nutria or coypu is endemic in the Patagonian subregion, which can be found in South America (Cabrera and Yepes 1940). Two subspecies are typical in Chile, which is the *Myocastor coypus coypus*, distributed in the central zone of the country, the other one is *Myocastor coypus melanops*, which one is restricted to Chiloé Island (Mann 1978, Osgood, 1943). The *Myocastor coypus bonarensis* is endemic in North Argentina, Bolivia, Paraguay, Uruguay and in the southern parts of Brasil. The *Myocastor coypus santacruzae* is endemic in Patagonia (Woods et al. 1992). The *Myocastor coypus bonarensis* subspecies can be found in the Northest part of the natural distribution of the species. That is the reason, why it is thought that, this is that subspecies of nutria, which had been introduced into other continents as well (Jacoby 2007). The animal is not only present in its original habitat, but feral pupolations are present in North America, Europe, East Africa, in the Middle East, northern Asia and in Japan (Aliev, 1966a; Bar-Ilan & Marder, 1983; Corbet and Hill, 1980, Figure 1). Nutria has been introduced in these new areas by fur industry, then later escaped from the furfarms, then later wild populations has been evolved (Jacoby & Leonard 2002, Scheide 2013, Tsiamis et al. 2017). There are Korean researches connected to the species, from which it can be suggested that there is a nutria population in Korea, as well (Do-Hun 2013). Bigger sized populations in Europe (Figure 2) can be found in Germany, France, Italy, Czech Republic and, in Netherlands (Schertler et al. 2020).

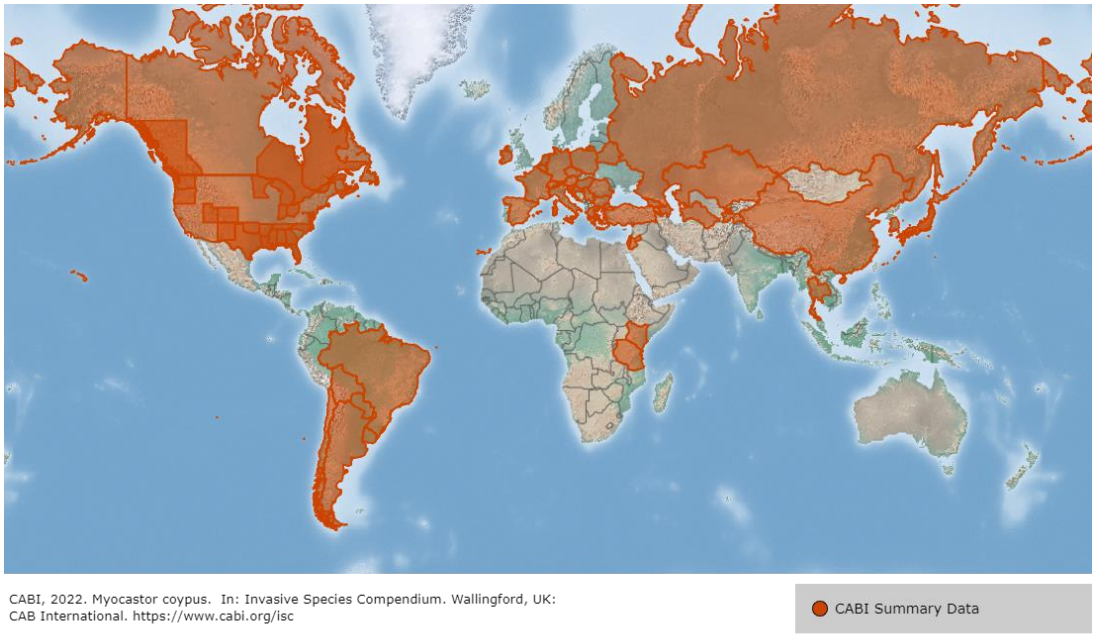


Figure 1: *The distribution of the nutria, in the World (CABI 2022). Red areas show the recent distribution of the species.*

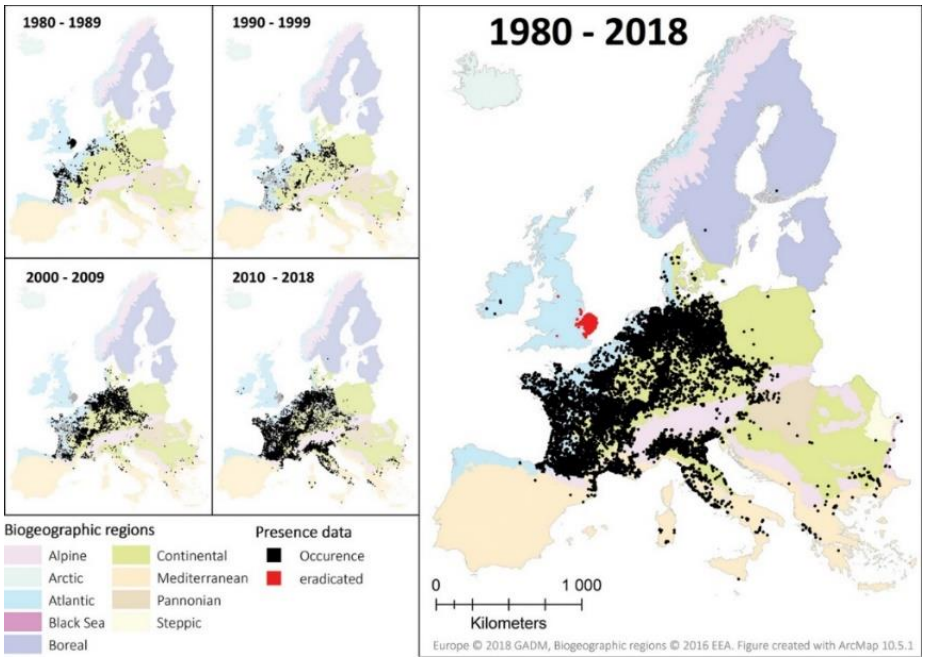


Figure 2: *The distribution of nutria in Europe 1980-2018 (Scherler 2020)*

2.1.3. The distribution of nutria in Hungary

There is no any data about the occurrence of nutria in Hungary, in the book The atlas of mammalian species, in Hungary (Bihari et al. 2007). The main base of the occurrence of nutria in Hungary can be originated back to Csallóköz, which can be found in South Slovakia, and which is the biggest terrestrial island in Europe, enclosed by river Danube. This place is close to the Hungarian state border, and as a consequence nutrias arrived to Szigetköz in Hungary from Csallóköz (Kovács 2017, Kovács 2023). The distribution of nutrias is connected to rivers. In Hungary river Danube and its tributaries serve as a green corridor in the spread of the species. The first detections of coypu in Zala county (Southwest Hungary) had been noted seven (in the time of the writing of the arcticle six) years ago by the coworkers of the directory of Balaton-felvidék National Park at the upper section of river Mura. Since that time they could observe numerous individuals of the nutria alung the rivers Mura and Kerka (Selmeczi Kovács 2022).

The nutria occurs in several sections of river Danube in Hungary. One of these places is the branch of Ráckeve (Soroksár), near to Budapest, where they were filmed during the shooting of a Hungarian nature movie (RSD – A marasztalt folyó, part2) (http 4). But there are notations from the middle of Budapest, at river Danube, between the Szabadság and Petőfi bridges (http 5, http 6).

On 10th August 2020 a carcass of a nutria was found near to a fish pond at Szakmár, which settlement is tot he South from Mikla-puszta, one of the core areas of Kiskunság National Park. The dead animal was identified by the coworker of the National Park. In spring of 2020 a roadkilled nutria was found in the area of Fertő-Hanság National Park, but there are also nutria detections from the periphery of Kunszentmiklós and Pétervására (http 7).

2.1.4. The appearance and characteristics of nutria

The external appearance of the animal is between the rat and the beaver (Picture 1). The full-grown animal's bodyweight is 4-9 kg in average, but there are individuals which can be more than 10 kg weighed (Holdas 1982, Maureen 1967, Doncaster et al. 1990). The average body length is about 40-60 cm, while the tail length is typically around 30-45 cm (Maureen 1967, Doncaster et al. 1990, Hillemann et al. 1958). The classic colour of the animal is brown which can be patchily lighter, but several types of colour mutation are known. Characteristic stigma of the animal is the white facial mask, with the white, long whiskers furthermore, the hinder legs with finger-webs, and the enormous, orange coloured incisors, which are coloured by the pigmentation, caused by the iron contaminent of the enamel (http8). The dental formula of the species is $\frac{1022}{1022}$, which means that the number of the teeth is 20 (Valentin 2022). The mammaries of the female individuals are placed highly, in order to make it possible to the offsprings to feed on even in that case, while the adult female is feeding in the water (http 9).

