THESES OF DOCTORAL (PhD) DISSERTATION

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INVESTIGATION ON DOMESTIC CATS FEEDING HABITS IN CROATIAN ISLANDS AND IN EUROPEAN SYNTHESIS

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1. BACKGROUND OF RESEARCH, OBJECTIVES

Background

Domestic cats (*Felis silvestris catus*) are popular pet animals; coexisting with humans for thousands of years due to natural process. They have populated almost the whole world with human mediation causing serious conservation problems and occasionally the extinctions of species. The domestic cat is considered to be one of the 100 worst invasive species in the world.

The domestic cat was introduced to the **Adriatic islands** (Croatia), but its feeding ecology and impacts on biodiversity in this region is unknown. We assumed that the feeding strategies of domestic cats as top mammalian predators on small Mediterranean islands vary in different environments, due to significant dissimilarities between the food resources of **house cats** living in villages and **feral cats** living on the outskirts of human settlements. The house cat is highly dependent on human households while the feral cat is independent on human households. We predicted that the feral cat, in comparison with the house cat, a) preys more frequently on wild-ranging prey species, and therefore b) has a more diverse food composition, and will be more food generalist and opportunistic than the house cat.

Differences in habitat use and availability of food resources should manifest in the feeding habits of cats belonging to the European *Felis* genus. Therefore, we assumed that diet composition and trophic niche of house and feral domestic cats and wildcats (*Felis s. silvestris*) differs. Based on the literature data from Europe we examined the diet of these three cat types using indirect diet analysis methods (stomach and scat analyses); and within

the house cat type we compared consumption data obtained directly from prey brought home and from indirect diet analysis.

The most widespread introduced mammalian predators on the Adriatic islands are black rats (*Rattus rattus*) and domestic cats, known bird nest predators. The population of the rat can be controlled partly by the feral cat. On islands both predators often take birds as prey, but egg consumption by predators is more difficult to prove. Our question was how these introduced mammal species can affect the breeding success of birds?

Goldcrest (*Regulus regulus*) is the smallest bird species in the Palaearctic (5-7 g). From October to April, it is found wintering in the Adriatic coastal region and islands in great numbers. Common Leadwort (*Plumbago europaea*) continues to flower on stonewalls well into October, exposing its sticky calyx and seed capsules for at least 30 days, meaning a threat to small birds by clinging to their feathers. The entangled feathers restrain the birds in their free movement, which either die or become easy prey for cats, rats or raptors. Our investigation was started after observation of such a case.

Objectives

1. The objective of the study performed on small islands of the Adriatic Sea was to compare the diet composition and feeding habits of domestic cats depending on cat type (house *vs.* feral), period (autumn bird migration *vs.* spring nesting period) and island (Olib *vs*. Silba).
2. The aims of our meta-analysis performed in European scale was to compare the food composition and trophic niche-breadth of the three cat types (house cat, feral cat and wildcat), to determine the differences in the trophic niche breadth in accordance to the geographic latitude based on the literature data of the stomach and scat analyses from European habitats, and

to explore the differences in the food composition of the house cat group, using varying methods.

3. The aim of our study performed on two Adriatic small islands has been to explore the survival rates of quail eggs in artificial nests located on the ground and on shrubs. On the basis of imprints left on plasticine eggs we tend to identify egg predators, as well as to analyse the role of introduced mammals as potential nest predators in damaging the clutches of native birds.
4. Based on our observations the question arose whether common leadwort, a native plant species on the Adriatic islands, acts as a natural trap of wintering small-sized songbirds passerines, or the cases we recorded were only occasional incidences, furthermore, whether the predation role of the domestic cat can be detected?

Main objective of my theses was to broaden knowledge of ecological role of the introduced domestic cat on Adriatic small islands, and to collect knowledge to help population management.

