Final report (NKFIH K120249)

1. Factors behind the variation in sex ratio adjustment

In many bird species, it may be beneficial for the parents to adjust offspring sex ratios to various environmental or parental traits (e.g. because of the sex-specific effects of those trait on the offspring). Results, however, show great variation among species and populations in terms of whether they support this hypothesis. We planned to seek factors that may explain this variation. During our search of the literature, we had to realize that the vast majority of the papers did not provide clear background and prediction for the studied traits making it impossible to test whether those traits that have sex-specific effects on offspring survival are more strongly related to offspring sex ratio, than those that have sex-specific effects only on the future reproductive chances of the offspring. So finally, focusing on the "mate attractiveness hypothesis", we tested whether the strength of the relationship between mate quality and offspring sex ratio depends on a) the rate of extra-pair paternity in the study population; b) whether the studied male trait had a proven role in sexual selection or this role was only assumed. We assumed that extra-pair paternity, which occurs in the majority of songbird species, reduces the benefits of adjusting sex ratio to the phenotype of the social mate, if a large proportion of the offspring is sired by an extra-pair male. Thus we predicted a negative relationship between the rate of extra-pair paternity in the population and the strength of relationship between mate quality and offspring sex ratio. We failed to find such a relationship suggesting that mate quality-dependent sex ratio adjustment may be driven by material rather than genetic benefits. However, the relevance of the studied parental trait to the tested hypothesis (i.e. whether the studied trait had a proven role in sexual selection or this role was only assumed) strongly predicted the observed effect sizes. It became clear that the inclusion of studies in that the preconditions of the male quality dependent sex allocation hypothesis were not tested, strongly distorted the results. After controlling for this problem, our results clearly suggested that male quality dependent sex allocation is an existing phenomenon. Our results are relevant not only to those working in the field of sex ratio adjustment, but have a more general message to anyone using meta-analyses, namely the inclusion of studies that neglect the assumptions of the hypotheses concerned may lead to the underestimation of the mean effect size and, eventually, false conclusions. Our results were presented at multiple conferences and published in *Oikos* (Szász et al. 2019a).

2. Are biased sex ratios adaptive?

Many hypotheses have been proposed to explain the adaptive value of sex ratio adjustment, however, not counting some rare examples, it is usually not tested whether the sex ratio of the broods produced is in fact adaptive. We planned to test this in 3 different species, each having its advantages and disadvantages (summarized in our research proposal).

2.1. Collared flycatchers (Ficedula albicollis)

Previous results suggest that in our population, brood sex ratio is related e.g. to the timing of breeding, and male aggression. Earlier we assumed that these relationships are likely to be the result of male nestlings being more sensitive to rearing conditions. However, as outlined in our research proposal, it was not yet known whether the observed sex differences in growth

rate have any long-term effect on the survival and reproductive success of the nestlings. To test whether the fitness of males and females changes with rearing conditions in a sex-specific way, and in turn, can act as a selection force on sex ratio adjustment, we investigated the long-term effects of our earlier brood size manipulation experiment using our long-term dataset. While reproductive output was unaffected by rearing conditions in females, males reared in enlarged broods were outperformed by males reared in reduced broods. This suggests that sensitivity to rearing environment is likely to be a strong selection force on sex allocation. The paper has been published in *Behavioral Ecology* (Szász et al. 2017).

Because our long-term study (Szász et al. 2017) confirmed that male nestlings are more sensitive to poor rearing conditions than female nestlings, we hypothesized that the female-biased broods observed in the nests of aggressive fathers may be adaptive if aggressive fathers feed their offspring less intensively. However, we showed that the feeding rate of male parents was unrelated to the level of aggression shown during the courtship period, and feeding rate was also unrelated to any other male or partner traits. This suggests that even if sex ratio adjustment in relation to aggressiveness is adaptive, this is probably not because of male quality dependent parental effort and sex-biased sensitivity of the offspring. Our results were presented at the XIXth Hungarian Ethological Conference, and the relevant MS has been published in *Behavioral Ecology and Sociobiology* (Szász et al. 2019b).