It is important to mention, that it is possible to mix up the nutria with two other different semi-aquatic rodent species, the muskrat *(Ondatra zibethicus)* and the European beaver *(Castor fiber)*. Although the muskrat is notably smaller, it can be a bit hard to differentiate it from the small-sized, juvenile nutrias. One of the important differential stigmas is that while the muskrat's tail is vertically flat (to make swimming easier), the nutria's tail is cylindrical, has a circle shaped intersection. In the case of the beaver we can mix the nutria up with the juvenile beaver, which has not reached its full body size. In this situation the big flat tail of the beaver can be the differential mark (http 10). There are other possible ways to differentiate the nutria from the muskrat. While the nutria has white facial mask with white whiskers and the colour of the incisors is orange, the muskrat does not have the white facial mask, and the colour of the whiskers is black, the incisors are yellow coloured and the finger-webs are totally absent from the hinder legs, not like in the case of the nutria. Moreover the integument of the muskrat is

rufous. In the case of the beaver the white facial mask is absent as well, and while swimming, only the head of it is over the water surface, while in the case of nutria the back and the head is visible as well, during swimming (Author's experience, Picture 2-5).

Picture 2: *The differences between the beaver, nutria and muskrat (http 10, 2022)*

Picture 3: *Hunting bag of nutria (left) and muskrat (right) showing the interspecific differences in colourisation and body size (Balázs Bócsi, 2022)*

Picture 4: *Juvenile nutria and muskrat (Balázs Bócsi, 2022)*

Picture 5: *Muskrat bag (Balázs Bócsi, 2022)*

2.1.5. The feeding habits of nutria

Due to the fact that the nutria is a prolific mammal, it is able to consume a huge mass of vegetation. One specimen is able to eat the 25% of its own bodyweight all year round (http8, McFalls et al. 2010). Typically they used to feed on the stems of the plants, but they are often able to dig out the roots and the rhisomes from the soil (Jacoby et al. 1999). Nutria prefers agricultural plants, mostly the maize and crop breeds (Bertolino et al. 2012, Panzacchi et al. 2007). Sometimes predating on the nest of waterfowls is possible, as well (Panzacchi et al. 2007).

2.1.6. The habitat and warren characteristics of nutria

The living places of nutria are typically freshwater marshlands and wetlands, but occasionally it can be a brackish water marshland or more rarely salt water marshland, as well (Jilian & Mouton 2011, Lyon 2000). Basically they live in warrens, which are used to be dug by them, but sometimes it can happen that they live in warrens which has been used by beavers formerly (http 11). Most parts of the routes of nutria warrens are under the water, and the main chamber is not under the ground. The nutria lives in colonies and a warren typically is inhabited by one male and 3 or 4 females, plus the offsprings. They use „feeding platforms" to which constructions are made by the nutrias by usage of massive materials (e.g.: stump or bigger branches of trees in the water) (http 12).

2.1.7. The reproduction of nutria

The species is able the copulate anytime during the whole year. The female nutrias will become mature when they reach age of 5-6 months old, and typically they are able to raise 2-3 litters per year. The gestation period is approximately 130 days (Kovács 2023). Several females are able to copulate in the following 2 days after farrowing. A female can rise 6 litters during her life. Typically the number of the offsprings is less in the first litter. The number of offsprings in a litter is mostly 5-6 specimens, but sometimes it can reach 12 (Guichón et al. 2003, http 13).

2.1.8. The natural enemies of nutria

Since the nutria is not only distributed in its original continent (Cabrera & Yepes 1940), but introduced in several parts of the World (Aliev 1966, Bar-Ilan & Marder, 1983, Corbet & Hill 1980, Figure 1), it has many natural enemy species, which prefer nutria as a potential prey species. Based on a video from the USA, which was recorded by a camera trap, in which a bobcat *(Lynx rufus)* is approaching a feeding nutria, bigger sized felid species can be predators of nutria (http 14). According to another video (http 15), in which an adult red fox is preying on an adult nutria, we can say that red fox is a predator of nutria. This affirmation is confirmed by hunters' experiences in Slovakia, who saw a fox while catching a juvenile nutria. Later the fox had been shot down (Picture 6). In the case of Hungary and even Slovakia, the predation by red fox can be more significant. In the water bigger sized wels catfish *(Silurus glanis)* can be a potential threat, mostly on juvenile individuals, but sometimes the adults as well can be the victims of the huge-sized fish (Kovács 2017, http 16). Raptor species can prey on nutrias too, but even in this case the youngs are mostly in danger (Kovács 2017).

Picture 6: *The shot fox with its nutria bag (Alexander Tirinda, 2023)*

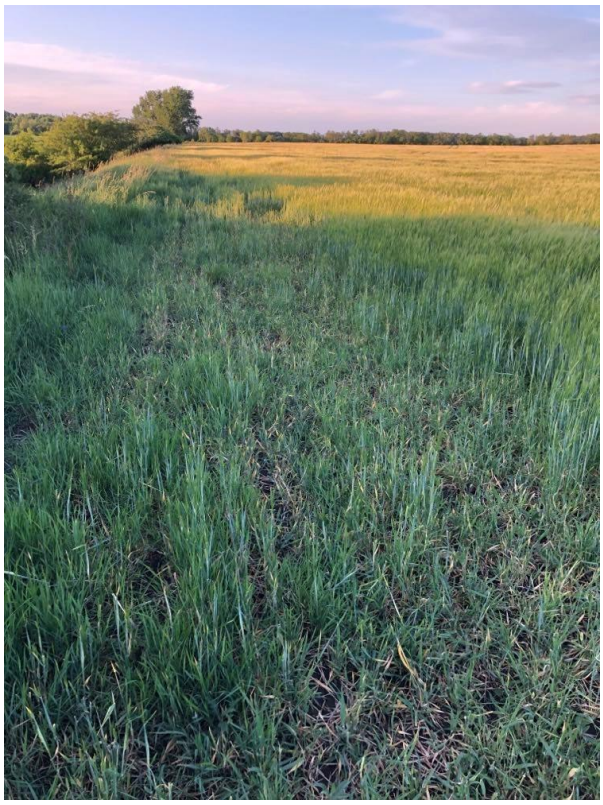
2.2. The actuality of the research topic

2.2.1. The problems and damages caused by the nutria

The first registered introductions of nutria go back to the 19th century, when fur industry, just like the zoos became the biggest vector of invasion of non-native, alien species, which vectors have led to establishments of nutria farms throughout Europe and the World (Jacoby & Leonard 2002, Scheide 2013, Tsiamis et al. 2017). More than 24 000 nutria detection has been registered in not less than 28 European countries (Schertler et al. 2020). There are several types of negative impacts of nutria and one of them is the demolition which can be caused in the native, marshland vegetations, or another in the agricultural cultivation (Picture 7, Picture 9.). However the most economically harmful destruction is linked to the burrowing lifestyle of the animal, which is problematic on the riverbanks, or it can demolish those human made constructions, which are part of water management and sometimes can lead to floods (Panzacchi et al. 2007, Picture 8.). Further harmful activity of the animal is the nest predation on ground-nesting, marshland birds' nests. It is a negative impact in terms of nature conservation, because most of these birds are protected or strictly protected; but it can mean a problem in the case of game management as well, if nutrias demolish the nests of huntable waterfowl species. The value of the caused agricultural damages can exceed 1 million €, while the value of the destructions on water management structures can reach 10 million € in a year (Panziacchi et al. 2007). For the reasons given above, the nutria is described as one of the most harmful invasive species even in European and World scales (Bertolino 2009).

***Picture 7**: Damage in canola (Balázs Bócsi, 2022)*

***Picture 8:** Destruction of bank (Balázs Bócsi, 2022)*



***Picture 9:** Damage in wheat (Balázs Bócsi, 2022)*

2.2.2. The solution against the problem of the invasion of nutria

The eradication of the nutria from introduced areas can be the key to solve the problems mentioned above. There had been several cases in the past, when non-native, invasive species (e.g.: vertebrates, plants, marine organisms etc.) had been eradicated successfully in a given area (Simberloff 2002, Genovesi 2005). By the opinion of several researchers, the prevention (Leung et al 2002), the eradication (Zavaleta 2000) and the control (Anderson et al. 2004) of the invasive, alien species is much more profitable in a long term, than doing nothing.