2. MATERIALS AND METHODS

2.1. Comparative diet analysis of domestic cats on Adriatic islands

Study area

We studied the feeding habits of house cats living in villages and feral cats on the outskirts of villages on two small islands (Olib and Silba) by analysing faecal samples collected in the spring and autumn periods. The natural vegetation consists of Mediterranean forests. In the outer zones of the islands there are extensively managed olive groves and abandoned fields, whereas inside the village traditional gardening is practiced. Gardens and lands in the outer zones are bordered by traditional, 1-1.5 m high dry stonewalls.

Populations of cats and their prey

We surveyed the abundance of cats (line transect survey and scat density estimation), their primary food types, e.g. small mammals (live trapping, capture-mark-recapture method), birds, rabbits (*Oryctolagus cuniculus*), and lizards on stonewalls (belt transect surveys).

Diet analysis

In order to determine the diet composition of the cat groups we analysed scat samples and we applied standard wet procedure. For expressing diet composition, two methods were used: the relative frequency of occurrence (or RFO, number of occurrences of a certain food type expressed as a percentage of the total number of occurrences of all food items) and the frequency of occurrence (or FO, percentage of scats containing a food item). The following six main food taxa (types) were used in the calculations related to trophic niche and the comparative analysis of scat composition for cat groups: small-sized (< 0.5 kg) mammals, rabbit, birds, reptiles, invertebrates and human-linked (or household) food. Trophic niche breadth was calculated

in accordance with Levins and standardized (B_A). The trophic niche overlap was calculated by the Renkonen index. We applied Ivlev's index of preference.

2.2. Comparative analysis of the diet of domestic cats and wildcat in Europe

Literature compilation and variable selection

We collected dietary data across Europe from literature found mainly in electronic databases (Web of Science, Scopus, Science Direct).

We separated three cat types: 1) house cats, feral cats and wildcats. The sample types used were scats ($n \geq 75$) or stomach ($n \geq 22$) contents (as indirect diet analysis method group). In the case of house cats a third sample type, records of "prey brought home" were also evaluated (as direct diet analysis method). The sampling period was annual or periodic (covering at least two seasons). We only used sources with results expressed as percentage relative frequency of occurrence of food types (RFO) or those that contained N data (number of food items for each food types). We distinguished eleven main food types (categories), namely: 1 – rodents, 2 – insectivores, 3– lagomorphs, 4 – carnivores, 5 – wild ungulates (consumption from carrion), 6 – household or human-linked food (e.g. domestic animals, pet food), 7 – wild birds (and eggs), 8 – reptiles, 9 – amphibians, 10 – fish and 11 – invertebrates. Stomach and scat sample numbers (n) in the studies were divided into classes according to quartiles of comparative analysis. For each geographical location we recorded bioclimate (Mediterranean or temperate), and included latitude (decimal degrees). We calculated trophic niche breadth (B_A) and trophic niche overlap (detailed above).

2.3. Artificial nest experiments on Adriatic islands

In six locations, groups of artificial ground and shrub nests were created in abandoned farmlands and gardens in the outskirts of settlements on both islands (May 2009). Nests were placed in sites similar to natural as possible. One quail egg and a plasticine egg of similar size were placed in each nest. The nests contained quail (real) egg for the evaluation of nest predation rates, and plasticine (artificial) egg for predator identification from tooth and bill imprints. In all six localities we placed five ground nests and five shrub nests alternately, twenty meters apart from each other, accordingly the nests of the same type were placed at double distances. We used altogether 30 nests on the ground and 30 nests in the bushes on each of the two islands. The content of the nests was checked on the first, fourth and seventh day after placement.

2.4. Estimating the indirect predation effect of leadwort

Coverage rates of common leadwort on stonewalls was estimated in October 2008, during a ten-day period on Olib and Silba, and surveyed bird abundance on Olib. We recorded predation cases when evidence of passerine birds (feather remains) was found on the flowering plant or in its immediate surroundings.