The relationship between male aggressiveness and brood sex ratio may be adaptive, if male aggressiveness is related to reproductive success. However, analysing the long-term personality database, we did not find any relationship between male traits (including aggression and tarsus length) and pairing probability, pairing speed, number of fledglings, probability of having (at least one) recruit(s). Though our data are based on a single reproductive event of each male, thus we cannot exclude the possibility that lifetime reproductive success (including extra-pair paternity) may be related to aggressiveness, or aggressiveness of female flycatchers is somehow related to their reproductive output, so far we have been unable to show benefits of male aggressiveness related sex ratio patterns. The results have been published in the *Science of Nature* (Szász et al. 2019c).

When estimating the fitness of the parents, in addition to the survival and reproductive success of the offspring, it is essential to take into account the possible costs of rearing male and female nestlings. The investigation of costs requires experimental manipulation of offspring sex ratio. Therefore in 2017 and 2018, we performed a cross-fostering experiment to investigate the effects of male/female-biased brood sex ratios on fitness components of parents and offspring. Given that male nestlings have the potential to grow faster, but are more sensitive to the rearing environment, we presumed that they have larger energy requirement. If so, those foster parents that rear a surplus of males are likely to be more challenged, thus we expected a negative relationship between the development and survival of the offspring and the experimental brood sex ratio of the foster parents. On the other hand, we expected a positive relationship between the development and survival of the offspring and the original brood sex ratio of the foster parents assuming that better quality parents have a male-biased offspring sex ratio and provide better parental care. Finally, as the rearing costs of males are supposedly unequal for parents of different qualities, we expected an interactive effect of the experimental brood sex ratio and the original brood sex ratio of the foster parents on the development and survival of the offspring. Specifically, if sex ratio adjustment is adaptive, parents that originally produced male-biased broods (and are assumed to be of better quality and have higher caregiving capability) are expected to raise male-biased foster broods more successfully than parents that originally produced female-biased broods. However, our results show that neither the pre- nor the post-manipulation brood sex ratios of the foster parents were related to the growth rate, prefledging survival and recruitment of the chicks. The interaction of the two sex ratios had no significant effect either. The sex of the offspring

per se proved to be related to growth so that male nestlings developed faster independent of the experimental conditions. Background variables (i.e. hatching order, brood size and year) were also related to growth. Our results were presented at the 12th Congress of the European Ornithologists' Union. We published our results in the *Journal of Evolutionary Biology* (Szász et al. 2023).

One possible explanation for the lack of the expected relationships may be that foster parents compensated the presumed increase in offspring need of male-biased broods. Though it was originally not planned in the proposal, we videorecorded the feeding behaviour of the experimental parents. To analyse whether the experiment had indeed no fitness consequences or the costs were paid exclusively by the parents, we analysed these videos. We found that the feeding rate of both parents were independent of the manipulated brood sex ratios, and only the feeding rates of the male parents were related to the original brood sex ratios so that fathers of female biased brood fed the chicks more often. The direction of the latter relationship was the contrary of what we expected based on theoretical considerations and results in the Czech population. To conclude our results suggest that biased brood sex ratios are not costly either for the parents or for the offspring. We have received comments on an earlier version of the MS from two reviewers. We are now revising the MS and plan to submit it to *Behavioral Ecology and Sociobiology* (Gyarmathy et al. MS).

Apart from the experiment, we planned to analyse the fitness consequences of sex ratio adjustment using correlative data. Because of the high proportion of extra-pair paternity in our population, this requires population-level genetic analyses. For this purpose, we optimized two multiplex PCRs to amplify 11 microsatellite loci. The DNA has been extracted from all samples collected in 2 study years, and the individuals have been genotyped. After screening the samples, we found a large number of microallele variants at some loci making it hard to separate some alleles from each other, so we have to use a restricted 8 loci set for our analyses, but even this provides sufficient resolution (exclusion probability = 0.999996). We are currently working on identifying the genetic father of each offspring.