Based on the opinion of the Italian Wildlife Institute (IWI) the status of the nutria should be huntable whole year round, which step would be the part of prevention. In Italy two forms of the regulation are legal. One of them is the trapping by live capture, cage traps, while the other is hunting by firearms (Cocchi & Riga 2001). One of the most successful methods is the usage of cage traps, especially the 1- or 2-door cage traps, or different types of leg-holding traps (if it is legal by the law of the given country, like in Hungary or the USA; Author's note), or other types of live capture traps. One of the advantages of using these traps is that they save a lot of time, because they are continuously „working" from the time of the placement, further, it do not kill the non-target species, which are under protection sometimes (Witmer et al. 2008). Another way of prevention can be exclusion, in which case fences, walls or other kind of structures can protect the endangered area from the damages of nutria. Different preventive methods can be cultural methods and habitat modifications, within which different groups can be distinguished, such as draining and grading, which means that water has to be eliminated in drainages, which are used by coypus as a travel route. Vegetation can be controled by eliminating brushes or those vegetation, which can be a shelter of nutrias. Water level can be manipulated or repellents can be useful (Dwight 1994). The rodent could have been succesfully eradicated from a large area in England. One of the reason of their success is the constant trapping, even in the continuous 2 year, when they already removed the animals (Gosling & Baker 1989).

3. Methodology

3.1. Description of the occurrence of nutria in Hungary

To map the occurrence of the species in Hungary we used sites in social media (Facebook). We have posted our request on information about nutria occurrence in Hungary in 3 different groups. One of them was a fishing group, two of them were hunting groups. The post contained a longer text, in which we described shortly what are we doing, what is our research, which is the investigated species and we attached a picture about nutria, to make it easier to identify it, and not mix it up with the beaver or the muskrat (we even highlighted it in the text, that the 3 animals are 3 different species). We asked the people to mention the location, the nearest settlement or the waterbody where they detected the animal. If it was possible we asked pictures and videos, as well. We even noted those reports which were told by people personally. After all, we had been searching on internet for reports about the appearance of nutria, in Hungary and recorded them, as well. Moreover, we had the opportunity to meet and talk with a former nutria breeder, who shared his notations in Hungary.

3.2. Studies on the morphology and reproduction of the species

3.2.1. Research area

The needed samples (animals) had been collected by invasive method, which means hunting in this case. The shooting and trapping of nutrias had been taken place in two different hunting clubs in Slovakia. These hunting clubs can be found in the southwestern part of the country, approximately 70-80 km away from Bratislava/Pozsony (the capital) and 60-70 km away from the Hungarian state border. The gatherings of the hunting samples needed by the research had been taken place in the hunting grounds managed by the Poľovnícke združenie Hubertus Dlhá nad Váhom (SK)/Hubertus Vadásztársaság Vághosszúfalu (HU)/Hubertus Hunting Club of Vághosszúfalu (EN), illetve a Poľovnícke združenie Nimród II Dolné Saliby (SK)/ Nimród Vadászegyesület Alsószeli (HU)/Nimród Hunting Association of Alsószeli (EN). The above mentioned hunting clubs can be found at Dlhá nad Váhom (SK)/Vághosszúfalu (HU) and Dolné Saliby (SK)/Alsószeli (HU) settlements.

The hunting club in Vághosszúfalu is an organisation for small game management, which manages a 890 ha big hunting area. The main game species are the European hare *(Lepus europaeus)*, the pheasant *(Phasianus colchicus)* and the roe deer *(Capreolus capreolus)*. The nutria, the game species, which is in the focus of our research has appeared in this area since the beginning of 2000s' and their population is still growing. As the nutria is a semiaquatic animal, its lifestyle is connected to the presence of water bodies, which is important to be mentioned here. One bigger (Picture 10) and two smaller canals crosses the location of our research, where two smaller-sized fish ponds can be found and River Vág(HU)/Váh(SK) flows in the border of it. Regarding the topography of the place, it is a flatland, mostly covered by cultivated lands with some edges and there is a small forested area, as well.

The hunting ground in Alsószeli is nearly 1900 ha big, it is also a small game area. The main species are the same as in the case of the hunting area in Vághosszúfalu, however here other big game species are present, as well, like wildboar *(Sus scrofa)*, red deer *(Cervus elaphus)* and rarely fallow deer *(Dama dama)*.

Picture 10: *Canal at Vághosszúfalu (Balázs Bócsi, 2022)*

Picture 11: *River Čierna voda (Balázs Bócsi. 2022)*

3.3. Sample and data collection on the field

During the works of the research we had 5 sample collecting trips to Slovakia, where nutria is a hunted species. The first one was on 25-27 March 2022, the second was on 19-21 May 2022, the third was on 03-05 July 2022, the fourth on 10-12 October 2022, while the fifth one lasted between 08-10 March 2023. The animals had been harvested typically by firearms (Picture 12-13), but we used traps, as well. In the case of traps we used one- and two door cage traps, which are live capture traps. It is important to mention, that the traps captured the nutrias alive, and beacuse of this we had to kill the animals by .22 Lr firearm, in the fastest and most humane way. In the case of guns we used shotguns and mostly .22 Lr rifles (warmint caliber). We engaged different types of hunting methods, in order to be more successful. In most cases we prepared baitsites in the stream banks, to attract nutrias and to make it easier to shoot them, but in many cases we had been stalking along the banks of water bodies. In the latter case we could check more parts of a given area. Most of the highseats were placed near to the nutria burrows. The traps were placed in sites which were baited formerly or near to the tracks of the animals, which were used usually by them or in banks of waterbodies which were found to be suitable by us. As a bait we mostly used apple and/or grain or whole maize. During the 5 research trips we could capture 12 individuals and 41 were harvested by firearms. As a whole we were able to collect 53 specimens of nutria (some of them were abnormal, Picture 16-19). From the 53 individuals 21 were harvested in Vághosszúfalu from which 1 was trapped and 20 were shot, and 32 in Alsószeli from which 10 were trapped and 22 were shot.

From the 5 occasions in 3 we used traps, whiches were the third, the fourth and the fifth sample collecting trips. During the third occasion we used 2 traps, one of them was a 25 cm x 25 cm sized one door cage trap, while the other was a bigger two door cage trap. We placed them in the afternoon and checked them in the next morning. Both of the 2 traps captured nutrias, so 2 traps captured 2 animals, during one night.

In the case of the fourth sample collecting trip we used 4 trap from whiches 3 were 25 cm x 25 cm sized one door cage traps and 1 was a smaller sized 2 door cage trap. The traps worked during 2 nights, but only one of the 25 cm x 25 cm sized one door cage traps captured 1 nutria.

The most successful was the fifth sampling trip, in which case we used 5 traps, above whiches 1 was the smaller sized 2 door cage trap, all the 4 others were 25 cm x 25 cm sized one door cage traps. We set the traps in the first day’s evening, until the sun was up. The traps worked 2 nights and captured 9 individuals. We checked them in the continous morning after

the first night and 2 traps captured 2 nutrias. W eset the traps again and we checked the traps in the same day's night, after the hunting. In this time 3 traps captured 4 individuals, which means that 1 trap caught 2 animals simultaniously. We reset the traps, and checked them in the next morning again. Until that morning 3 traps captured 3 nutrias. In all cases the 25 cm x 25 cm sized one door cage traps were successfuls, while the smaller sized 2 door cage trap did not capture any nutrias.

Picture 12: *Nutria bag (Mátyás Tirinda, 2022)*

Picture 13: Morning hunt of nutria *(Balázs Bócsi, 2022)*

3.4. Laboratory works

The samples had been processed in most of the cases in the laboratory, in some cases in the field, but we prefered the work in the laboratory. The measurements were implemented by the precisity of one decimal. The length and width values were measured in centimeter (cm) in every cases, while the body weight was measured in kilogram (kg), the weight of the testicles, embryos and stomach contents were measured in gram (g). We also measured the volume of the bladder content as well, in mililitre (ml), for having additional information. During the investigations to measure the body weight of the animals we used spring scale, meanwhile digital scale for measuring other mass data. The body length of the individuals was measured by tape from the tip of the nose to the base of the tail (Picture 14). Then we measured the length of the tail, from the base to the tip of it. The length and the width (zygomatic distance) of the head was measured by caliper (Picture 15). The cranial length was measured from the tip of the nose to the tip of the occipital bone *(Os occipitale)*. We got the value of the head width by measuring the distance between the two widest points of the head. For the measurements we used the external points of the zygomatic bones *(Os zygomaticum)*. The length of the hind foot was also measured by caliper, in which case the measurements were performed from the tip of the heel *(Os calcaneus)* to the tip of the middle finger *(Digitus medius)*.

The other important part of the measurements related to the organs (Picture 16). In the case of the males we examined the testicles, at the female individuals we checked the oestruses and if they had embryos. We investigated the stomachs and bladders as well.