2.5. Statistical analysis

Comparative diet analysis of domestic cats on Adriatic islands

We applied multivariate analysis of variance (MANOVA) on abundance and density data, where density or relative abundance indices were dependent variables, whereas the time of the year (October and May), the island (Olib

and Silba) and the habitat type (village or outskirts) were fixed factors. Log-transformation was performed on densities, relative abundance of cats and rabbits, birds and lizards. We compared preference indices and trophic niche breadth values (normal distributions) using paired sample t-test between the two cat groups. General log-linear likelihood tests were used on frequency of occurrence data, to test for dietary differences between cat groups, periods and islands. The unit of analysis was feral cat and house cat scats and the response variable was the presence or absence of the food item considered. We fitted the complete models using cat groups, period/season and island as independent variables. For the analysis of correlation between the resource and consumption of small mammals, rabbits and birds, the Pearson correlation was applied.

Comparative analysis of the diet of domestic cats and wildcat in Europe

In order to test for bias caused by the bioclimate (Mediterranean or temperate), sampling period (annual or two-seasonal), sample type (stomach or scat) and sample size (1-4 category), i.e. whether these variables have an effect on diet composition, the multivariate general linear model (GLM) was applied with the cat type (house cat, feral cat, wildcat) as fixed factor; bioclimate, sampling period, sample type and sample size category as covariates and the arcsin transformed RFO of each of the eleven food types as response variable.

We used one-way analysis of variance (ANOVA, Tukey post-hoc test) to explore differences in diet composition (11 main food types) and standardized trophic niche breadth (B_A) data among three cat types. In the case of the three cat types we separately used Spearman correlation to analyse the statistical relationships among main food types, and between consumption ratios and B_A data.

We evaluated associations between geographic (latitude) and standardized trophic niche breadth (B_A) for dietary data of three cat types with linear regression and the Mantel test. The simple Mantel tests were performed in XLSTAT 2014.5.03 version, with significance determined via 10000 permutation tests, using Pearson correlation. Where significant correlation was observed, regression analysis was used to describe the relationship of the latitudinal values *versus* the B_A values.

We compared consumption data from the direct method (i.e. prey brought home) and indirect diet analysis methods (i.e. stomach and scat analyses) within the house cat type by using independent samples t-test (arcsin transformed RFO, 11 main food types). We applied hierarchical cluster analysis to compare and to visualize the diet composition data recorded for the three cat types (and direct and indirect sampling methods in the case of the house cat) from the literature across Europe on the basis of arcsin transformed RFO data of 11 main food types.

Nest predation test on the Adriatic islands

We used Mayfield's method for estimating the daily survival of a sample of nests or eggs using exposure days (the cumulative number of days that the nests in the sample were monitored) and the number of known losses. For comparing the proportions of plasticine eggs left intact, taken away (disappeared) or marked by different predators (mammals, birds, snakes) in ground and shrub nests on the islands of Olib and Silba, 4 × 2 and 5 × 2 contingency tables were used.

Leadwort coverage

Testing for differences between village and outer areas and between the villages Olib *versus* Silba was performed using independent samples t-tests, following arcsin transformation of leadwort coverage data.

3. RESULTS

3.1. Comparative diet analysis of domestic cats on Adriatic islands

Abundance of cats

The estimated relative abundance of cats (individuals/km^2) was significantly higher in villages than on the outskirts (180 *vs*. 0.4, MANOVA, $P < 0.0001$). It was also higher in autumn than in spring (87 *vs*. 17, $P = 0.033$), but there was no island-dependent difference (Olib: 70, Silba: 59, $P = 0.416$).

Diet, prey choice and trophic niche

A total of 578 scat samples were collected and analysed (Olib: 325, Silba: 253). The main prey type was **small mammals**. Feral cats, as compared to house cats (log-linear analysis), consumed small mammals more frequently (FO, 95.2% *vs*. 44.0%). Small mammal consumption on Olib was more frequent in the spring, whereas on Silba it was more frequent in the autumn. Cats **preferred** (E_i, Ivlev's index) black rats (feral cats $E_i = 0.72$, house cats $E_i = 0.14$), and slightly ate less (avoided) wood mice (feral cats $E_i = –0.18$, house cats $E_i = –0.08$) and shrews (feral cats $E_i = –0.30$, house cats $E_i = 0.00$). The preference for various small mammal taxa did not differ significantly between the two cat groups (paired samples t-test, black rat: $P = 0.349$, wood mouse: $P = 0.256$). Small mammals as a resource (individual per 100 trap nights) and their consumption (RFO) did not show a close relationship (Pearson correlation, $r_P = 0.79$, $P = 0.209$).