The paternity analyses of experimental broods from 2018 have already been completed. Because we had data also on the feeding effort of the male parents in these broods, we could test whether the presence/absence of extra-pair offspring in the broods is related to paternal feeding rate. Some earlier reports on various passerine populations (including a northern population of the collared flycatcher) suggested that males penalised unfaithful females by reducing their feeding rates, but in our population, extra-pair paternity rate is high (56% of the broods contain extra pair young), and it may be harder for the males to keep track of their partners' behaviour. Our preliminary results were still surprising. We found that cuckolded males fed their chicks more frequently than uncuckolded males. These preliminary result have been presented at the 14th European Ornithologists' Union Congress.

The paternity analysis that we developed for our collared flycatcher population, as part of our project, was applied not only for the samples in the sex ratio project. We investigated the genetic structure of a family where three parents (2 females and 1 male) were feeding the chicks. This family structure is very unusual in our primarily socially monogamous species. Our analyses revealed that all offspring had the same genetic mother, and one of the females was an unrelated helper. We also showed that only one offspring was sired by the feeding male, and the rest of the offspring were sired by at least two extra-pair males. The results that were published in *Ecology and Evolution* (Laczi et al. 2021) suggest not only that females may mate with multiple extra-pair partners, but also that (at least in rare cases) even the identity of the genetic mother is questionable and requires genetic analyses. From the point of our project, it was also important that the method we developed proved to have sufficient resolution to investigate the genetic structure of even very extreme families and will provide

sufficiently high quality data when we analyse the fitness consequences of sex ratio adjustment.

Measuring the fitness consequences of any behaviour or phenomenon is inherently difficult. Ecological studies use various estimates starting from the number of fledged/weaned offspring to the number of recruits produced. Because offspring that become independent but die before reproduction will not contribute to the gene pool of the future generations, the former method may lead to misleading results. On the other hand, in species where dispersal is sex-biased, the number of recruits is expected to be related to the sex ratio of the brood, and as a consequence, studies using recruitment rate as a measure of fitness may underestimate the fitness of broods with sex ratios biased to the more dispersive sex. In birds in general, females disperse further from their natal area, so the problem may be widespread in avian taxa. Though it was not planned in our application, we investigated this issue using our long-term database (including the years covered by our grant). Though previous results on the Swedish population of collared flycatchers suggested that the general trend of larger dispersal distance of females is true also in our study species, according to our results, the sex ratio of the broods was unrelated to the number of recruits. Later we found that in our population, there was only a slight and non-significant tendency for sex-biased dispersal, and this may explain our results. Finally, we decided to keep back the prepared manuscript and contacted a colleague to get data from a population where significant sex-biased dispersal has been observed, because such a population would be more useful to test our hypothesis. We are currently waiting for the data, and after the analyses, we plan to publish the results from the two populations together.

2.2. Budgerigars (Melopsittacus undulatus)

We planned to perform a laboratory experiment on budgerigars. Because (for reasons detailed in the yearly reports) we were delayed in other parts of the project, we tried to find an alternative study species to get results faster. We chose the cowpea weevil *(Callosobruchus maculatus)*. The species happily breeds in various types of beans that provide various amount of resources for the offspring. Thus the cowpea weevil seemed to be a suitable species for investigating the adaptive value of sex allocation. Unfortunately, after several trials with various types of beans, we failed to find any sign of food quality dependent sex allocation, so we had to abandon these trials and return to the original idea. In 2019/2020, we invested a lot of time to find an appropriate amount of wild-type budgerigars from reliable breeders. Unfortunately, all possible sources of budgerigars were abroad, and due to the COVID situation we were not able to obtain birds. Finally, we decided to perform a simplified experiment on zebra finches instead.