Sex of the animals was determined externally based on the anogenital distance (AGD, for males > for females) and the presence of penis, which is possible to push out. Additionally, we proved our identification by recognition of internal sexual organs (testicles or oviduct and ovary). Moreover, we observed these and other organs and embryos, as well. In the case of male individuals we observed the testicles and measured their weight in gram (g), their length and the width in centimeter (cm). Assuming the female specimens, we investigated the uterus. We looked for embryos. If we found embryos we counted them in total, but we listed the numbers of them per both uterine horns (both the left and right). After all, we measured the weight of each embryos in gram (g) by digital scale, then the length of them in centimeter (cm) by caliper. If it was possible, we observed the sexes of the embryos (again based on the AGD), but we could determine it only in case if the embryo was in an enough developed condition.

In the case of stomach we measured the weight of the stomach content in gram (g) by digital scale and stored them for future investigations. The liquid content of the bladder was also measured in mililitre (ml) by measuring cylinder. We took muscle tissues for genetic analysis in the future, from the hind legs.

Furthermore, over the formerly mentioned datas, as an additional note, we investigated the integrity of the teeth, mainly the incisors, or the different pigmentation of the animals' fur. We examined the colour of the exudate of anal gland to test its variability (in case of beaver it is an important differentiation opportunity for species and sexes).

Picture 14: *Body length measuring (Krisztián Katona, 2022)*

Picture 15: *Head length (Krisztián Katona, 2022)*

Picture 16: *Nutria on the dissection table (Krisztián Katona, 2022)*

3.5. The evaluation of data

During the investigation of the nutria's occurrence we got answers from those online communities, which were approached by our questions. Based on their feedbacks we could create a map by QGIS, which highlights the occurrence of nutria in Hungary. Some of the „participants" were able to share pictures or videos, which were analyzed, if the animal is a nutria or not.

We measured the effectiveness of trapping by the calculation of the catching rate per trapnights. We calculated it in four different ways. We counted the captures in total, all the captures by all the traps. In the second calculation we counted only the traps sized 25 cm x 25 cm big enterance, but the timing stood the same. The third calculation was related only to the last sample collecting trip, but we calculated by dividing the number of every capture by every trap. In the last way of calculation we observed only the traps sized 25 cm x 25 cm and only in the last trapping campaign.

The data of the body sizes of the males and females (body weight, body length, tail length, head length, head width, hindfoot length) were compared by non-parametric Mann-Whitney U-test, in the case if the datasets were not normally distributed, but in case of normal distribution, we conducted t-test. Normal distribution of datasets were tested by Anderson-Darling normality test. For the statistical analyses we used the PAST 4.03 software. Furthermore, we provided more additional descriptive information (about the number and development of embryos, size of testicles, colour of anal gland exudate, and saturation of bladder) in the Results.

4. Results

4.1. The results of the investigation of the occurrence of nutria in Hungary

In total 27 people reported me nutrias. On the post, in the fishing group 1 person reacted and attached videos about nutria. In the first hunting group 10 people shared with us their notations, while in the other one 5 members. In private message 9 people sent us their data, from which 3 sent us videos taken at the following settlements: Darnózseli, Esztergom, Kisbajcs, Nagyigmánd, Pilismarót and Tata and 3 attached pictures to the settlements: Ásványráró, Nagyigmánd, Tata. There were 2 personal talks, and those 2 people showed us videos, one of them pictures, as well. The number of the settlements, where the participants detected nutrias was 33 and these were as follows: Ács, Almásfüzitő, Ásványráró, Barcs, Bezenye, Bodonhely, Darnózseli, Dunakiliti, Dunasziget, Esztergom, Farád, Győr, Jánossomorja, Kimle, Kisbajcs, Komárom, Kóny, Mezőlak, Mosonmagyaróvár, Nagyigmánd, Nagyszentjános, Neszmély, Pilismarót, Püski, Rábacsécsény, Rábagyarmat, Rábapatona, Rábaszentmihály, Rajka, Szentgotthárd, Szőny, Tata, Vámosszabadi. Darnózseli, Esztergom, Kimle, Mosonmagyaróvár, so 4 settlements were named twice, while 2 settlements, Győr and Tata were mentioned three times. It means that, based on the comments of the people, we had 41 detections in total.

Although we used a post for mapping the distribution of nutria, in Hungary, we had been searching for reports, videos and articles on internet, which have reported the occurrence of nutria. Based on these data we found that the nutria has occurred in: Budapest, Kunszentmiklós, Pétervására, Ráckeve, Szakmár. Therefore 5 more settlements we recognised, from which one is the capital of Hungary.

The former nutria breader, with whom we could talk, named 4 more settlements, where he saw nutrias.

We prepared an occurance map (Figure 3) as a result of the research, which shows the occurrence of nutria, based ont he reports that we have got. We placed in the map 42 settlements and 50 detections and 9 of the detections had video or photo documentation .

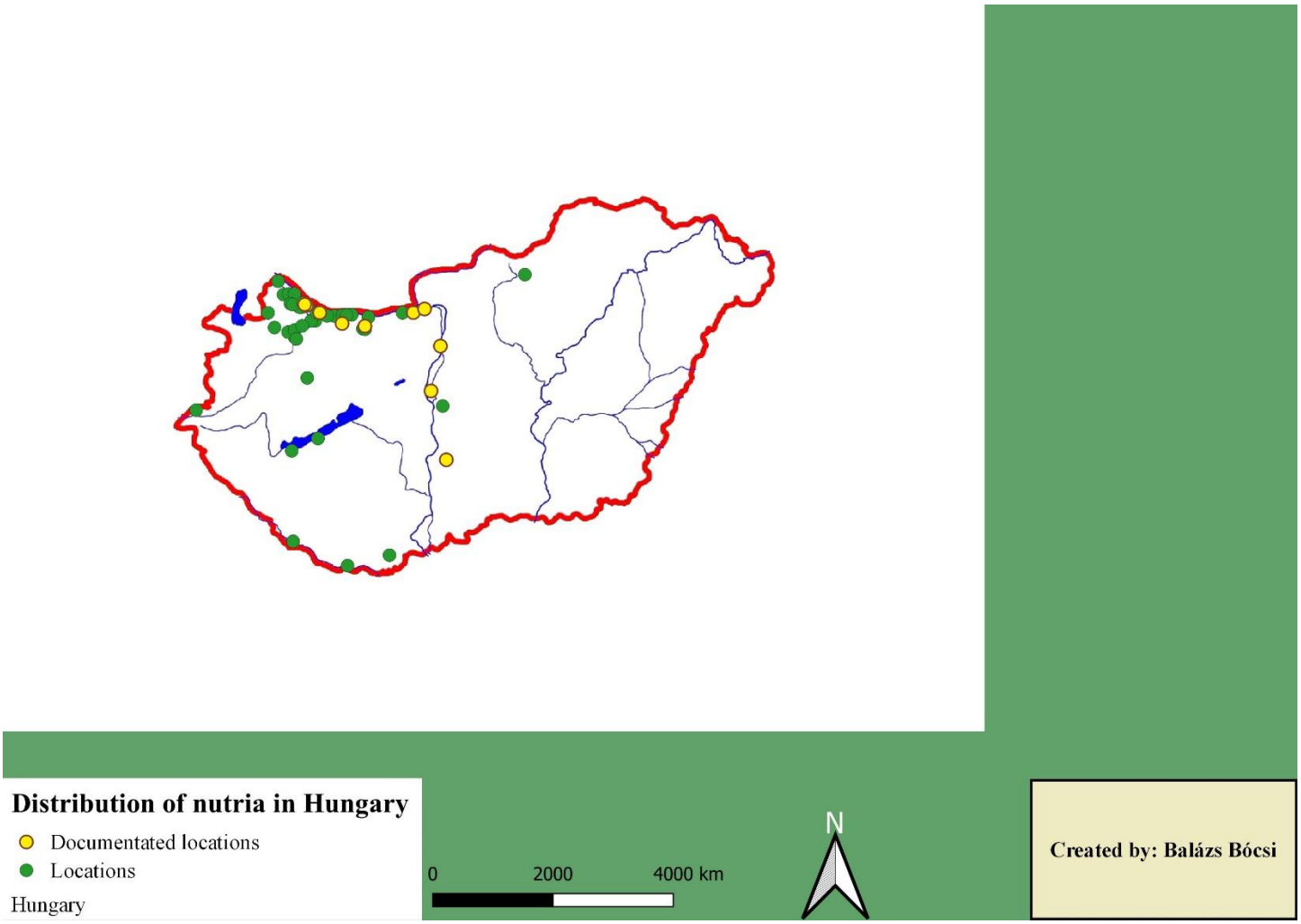


Figure 3: *Distribution of nutria in Hungary*

4.2. The results of the trapping of nutria

However, our main research is not related to the trapping of nutria, we were successful in capturing nutrias and because of this wee keep it interesting and important to share our trapping results.