Birds were consumed more frequently by house cats than by feral cats (FO, 12.7%, *vs*. 7.3%), in autumn than in spring (FO, 15.9% *vs*. 4.1%). On Olib, bird abundance (n/km/day) showed a close relationship with bird consumption by cats (RFO) (Pearson correlation, $r_P = 0.999$, $P = 0.025$).

Reptiles (mainly **lizards**) were more frequently consumed by feral cats, as compared to house cats (FO, 21.7% *vs*. 2.7%), on Olib than on Silba (15.9% *vs*. 8.6%), and in the autumn than in the spring (15.8% *vs*. 8.7%). The consumption of **household food** was more frequent in house cats than in feral cats (58.1% *vs*. 3.9%), on Silba than on Olib (41.3% *vs*. 20.6%), and in the autumn than in the spring (36.0% *vs*. 26.0%). The effect of cat groups was not important in the consumption of **rabbits** (FO, 4.3% *vs*. 1.5%) and **invertebrates** (3.9% *vs*. 6.0%), nor were the other main effects significant. Relative rabbit abundance (n/km) did not show a strong correlation with the consumption of rabbits (RFO) (Pearson correlation, r_P =0.46, P = 0.248).

The **trophic niche** was not significantly broader in house cats than in feral cats (mean ± SE, B_A = 0.27 ± 0.070 *vs*. 0.17 ± 0.049, paired-samples t-test: P = 0.191), the trophic niche overlap between the two cat groups was moderately low (35-41%).

3.2. Comparative analysis of the diet of domestic cats and wildcat in Europe

Differences in the diet of cat types

On the basis of literature reviewed, in Europe house cats, feral cats and wildcats preyed upon: 143, 70 and 79 animal species, respectively.

The diet composition of the three cat types on the basis of stomach and scat samples differed significantly in four main food types. House cats consumed household food more frequently than feral cats and wildcats, while wildcats consumed rodents, insectivores and ungulates more frequently compared to house cats. Feral cats consumed rodents and household food

with similar frequency to wildcats, while they consumed insectivores similarly to house cats.

Consumption of rodents (as main prey type) negatively correlated with household foods in the case of house cats (Spearman correlation, $r_S = -0.835$, $P < 0.001$), whereas consumption of rodents negatively correlated with lagomorphs in the case of wildcats ($r_S = -0.578$, $P = 0.012$).

Factors affecting trophic niche

House cats had a broader trophic niche compared to wildcats, while feral cats were closer to wildcats. The trophic niche overlap between house cat and feral cat and between house cat and wildcat was 59.9% and 56.4%, respectively; while between feral cat and wildcat it was 91.7%.

Standardized trophic niche breadth (B_A) negatively correlated with consumption of rodents in the case of feral cats (Spearman correlation, $r_S = -0.927$, $P < 0.001$) and wildcats ($r_S = -0.957$, $P < 0.001$), while B_A positively correlated with the consumption of lagomorphs ($r_S = 0.491$, $P = 0.039$) and reptiles ($r_S = 0.546$, $P = 0.019$) in the case of wildcats or with birds in the case of house cats ($r_S = 0.636$, $P = 0.011$).

Latitude negatively correlated with consumption of reptiles in the case of house cats (Spearman correlation, $r_S = -0.564$, $P = 0.029$) and wildcats ($r_S = -0.777$, $P < 0.001$), and with invertebrates ($r_S = -0.677$, $P = 0.032$) in the case of feral cats.