We planned to 1) breed previously unmated male and female birds in aviaries and collect information on individual quality and offspring sex ratio; 2) release the offspring in two aviaries thereby giving them the possibility of free mate choice and reproduction. We wanted to investigate, whether the sex ratio biases observed in the first part of the experiment are indeed adaptive, i.e. whether male offspring from male biased broods are more successful in the second part of the experiment. We built two new aviaries, measured morphological & spectral traits of the birds, then allowed them to breed. Unfortunately, a large proportion of the birds did not start to breed despite their possibility to choose their partner freely, and even hatching success was low. In order to have enough offspring to start the second part of the experiment, we continued the experiment much longer than we planned. Though we had significantly improved hatching success, many birds still did not breed and we did not have enough genetically independent offspring to start the second part of the experiment.

2.3. Humans

Using questionnaires, we planned to investigate sex ratio adjustment also in humans. Because we had many conditional questions and we planned to run some verifications, the standard forms (e.g. google questionnaire) were not suitable for our goals. We had to arrange the programming of our questionnaires and we faced a lot of unexpected technical difficulties during this process. In addition, we had to wait long for the ethical permit (our application was rejected by various committees, because they did not feel themselves cognizant in the issue). These factors delayed the project. After we got the ethical approval, we sent the advertisement of the questionnaire to 141 state owned secondary schools in Budapest to ensure that our sampling is as representative as possible (within Budapest). Despite all efforts, we ended up with a very low number of responses. To increase our sample size, we issued a press release via our university. This substantially increased the number of respondents, however, finally we had to start a Facebook campaign to reach the minimum sample size we aimed for. After processing the data, we investigated multiple questions.

First, the Trivers-Willard hypothesis (TWH) suggests that in polygynous societies, females in good body condition should produce more male offspring, because the condition of the mother and condition of the offspring is correlated, and male offspring benefit more from good body condition than female offspring. This hypothesis can be extended to any parental or environmental traits that are related to fitness in a sex biased manner, and to any societies where reproductive success of males is more dependent on a trait than that of females. Therefore it was suggested that in human societies, mothers of high socioeconomic status should produce male biased offspring sex ratios. We investigated whether this prediction is supported by our data. In addition, we investigated whether the assumptions of the TWH hold in our population. This step is substantial when testing a hypothesis, still it is neglected in the human TWH literature. We found a positive correlation between maternal status and the offspring's status at adulthood, however, we found no support for the other precondition of the TWH. Namely, the socioeconomic status at adulthood showed no sex-specific relationship with reproductive output. Not surprisingly the prediction of the TWH were not supported either. Our MS is now under revision and will be sent back to *Evolutionary Human Sciences* (Sarkadi et al. manuscript).

Our second question was whether sex-dependent costs exist in the contemporary human population, and whether we can observe birth order specific sex ratio adjustment. According to our preliminary results, the interbirth interval was not dependent on the sex of the first child, however, first born sons were more likely to be followed by daughters (the presumably less costly sex). Interestingly, the pattern does not seem to be adaptive, because the reproductive output of the second child was independent of its own sex, the sex of the first born sibling or the interaction of the two factors. We think that the observed sex ratio pattern may have been adaptive earlier during human evolution, however, is not adaptive anymore in modern societies. We plan to publish these result in a leading journal of our field.

Finally, according to our preliminary results high quality parents overproduced sons as expected, however, the reproductive success of sons was not more dependent on parental quality than the reproductive success of daughters. Again this suggests that the sex ratios observed in the contemporary population of Hungary are not adaptive. The fact that high quality parents overproduced sons may be the consequence of the evolutionary history of the human species, i.e. some evidence suggests that in the past, humans were polygynous, and in such societies the observed sex ratio pattern would be adaptive. We plan to publish these result in a leading journal of our field.