Our first type of calculation is related to the whole sampling, which means that we calculate all traps and all the captured animals. Based on this calculation we got the following result: 11 traps captured 12 animals, during 5 nights (Picture 17-18).

$$\frac{12\ captures}{11\ traps \times 5\ nights} \times 100 = 21.81\ captures/100\ trap - nights$$

The second type of calculation is related to the whole sampling, but in this case we only calculated with the 25 cm x 25 cm sized one door cage traps and their captures, because we mostly used this type of traps. In this case we had a result with these data: 8 traps captured 11 animals in 5 nights.

$$\frac{11\ captures}{8\ traps \times 5\ nights} \times 100 = 27.5\ captures/100\ trap - nights$$

Our third way of calculation is that to calculate only the last trapping campaign's captures involving all traps which we have used. In this case we calculate by 5 traps, 9 captures in 2 nights.

$$\frac{9\ captures}{5\ traps \times 2\ nights} \times 100 = 90\ captures/100\ trap - nights$$

In the last way of calculation, we calculated only the captures of the 25 cm x 25 cm sized one door cage traps in the last trapping campaign. So we calculated 9 captures of 4 traps in 2 nights.

$$\frac{9\ captures}{4\ traps \times 2\ nights} \times 100 = 112.5\ captures/100\ trap - nights$$

Although these results shows that we were very successful, we have to mention that our sample size is not enough big yet!

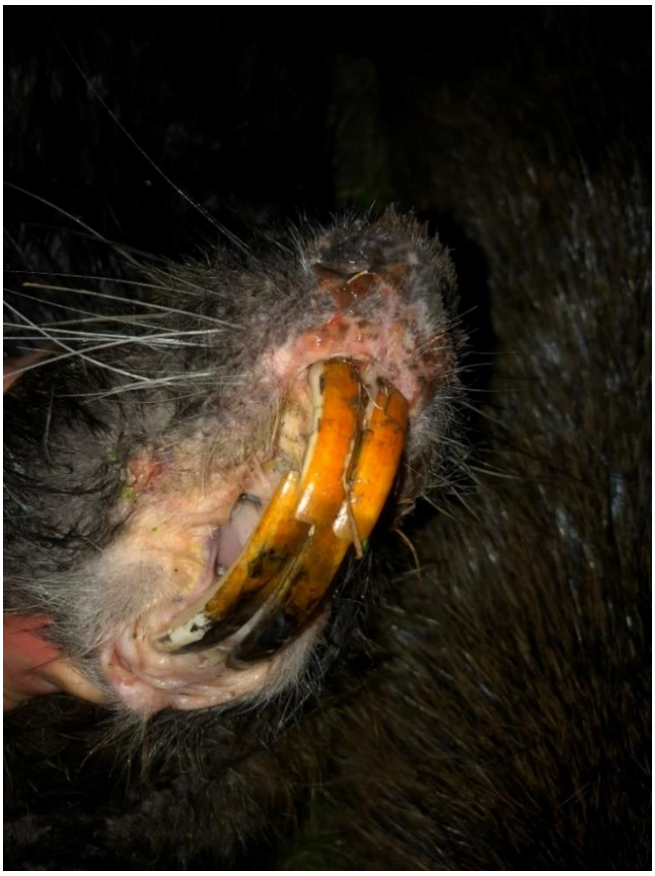
Picture 17: *2 nutrias in 1 trap (Balázs Bócsi, 2023)*

Picture 18: *Captured nutria (Balázs Bócsi, 2023)*

4.3. The results of the anatomical investigations

4.3.1. Investigations of appearance

Regarding the teeth the juvenile individuals' teeth were developing. In some cases the edges of the incisors were broken or the size of them were longer than in average (Picture 19). In other cases the enamels could have been injured, or in one case it had a different colour and half of the incisors were absent (Picture 20). During our researches we were able to harvest nutrias with unusual colouring, which became the part of additional notes. During our researches, such colour was the greyish, silverish fur colour, on the one hand „silvernutria" colour, named by former nutria breeders (Holdas 1982, Picture 21-22), or the lighter colour than average. It was possible to observe and harvest the firstly mentioned type in the nature, even before this research.



Picture 19: *Overgrown incisors (Balázs Bócsi, 2022)*

Picture 20: *Unhealthy incisors (Balázs Bócsi, 2022)*

Picture 21: *Silvernutria (Alexander Tirinda. 2022)*

Picture 22: *Harvested silvernutria (Balázs Bócsi. 2019)*

4.3.2. Size measurements of male genitals

As a result of the data analyses of the male individuals we got the following values. From the investigated 53 individuals 33 were males, from which 16 were juveniles and 17 were adults. The full-grown animals were visibly bigger, than the young ones. Regarding the testicles, among 33 animals we could not measure the data of 2 individuals and in the case of another animal the right testicle, because they were destroyed or injured due to the shots that the animals got during hunting. Table 1 and 2 highlight the data of the testicles of the adult and juvenile individuals.

Table 1: *Data of the adult nutrias' testicles*

Adult individuals	Average weight of testicles (g)	SD of testicles' weight (g)	Average length of testicles (cm)	SD of testicles' length (cm)	Average width of testicles (cm)	SD of testicles' width (cm)
Left	6.34	1.63	3.34	0.46	2.22	0.48
Right	6.29	1.50	3.35	0.67	2.03	0.25

Table 2: *Data of juveniles nutrias' testicles*

Juvenile individuals	Average weight of testicles (g)	SD of testicles' weight (g)	Average length of testicles (cm)	SD of testicles' length (cm)	Average width of testicles (cm)	SD of testicles' width (cm)
Left	2.89	1.54	2.51	0.54	1.54	0.25
Right	2.9	1.52	2.51	0.51	1.59	0.31

4.3.3. Size measurements of female genitals

Among the harvested, later investigated 53 animals, 20 were females. The formerly mentioned measurements, which were independent from the sexes of the animals, had been carried out in the case of the females, as well. As a result of the examinations of the uterus we found that among the 20 female specimens 14 (70%) were pregnant. But in the cases of 4 individuals the embryos were in the first phases of the embryonic period, and because of this,

we were not able to measure the related data. Among the 20 female nutrias, 10 were harvested in Spring and the other 10 in Autumn. The total number of the embryos was 92, in the case of each pregnant individuals: 4, 4, 4, 5, 5, 5, 7, 7, 7, 7, 9, 9, 9 and 10, respectively. The average number of embryos was 6.6±2.1. The average number of the embryos in Spring was 6.44±2.24 and, in Autumn 6.8±2.05. Further notation was that the embryos were more developed in Spring than in Autumn (average weight: 22.40±41.61 g vs. 1.32±no data g). Most of the Autumn embryos had been destroyed, or were in rudimentary phase and could not be weighed. The data of embryos are shown in the Table 3.

Table 3: *Data on the number and average sizes of the embryos*

	Date of harvest	**Number of embryos**	**Embryos' length (cm)**	**Embryos' weight (g)**
female 1	19.05.2022.	9	1.6	0.68
female 2	20.05.2022.	5	4.7	2.26
female 3	20.05.2022.	4	12	25.32
female 4	10.10.2022.	10	No data	No data
female 5	10.10.2022.	7	3	1.32
female 6	11.10.2022.	5	No data	No data
female 7	11.10.2022.	5	No data	No data
female 8	11.10.2022.	7	No data	No data
female 9	09.03.2023.	7	0.6	0.7

female 10	10.03.2023.	7	7.6	7.93
female 11	10.03.2023.	9	1	0.7
female 12	09.03.2023.	4	15	35.35
female 13	09.03.2023.	4	24.6	128.1
female 14	09.03.2023.	9	1.6	0.6

4.4. Body sizes of the two sexes

Those data, which have been presented in the cases of both sexes (e.g.: body weight, body length etc.), were compared, in order to get image about the size differences between the two sexes.