Negative linear relationships were found between latitude and B_A values in all three cat types. However it was statistically significant only in the case of wildcat (simple regression analysis, $r = -0.511$, $P = 0.030$), while in the case of house cat ($r = -0.373$, $P = 0.170$) and wildcat ($r = -0.511$, $P = 0.131$) the relationship was not significant. The evaluation of the same relationship based on permutation test (Mantel test) resulted in similar correlation but

different probability, representing a more realistic association. Associations between latitude distances and B_A differences were found in all three cat types (negative linear relationship), with only marginally significant P-value in the case of the house cat (Mantel test, $R^2 = 0.077$, $P = 0.050$), while the association was significant in the case of feral cat ($R^2 = 0.192$, $P = 0.029$) and wildcat ($R^2 = 0.295$, $P < 0.001$).

Direct versus indirect diet analysis

Comparing dietary data of house cats from the direct method, i.e. prey brought home with data from indirect diet analysis methods (stomach and scat), detection of rodents (independent samples t-test, $P = 0.08$), insectivores ($P < 0.001$), birds ($P < 0.001$) and amphibians ($P = 0.014$) was more frequent in the case of prey brought home, while household food ($P < 0.001$) and invertebrates ($P = 0.018$) were less frequently detected. Considering the effect of the source of dietary data (i.e. direct and indirect analyses) the diet of house cats was most different from both the wildcat and the feral cat when analysed indirectly, however the difference was little when only prey brought home was considered.

3.3. Nest predation test on the Adriatic islands

Daily survival rate

On Olib island predators damaged quail eggs in 43% of the artificial ground nests and 40% of shrub nests. The daily survival rate of quail eggs in ground nests was 0.92, similar (Mayfield-test, $P = 0.847$) to eggs in shrub nests at 0.93. The results obtained on Silba were somewhat different, quail eggs having been predated in only 33% of ground nests and 70% of shrub nests. The daily survival rates of quail eggs in ground nests was 0.94 which was significantly higher ($P = 0.014$) than in shrub nests 0.86. The daily survival

rate of quail eggs in ground nests on Olib and Silba were similar (P = 0.408), and the differences in daily survival rates of quail eggs in shrub nests between the two islands were not significant (P = 0.058).

Predators managed to break only four and two quail eggs in ground nests on Olib and Silba, while the remaining quail eggs in shrub nests on both islands were left intact. The number of quail eggs having disappeared from shrub nests on Olib (40%) and Silba (70%) were higher than the number of eggs that disappeared from ground nests, 30% and 27%, respectively.

Nest predators

The proportions of plasticine eggs left intact, taken away or marked by different predators were significantly different between ground- and shrub nests on the islands Olib (contingency test, P < 0.001) and Silba (P < 0.001). According to marks left on plasticine eggs in **ground nests**, the egg predator communities differed between the two islands (P < 0.001). On Olib, marks on plasticine eggs left by small mammals dominated (n=18), with only two cases of beak marks, originating from hooded crows. On Silba, however, plasticine eggs had marks from small birds (n=2), small mammals (n=7), and there were five instances of snake bite impressions. On both islands, the small mammal marks on plasticine eggs in ground nests corresponded to tooth marks of black rats, suggesting that these introduced animals could have damaged at least 17% of eggs in ground nests of birds. Based on the traces preserved on plasticine eggs, the predator communities robbing the **shrub nests** in the two islands were similar (P > 0.05). Most of the plasticine eggs disappeared from shrub nests, but on some of the remaining ones we found the beak marks of some large bodied birds, probably of hooded crows. Small mammal tooth marks on plasticine eggs were recorded in one case on Olib and also in one case on Silba.

3.4. Estimating the indirect predation effect of leadwort

Leadwort coverage, predation cases

Based on our estimations, the calculated mean stonewalls coverage by leadwort in the areas of Olib was significantly higher (independent samples t-test, $P < 0.001$) inside the village ($0.63 \pm 0.162\%$) than in outer areas ($0.01 \pm 0.008\%$). In the island of Silba, it was found to exist only on walls inside the village ($0.01 \pm 0.019\%$). During the survey in the village of Olib, 921 individuals of 19 bird species were observed in total. Among smaller bird species, goldcrest was the most frequent. During the transect surveys there were five cases when we found evidence of the indirect effect of common leadwort plants on small birds. All five instances were recorded in inner areas of Olib, but no similar cases were observed in the village of Silba or its outer areas.