3. Student training

We find the training of the new researcher generation important and students of various levels have been involved in the project. Students of two BSc courses were involved in the review of the human sex ratio literature, furthermore the design and testing of our questionnaire. Fanni Sarkadi joined the project during her BSc Studies, and both her BSc and MSc theses were related to the project. Helga Gyarmathy joined the project during her MSc studies and her MSc theses was related to the project. Both of them participated at the Scientific Student Conference of Eötvös Loránd University. Fanni got the 2nd award in her section, and both of them qualified themselves to the National Scientfic Student Conference. At the national conference, Fanni got a special award. Fanni Sarkadi and Helga Gyarmathy are now PhD students and their work is partly related to the project. Eszter Szász has successfully prepared and defended her PhD thesis (title: "The adaptive value of sex ratio adjustment") and obtained the PhD degree (summa cum laude). The thesis was mainly based on the results mentioned above. All students were supervised by Balázs Rosivall.

4. Publications

Published papers:

Szász, E., Sarkadi, F., Szöllősi, E., Kopena, R., Török, J., Rosivall, B. (2023): Are brood sex ratios adaptive?—The effect of experimentally altered brood sex ratio on nestling growth, mortality and recruitment. Journal of Evolutionary Biology 36(1):156-168.

Laczi, M., Kopena, R., Sarkadi, F., Kötél, D., Török, J., Rosivall, B. and Hegyi, G. (2021): Triparental care in the collared flycatcher (*Ficedula albicollis*): Cooperation of two females with a cuckolded male in rearing a brood. Ecology and Evolution 11(16):10754-10760.

Szász, E., Garamszegi, L.Z., Rosivall, B. (2019a): What is behind the variation in mate quality-dependent sex ratio adjustment? – A meta-analysis. Oikos, 128(1):1-12.

Szász. E., Markó, G., Hegyi, G., Török, J., Garamszegi, L.Z., Rosivall, B. (2019b): Nest-site defence aggression during courtship does not predict nestling provisioning in male collared flycatchers. Behavioral Ecology and Sociobiology 73:62.

Szász. E., Jablonszky, M., Krenhardt, K., Markó, G., Hegyi, G., Herényi, M., Laczi, M., Nagy, G., Rosivall, B., Szöllősi, E., Török, J., Garamszegi, L.Z. (2019c) Male territorial aggression and fitness in collared flycatchers: a long-term study. Science of Nature 106(3-4):11.

Szász, E., Szöllősi. E., Hegyi. G., Török. J., Rosivall, B. (2017): Rearing conditions have long-term sex-specific fitness consequences in the collared flycatcher. Behavioral Ecology 28(3):717-723.

Published papers not related to the topic of the project but utilized data obtained partly during the project:

Hegyi, G., Laczi, M., Herényi, M., Markó, G., Nagy, G., Rosivall, B., Szász, E., Török, J. (2022): Functional integration of multiple sexual ornaments: signal coherence and sexual selection. American Naturalist 200(4): 486-505.

Jablonszky, M., Canal, D., Hegyi, G., Herényi, M., Laczi, M., Lao, O., Markó, G., Nagy, G., Rosivall, B., Szász, E., Török J., Zsebők S., Garamszegi L.Z. (2022): Estimating heritability of song considering within-individual variance in a wild songbird: The collared flycatcher. Frontiers in Ecology and Evolution 10: 975687.

Manuscripts prepared:

Sarkadi, F., Szász, E., Rosivall, B. (manuscript under revision): No support for the Trivers–Willard hypothesis in the contemporary Hungarian population. Evolutionary Human Sciences.

Gyarmathy, H., Kopena, R., Sarkadi, F., Szöllősi, E., Szász, E., Török, J., Rosivall, B. (manuscript): Are brood sex ratios adaptive? – The effect of experimentally altered brood sex ratios on parental workload

BSc, MSc and PhD Theses:

Sarkadi, F. (2021): A fészekaljak ivararányának hatása a fiókák visszatérési rátájára. *MSc Thesis* [in Hungarian], Eötvös Loránd University. (Supervisor: Rosivall, B.)