Table 4: *The statistical comparison of the sizes of the two sexes*

	Body weight	**Body length**	**Tail length**	**Head length**	**Head width**	**Hindfoot length**
U value	319	-	-	-	245	-
t value	-	1.041	0.854	2.350	-	1.418
p value	0.847	0.303	0.4	0.023	0.213	0.162

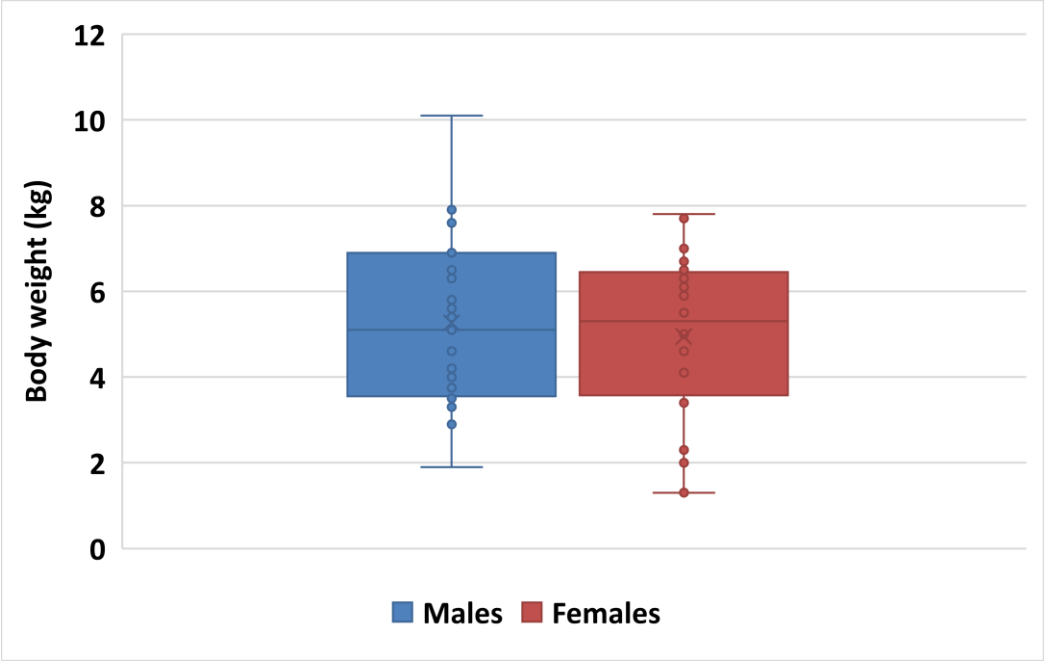


Figure 4: *Differences between the two sexes' body weight*

The average body weight of the male individuals was 5.27±1.94 kg, while this value in the case of females was 4.94±2.01 kg.

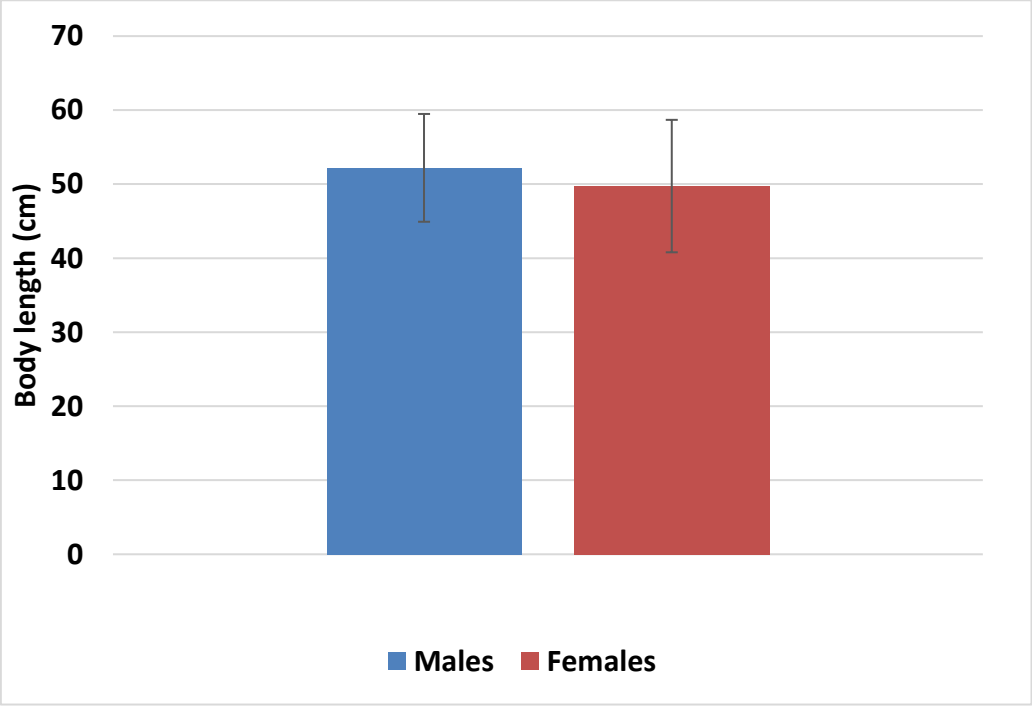


Figure 5: *Differences between the two sexes' body length*

The average body length of the male individuals was 52.20±7.28 cm, while this value in the case of females was 49.74±8.95 cm.

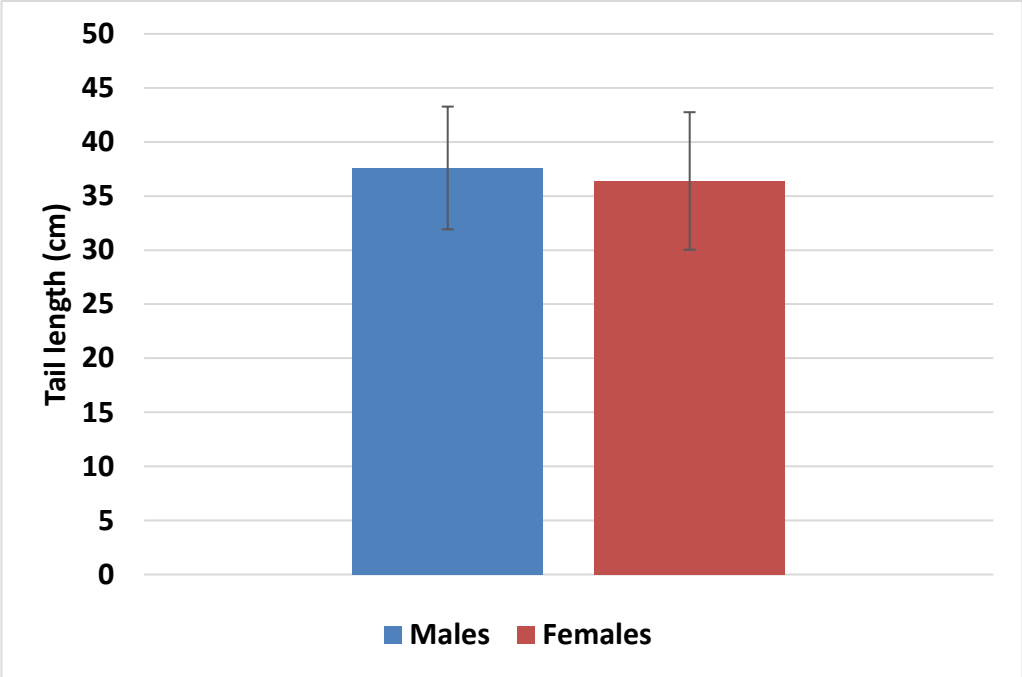


Figure 6: *Differences between the two sexes' tail length*

The average tail length of the male individuals was 37.60±5.68 cm, while this value in the case of females was 36.40±6.36 cm.

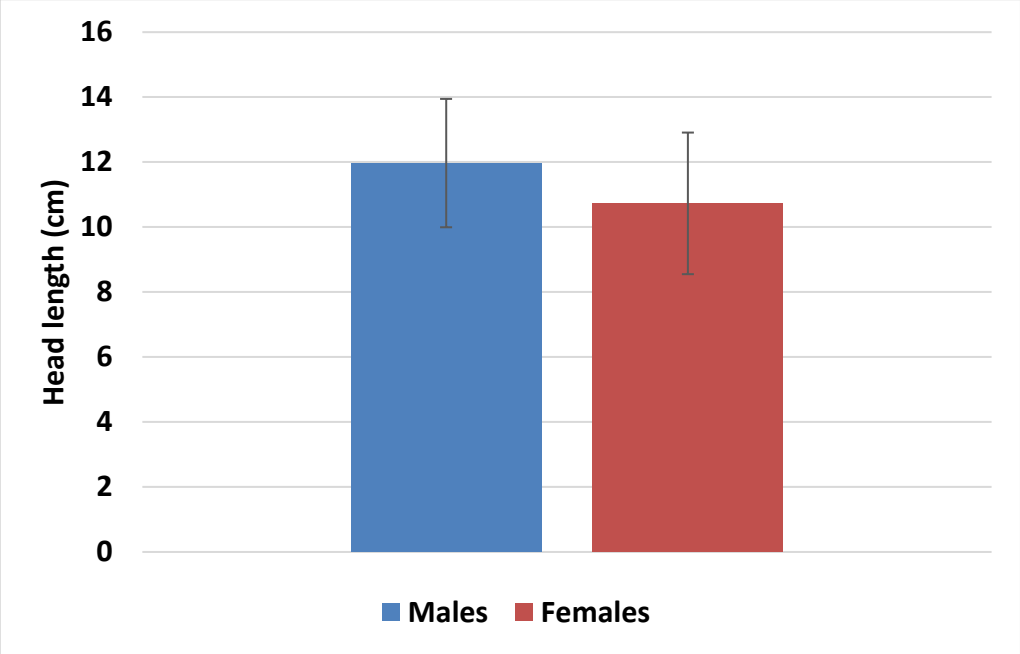


Figure 7: *Differences between the two sexes' head length*

The average head length of the male individuals was 11.97±1.98 cm, while this value in the case of females was 10.73±2.18 cm. Here we can see significant difference, the p value is 0.023.