Potential predation impact

Having surveyed a substantial part (0.123 km^2), of the residential areas of the village of Olib (*ca*. 0.388 km^2), we have recorded 5 cases of birds stuck into common leadwort during a period of 10 days. Estimated number of cases on the whole area ($0.388 / 0.123 = 3.15$) is $3.15 \times 5 = 15.75$. Goldcrests arrive in the island for wintering in October when common leadwort still continues to flower. The overlap of goldcrest wintering period and common leadwort flowering is approximately 30 days (therefore the figure 15.75 for ten days was multiplied by 3 equals to 47.25). Throughout that period, in the entire inner area of Olib the gluey common leadwort could trap at least 47 goldcrests, considering that 0.63% of stonewalls were covered by this plant.

4. CONCLUSIONS

4.1. Main findings of comparative diet analysis of domestic cats on Adriatic islands

The removal of predators from sensitive ecosystems is often a successful solution even in itself. In seriously altered habitats with a number of introduced species, due to the effect of the cascade mechanism function on trophic levels, however, additional possibilities should also be considered. The eradication of feral domestic cats (as super- or apex predator) is not always the best solution to protect prey (e.g. endemic birds) when rats (as mesopredators) are also present. Similarly, in an urban setting where cats are important predators of introduced species (house mouse, rats, certain bird species), controlling cat numbers or reducing their night time activity would need to be accompanied by rat control. Although, no such investigations or interventions have been performed in the Adriatic islands, our study showed that cats prefer the introduced and common black rat in their feeding, suggesting that the question of nature conservation-oriented habitat management in the islands is complex and has to be carried out carefully.

The frequent consumption of lizards by cats (especially by feral cats) can mean a threat to the native lizard populations of the Adriatic islands. The abundance of rabbits introduced to the Adriatic islands can decrease due to diseases (e.g. myxomatosis), and their population can be kept at low levels by hunting. By that means, the number of predators (cats) can be reduced, which can indirectly help the survival of native lizard populations, and directly serve the preservation of native plant species. On the other hand, decline in rabbit abundance may result in cats' switching to other prey groups, such as lizards and small mammals.

4.2. Main findings of comparative analysis of the diet of domestic cats and wildcat in Europe

According to our comparative investigation of literature data based on the stomach and scat samples, the diet composition of the cat types showed differences in the consumption of rodents, insectivores, wild ungulates and household food, supporting the "dietary differences originate from varying resources" hypothesis. The dietary differences especially between the house cat and wildcat were considerable. Although, the diet composition of the feral cat showed moderate characteristics from several points of view, it was more similar to the wildcat.

The trophic niche breadth of all three cat types increased along a latitudinal gradient from northern to southern areas of Europe; however the power of the negative linear association between geographic latitude and trophic niche breadth differed depending on cat types.

The predation of the house cat which was examined from prey brought home differed from the data obtained by indirect diet analysis, however it yielded similar results to the diet of the feral cat and the wildcat.

4.3. Main findings of nest predation test

Overall, the daily survival rates of quail eggs and the marks on plasticine eggs together suggest that shrub nests were robbed almost exclusively by hooded crows, but the eggs located in ground nests were accessible for more types of predators. We demonstrated the substantial predation role of the black rat, while we found no indication of strong predation by domestic feral cats. Studies on food composition having been performed on other islands have shown that free ranging domestic cats are responsible for a substantial

degree of predation on birds. Cats could possibly have contributed to egg losses in the 'unknown predator' category (missing eggs) in addition to other predators, yet their importance was found to be much more limited than expected.

4.4. Main findings of the role of leadwort as a natural bird trap

Goldcrest wintering areas are in substantial overlap with the distribution area of common leadwort, meaning that the sticky seedheads of this plant in the final weeks of flowering in October can pose a considerable mortality factor. With low common leadwort coverage rates (< 0.1%) such as measured in the island of Silba and outskirts of Olib village, the effect of this plant on small passerines is probably negligible.