Gyarmathy, H. (2021): Ivararány-manipuláció és utódgondozás az örvös légykapónál. *MSc Thesis* [in Hungarian], Eötvös Loránd University. (Supervisor: Rosivall, B.)

Sarkadi, F. (2019): Ivararány-manipuláció és fiókafejlődés az örvös légykapónál. *BSc Thesis* [in Hungarian], Eötvös Loránd University. (Supervisor: Rosivall, B.)

Szász, E. (2018): The adaptive value of sex ratio adjustment. *PhD thesis*, Biology PhD School, Eötvös Loránd University. (Supervisor: Rosivall, B.) *DOI: 10.15476/ELTE.2018.187*

Conference contributions:

Rosivall, B., Gyarmathy, H., Kopena, R., Sarkadi, F., Szöllősi, E., Szász, E., Török, J. (2023): Do males penalize unfaithful females in a population with high level of extra-pair paternity? – poster, 14th European Ornithologists' Union Congress, Lund. Abstract Book p281

Rosivall, B., Garamszegi, L. Z., Szász, E. (2022): Attractive males have more male offspring, but why are results so heterogeneous? – talk, Congress of the European Society for Evolutionary Biology, Prague. Abstract Book p349

Sarkadi, F., Szász, E., Rosivall, B. (2022): Partial support for the Trivers-Willard hypothesis in the contemporary Hungarian population – poster, Congress of the European Society for Evolutionary Biology, Prague. Abstract Book p763

Gyarmathy, H., Kopena, R., Szöllősi, E., Sarkadi, F., Szász, E., Török, J., Rosivall, B. (2022): Is brood sex ratio related to parental feeding rate? An experimental study on collared flycatchers – poster, Congress of the European Society for Evolutionary Biology, Prague. Abstract Book p772

Gyarmathy, H., Sarkadi, F., Szász, E., Rosivall, B. (2021): Több pénz, jobb esélyek? – Félrelépések Magyarországon – talk [in Hungarian], XXIII. Hungarian Ethological Conference, online. Abstract Book p45.

Sarkadi, F., Kopena, R., Sarkadi, F., Kötél, D., Török, J., Rosivall, B., Hegyi, G, Laczi, M. (2021): A Jó, a Rossz és a Csúf – háromszülős utódgondozás az örvös légykapónál – talk [in Hungarian], XXIII. Hungarian Ethological Conference, online. Abstract Book p53.

Sarkadi, F. (2021): A fészekaljak ivararányának hatása a fiókák visszatérési rátájára. – talk [in Hungarian], XXXV National Scientific Student Conference, online. Abstract Book p60. – ***special award***

Gyarmathy, H. (2021): Ivararány-manipuláció és utódgondozás az örvös légykapónál– talk [in Hungarian], XXXV National Scientific Student Conference, online. Abstract Book p56

Sarkadi, F. (2020): A fészekaljak ivararányának hatása a fiókák visszatérési rátájára. – talk [in Hungarian], Scientific Student Conference of Eötvös Loránd University, Budapest. Abstract Book p7-8. – ***2nd award***

Gyarmathy, H. (2020): Ivararány-manipuláció és utódgondozás az örvös légykapónál– talk [in Hungarian], Scientific Student Conference of Eötvös Loránd University, Budapest. Abstract Book p7.

Kopena, R., Gyarmathy, H., Sarkadi, F., Szász., E., Szöllősi, E., Török, J., Rosivall, B. (2020): Csökkentik-e etetési aktivitásukat a felszarvazott hímek? – poster [in Hungarian], XXII. Hungarian Ethological Conference, online. Abstract Book p62.

Sarkadi, F., Hegyi, G., Herényi, M., Laczi, M., Markó, G., Nagy, G., Szász, E., Szöllősi, E., Török, J., Rosivall, B. (2020): A fészekaljak ivararányának hatása a visszatérő fiókák számára – poster [in Hungarian], XXII. Hungarian Ethological Conference, online. Abstract Book p59.