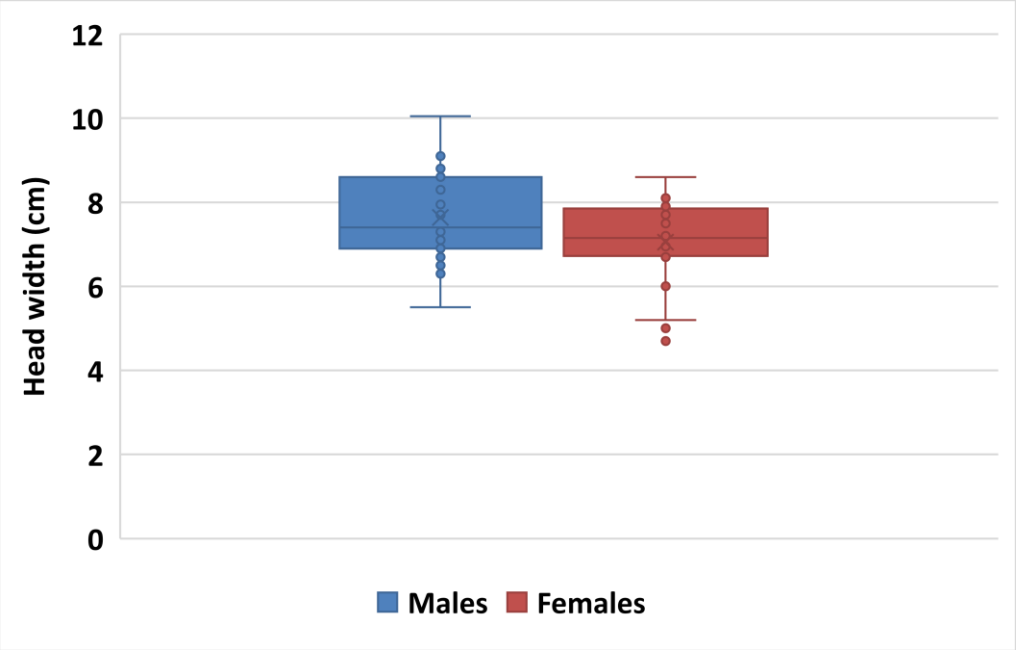


Figure 8: *Differences between the two sexes' head width*

The average head width of the male individuals was 7.64±1.07 cm, while this value in the case of females was 7.05±1.09 cm.

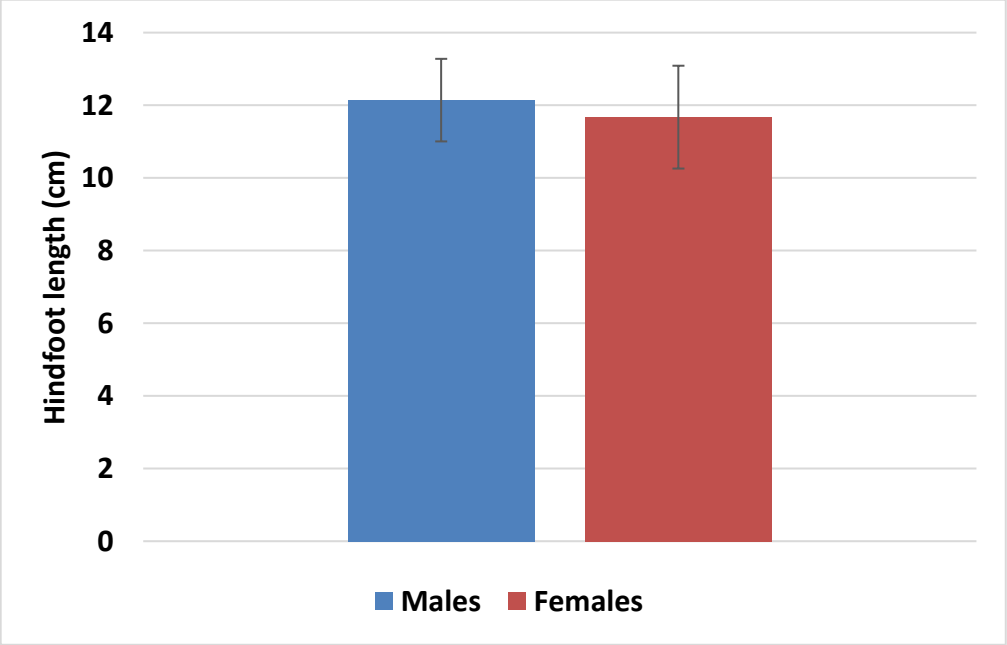


Figure 9: *Differences between the two sexes' hindfoot length*

The average hindfoot length of the male individuals was 12.14±1.14 cm, while this value in the case of females was 11.67±1.42 cm.

We keep it interesting to mention, that the biggest harvested and investigated nutria was a male individual, weighing 10.1 kg and the body measured 70 cm long (Picture 23-24).

Picture 23: *Big nutria (right) of 10.1 kg (Balázs Bócsi, 2022)*

Picture 24: *Big nutria (Balázs Bócsi, 2022)*

5. Discussion

5.1. Evaluation of the results

Based on the research which has aimed to map the distribution of nutria in Hungary, we could create a map which shows that the occurrence of nutria became common in the Northwest part of Hungary. The main region, where the number of detections were higher is called Szigetköz, but there were several other records from the banks of river Rába or other locations along the river Danube. There were other places in Hungary where nutrias have been occurred, but these were rather sporadics.

Based on the experiences of my collegues and me, the hunting and trapping of nutria is successful. During the 5 sampling trips we could collect 53 animals as samples. Just in the last trip, which lasted from 08.03.2023 to 10.03.2023 we could bag 21 animals, while in the previous occasion which lasted from 10.10.2023 to 12.10.2023. we could bag 19 animals. Just during the night of 10th of October, we were able to harvest 12 nutrias. Regarding the trapping we can say that it is an effective method of controling nutria. From the harvested 53 individuals we captured 11 animals. It is important to mention that from the 5 occasions 3 were those when we used traps. Once we were able to capture 2 individuals together at the same time by one trap. To sum everything we can say that trapping of nutria was effective.

We investigated the collected animals in the laboratory and measured the different body sizes. We know the different types of body sizes and some anatomical data of the animals in the original living place by the literature. Based on those values which we got as a result of the laboratory investigations, we can say that the nutrias in the studied introduced areas reached or have the same values, which their „relatives" have in their native habitats. Based on these facts we can say that these animals adaptated well to their new environment, and they are in a good condition.

During the laboratory works we observed all the harvested 53 individuals, which observations contained the investigation of genital organs, as well. We did it in the case of the males and the females too. Based on the big sizes (weight, length, width) of the testicles we can say that the animals reproduce a lot. The average weight of the left testicles was 6.34 g and the right testicles average weight was 6.29 g in the case of adult nutrias. There were size differences between the testicles, but they were linked to the age of the given animal, therefore it was not related to the period of the year. We found a large number of embryos in the significant portion

of female individuals' uterus, which means that they were fertilized, so they took part in reproduction.

The nutria is a fastly reproducing species, because from 20 individuals 14 were pregnant and the embryos were in different developing pase. We have another experience, which strengthens our conclusion. One of the trapped female individuals was captured with her young cub together. We examined the female specimen in the laboratory and we found 4 well-developed embryos. The female nutria had been still raising an offspring, and she was already pregnant.

We observed 20 female nutrias, from which 14 were pregnant. Abowe the pregnant animals 9 had been harvested in Spring, while the other 5 in Autumn, so in different periods of a year. When we examined the embryos we saw that they were in different developing periods, which means that the female animals had been fertilized in different periods of the year. Based on these investigations, which were linked to the embryos we can say that the period during a year which is covered by reproduction can be the whole year. After all these facts it is visible that the nutrias are highly reproductive in the wild.