5. NEW SCIENTIFIC RESULTS

1. Based on evaluation of domestic cat scat samples collected on two small Adriatic island (Olib, Silba), feral cats consumed more frequently small mammals and lizards and consumed less frequently household food and birds, and on the basis of preference calculation, they preferred more black rat a pest species, than house cats.

2. According to meta-analysis on European literature data of diet composition of different cat types within the *Felis* genus it can be stated that diet composition of the three cat types, such as the house and feral domestic cat and the wildcat on the basis of indirect methods (scat and stomach analyses) differs. The predation of the house cat, which was examined from prey brought home, differed from the data obtained by indirect diet analysis; resulting similar results to the diet of the feral cat and the wildcat.

3. The trophic niche breadth of all three cat types increased along a latitudinal gradient from northern to southern areas of Europe.

4. Based on nest predation test performed on the Adriatic islands substantial predation role of the black rat was demonstrated, while no indication of strong predation by domestic feral cats was supported.

6. RECOMMENDATIONS

- A better knowledge on the feeding biology of domestic cats in the islands is important for developing biodiversity conservation management techniques. I recommend using diet analyses for monitoring purposes, as well as before nature conservation treatments.
- The scat analysis can also be used for faunistic purposes on other islands.
- The study of trophic cascade should be extended to other islands as well.
- I suggest the survey of prey brought home by means of questionnaires based on internet and personal interviews; furthermore I suggest observing cats by video camera application on collar.
- Mapping predation conditions can be an important parameter in monitoring the ecological status of the islands. Therefore, knowledge on survival rates of bird nests bear high importance for interpreting the most suitable, island specific management techniques for preserving biodiversity on islands.
- The rate and the indirect predation pressure of the "trapping" of the small-sized birds by the common leadwort depends on the area (island, stonewalls features), and on the predators present and their population sizes. Common leadwort is a native, legally protected plant in Croatia, worthy for conservation.
- Domestic cat is traditionally a pet animal on the islands of the Adriatic Sea. In autumn cats left behind on the islands, mean a continuous supply for the feral cat population. It would be important to manage cats that became orphaned (identification, owner notification, capture, population control).

7. PUBLICATIONS ON THE SUBJECT OF THE DISSERTATION

Peer-reviewed papers published in journals

Széles, G.L., Purger, J.J., Molnár, T., Lanszki, J. 2018: Comparative analysis of the diet of feral and house cats and wildcat in Europe. Mammal Research 63: 43-53. ($IF_{(2016)}$= 1.069)

Lanszki, J., Kletecki, E., Trócsányi, B., Muzinic, J., **Széles, G.L.,** Purger, J.J., 2016: Feeding habits of house and feral cats (*Felis catus*) on small Adriatic islands (Croatia). North-Western Journal of Zoology 12: 336-348. (IF= 0.539)

Purger, J.J., Kletecki, E., Trócsányi, B., Muzinic, J., **Széles, G.L.,** Lanszki, J. 2015: Daily survival rates of eggs in artificial ground and shrub bird nest on small Adriatic Islands. Ardeola 62: 383-390. (IF= 0.696)

Purger, J.J., Kletečki, E., Trócsányi, B., Mužinić, J., Purger, D., **Széles, G.L.,** Lanszki, J. 2012: The common leadwort *Plumbago europaea* L. as a natural trap for the wintering goldcrests *Regulus regulus*: a case study from Adriatic islands. Journal of Biological Research 17: 176-179. (IF= 0.618)

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Full-length English-language publications

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Lanszki, J. **Széles, G.L.**, Yoxon, G. 2009: Diet composition of otters (*Lutra lutra* L.) living on small watercourses in southwestern Hungary. Acta Zoologica Academiae Scientiarum Hungaricae 55: 293-306. (IF= 0,514)

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Lanszki, J. **Széles, G.L.** 2006: Feeding habits of otters on three moors in the Pannonian ecoregion (Hungary). Folia Zoologica 55: 358-366. (IF= 0,529)

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