Szász, E., Sarkadi, F., Rosivall, B. (2020): A Trivers–Willard-hipotézis vizsgálata a magyar populációban– talk [in Hungarian], XXII. Hungarian Ethological Conference, online. Abstract Book p39.

Rosivall, B. (2020): Ivararány-manipuláció és rátermettség – talk [in Hungarian], Conference of the New National Excellence Program, Eötvös Loránd University, Budapest. Abstractbook p333

Rosivall, B., Sarkadi, F. (2019): Az utódok neme és szaporodási sikere – kérdőíves adatgyűjtési problémák – – talk [in Hungarian], XXI. Hungarian Ethological Conference. Abstract Book p49.

Sarkadi, F.; Szász, E.; Szöllősi, E.; Kopena, R.; Török, J.; Rosivall, B. (2019): Hatással van-e a fiókák ivararánya a szülők következő évi visszatérésére és szaporodására? – – poster [in Hungarian], XXI. Hungarian Ethological Conference, Mátrafüred. Abstract Book p61

Gyarmathy, H.; Kopena, R.; Szöllősi, E.; Sarkadi, F.; Szász, E.; Török, J.; Rosivall, B. (2019): A fészekaljak ivararányának hatása a szülői befektetésre – – talk [in Hungarian], XXI. Hungarian Ethological Conference, Mátrafüred. Abstract Book p14.

Rosivall, B., Sarkadi, F. Szöllősi, E., Kopena, R., Szász, E., Török, J. (2019): The effect of brood sex ratio on offspring growth – poster, 12th Congress of the European Ornithologists' Union, Cluj-Napoca. Abstract Book p151.

Rosivall, B. (2019): „Az ivararány-manipuláció rátermettségkövetkezményei" című kutatási projekt mint a kutatóképzés eszköze – talk [in Hungarian], Conference of the New National Excellence Program, Eötvös Loránd University, Budapest. Abstractbook p 289.

Sarkadi, F. (2019): Ivararány-manipuláció és fiókafejlődés az örvös légykapónál – talk [in Hungarian], XXXIV National Scientific Student Conference, Budapest. Abstract Book p 55.

Rosivall, B., Sarkadi, F., Szöllősi, E., Szász, E., Török J. (2018): A fészekaljak ivararányának hatása az utódok fejlődésére – talk [in Hungarian], XX Hungarian Ethological Conference, Cluj-Napoca, Abstract Book p22.

Sarkadi, F. (2018): Ivararány-manipuláció és fiókafejlődés az örvös légykapónál – talk [in Hungarian], Scientific Student Conference of Eötvös Loránd University, Budapest. Abstract Book p13.

Rosivall, B., Sarkadi, F. (2017): Az utódok neme és szaporodási sikere – kérdőíves felmérés. – talk [in Hungarian], XIX Hungarian Ethological Conference, Dobogókő, Hungary. Abstract book, p52

Szász, E., Markó, G., Hegyi, G., Török, J., Garamszegi, L. Zs., Rosivall, B. (2017): Az apai agresszió és az utódgondozás kapcsolata örvös légykapóknál. – talk [in Hungarian], XIX Hungarian Ethological Conference, Dobogókő, Hungary. Abstract book, p55

Szász, E., Garamszegi, L.Z., Rosivall, B. (2017): Male quality and brood sex ratio: does extra-pair paternity explain the variation in effect sizes? – poster, 11th Conference of the European Ornithologists' Union, Turku, Finland. Abstract Book p193

Rosivall, B., Szöllősi, E., Laczi, M., Kiss, D., Török, J. (2016): Élőhelyfüggő szezonális ivararány–mintázat egy énekesmadárfajnál. – poster [in Hungarian], XVIII. Hungarian Ethological Conference, Debrecen, Hungary. Abstract book, p61