5.2. Management recommendations

After the formerly mentioned facts we advice to prepare more publications and flyers about nutrias, in order to make them well known among more people and to highlight the problems that they can cause. We keep it important, because based on the social media it is seen that most of the people is happy, because of the presence of nutria and they are not able to recognise the real problems, due to the lack of knowledge the prevention of the negative impacts of nutria will be lagged behind. We could make the mentioned publications and flyers reachable in events, in order to make it easier to the people to get these information. We would like to reach it to make this big sized rodent well-known in Hungary, before it would be too late, and it would become a commonly spreaded animal, and its damages would be stronger. Because of this reason we would like to reach it as well to make the Hungarian hunter society to get to know the presence of nutria and about the problems which are linked to it in order to extend the list of huntable species with nutria. What more we would like the Hungarian hunting law to mention the legal hunting methods of nutria. We strive to make the nutria a huntable species in Hungary by the law, whole year round if it is possible. In order to make their hunt popular it would worth to highlight the foods made by nutria in the formerly mentioned publications. Another idea is

to make the nutria hunts more popular is just like in case of fox, badger and golden jackal skulls, making a judging system, where we can score the skulls as trophies, and if its reasonable, they can be rewarded by bronze, silver and golden medal. With this step, we can make the hunters to think about the nutria skulls as a potential trophy, and make them more motivation to hunt on them. After all the nutria taxidermies (Picture 25) and rugs (Picture 26-27) made by their furs are really nice decorative elements of trophy rooms.

Picture 25: *Nutria taxidermy (Balázs Bócsi, 2022)*

Picture 26-27: *Nutria fur rugs (Balázs Bócsi, 2022)*

6. Abstract

Until nowadays the appearance of the invasive species became a usual problem in several places on the Earth. A species like this is the nutria *(Myocastor coypus)*, whose original living place is in South America, however until nowadays its presence is noted in some of the negihbouring countries like Slovakia, but in Hungary, as well. In our research we wanted to get to know more about this animal, therefore we tried to answer on different types of question. Our questions were the followings: What is the occurrence of nutria in Hungary? How much the hunting (especially trapping) of the nutria can be effective? Are the individuals in good condition in the wild? What are the body sizes of male and female nutrias? Could the reproduction of nutria in the wild be proven by the observation of genital organs? How much the nutria is a fastly reproducing species based on the condition of the genital organs and the number and sizes of the embryos? How long period can be covered by reproduction during the year based on the development of the nutria embryos in different seasons?

To find the answers on the questions, we had different methods. For mapping the occurrence we used the social media on Internet. We wrote down, what we were looking for, and were waiting the feedback of the people. To get information about the successfulness of trapping we used traps as well, while we were hunting nutrias, for sample collection. Later we investigated the harvested animals in the laboratory.

Through the social media 27 people answered in 3 different social media groups. They mentioned 33 settlements, but the total number of their detections were 41. As a result of searching on Internet we found 5 more places and a former nutria breeder shared with us his notations at 4 different settlements. In the field we could harvest 53 individuals (33 males and 20 females), from which 12 were trapped and whiches were investigated later in the laboratory.

As a result of the investigation of occurrence we got that, nutria is occurred with a higher number in the northwestern part of Hungary along river Rába and Danube. The trapping was qualified as an effective tool of the control of spreading of nutria. In terms of body sizes we found significant difference only in the case of the head length of the two sexes. The average number of embryos was 6.6±2.1, so nutria is a highly reproductive species.

We advice to spread the knowledge about this animal and try to stop the expansion of it, before it would make more problems in the introduced areas.

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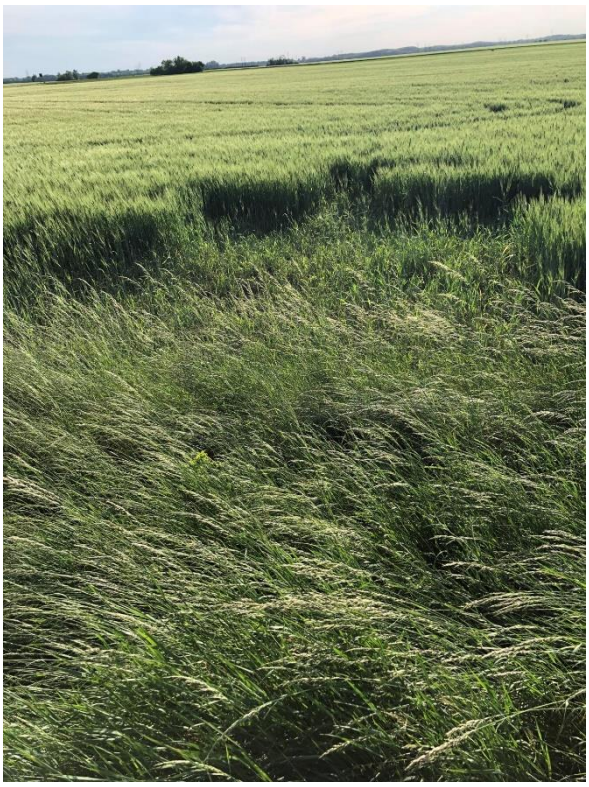
9. Appendix

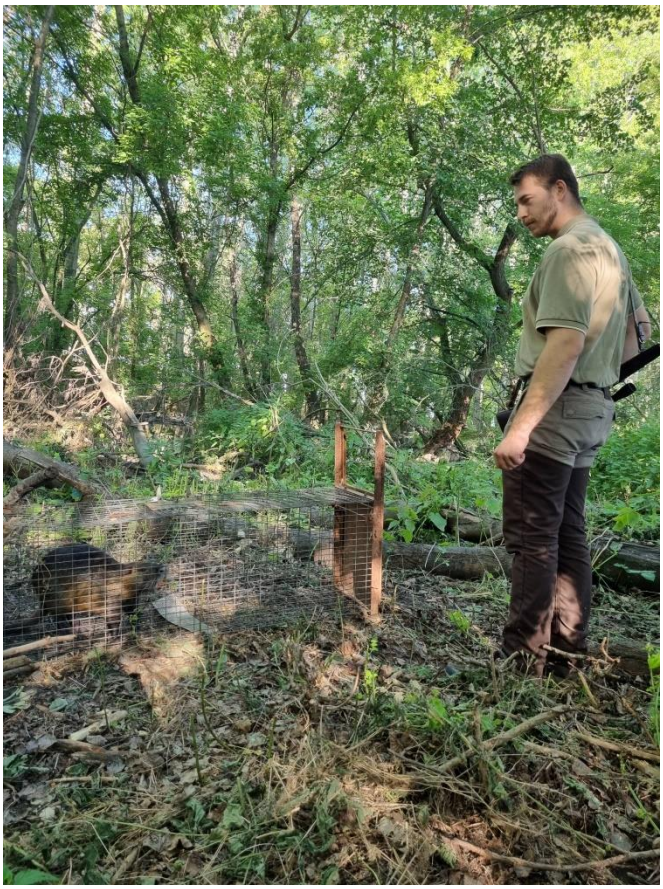
Picture 1: *Living area 1 (Balázs Bócsi, 2019)*

Picture 1: *Living area 2 (Balázs Bócsi, 2019)*

Picture 3: *Living area 3 (Balázs Bócsi, 2022)*



Picture 4: *Damage in wheat (Balázs Bócsi, 2022)*



Picture 5: *Trap checking (Mátyás Tirinda, 2022)*

Picture 6: *Captured nutria 1 (Mátyás Tirinda, 2022)*

Picture 7: *Captured nutria 2 (Ferenc Hatvanyi, 2022)*

Picture 8: *Captured nutria 3 (Balázs Bócsi, 2023)*

Picture 9: *Captured nutria 4 (Mátyás Tirinda, 2023)*

Picture 10: *Captured nutria 5 (Mátyás Tirinda, 2023)*

Picture 11: *Captured nutria 6 (Mátyás Tirinda, 2023)*

Picture 12: *Laboratory work (Krisztián Katona, 2023)*

Picture 13: *Embryos (Balázs Bócsi, 2023)*

Picture 14: *Papilloma on the nose of nutria*

(Ferenc Hatvanyi, 2023)

Picture 15: *Nutria skulls (Balázs Bócsi, 2022)*

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Title of the document:	Occurrence, morphological and repruductive characteristics of the invasive nutria *(Myocastor coypus)* in Central Europe
Year of publication:	2023
Department:	Department of Wildlife Biology and Management

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