

## EVALUATION OF DISSERTATION OF MARTA WITKOWSKA

**Review for:** Biological Sciences Discipline Board, University of Gdańsk, Poland

**Dissertation Title:** Body condition in relation to environmental factors on the breeding grounds and given stages of the annual cycle of adult Great Snipes *Gallinago media* from Eastern-European, lowland population

**Author:** Marta Witkowska MSc., University of Gdańsk, Poland

**External Referee:** Brett K. Sandercock PhD, Senior Research Scientist, Department of Terrestrial Ecology, Norwegian Institute for Nature Research, Trondheim, Norway (EM: brett.sandercock@nina.no, PH: +47 452 16 480)

*Contents of dissertation.*—The dissertation includes a summary and a concluding outlook in English and Polish that frame three main chapters that present new information on migratory birds. The three chapters include one unpublished manuscript, and two articles that have been successfully peer-reviewed and published in the *Journal of Ornithology*. Witkowska has been the lead author on all three manuscripts and letters of support from her four coauthors confirm that she has taken a lead role in developing the conceptual framework, compiling the data, completing the statistical analyses, and preparing the manuscripts. Successful publication as a lead author confirms that Witkowska has met expectations for developing new scientific knowledge in her PhD project.

*Scope of study system.*—The three chapters of the dissertation focus on the breeding ecology of a migratory bird, the Great Snipe (*Gallinago media*). Witkowska has summarized the unique life-history traits of the species that make the species particularly interesting as a study system. Great Snipe are unusual among European birds because they have a lek-mating system where males congregate on display arenas, make rapid long-distance migratory movements across major geographic barriers, and have a specialized diet that primarily consists of energy-rich earthworms. Witkowska has made a major contribution to understanding the ecology of Great Snipe as a migratory bird with her analyses of long-term data from 20+ years at a field site in Belarus, a key breeding site for the lowland breeding population of the species.

*Role of feeding conditions during breeding.*—Lek-mating birds have energetically intensive mating displays and a key question for understanding the dynamics of the social system is the role of feeding conditions. In Chapter 1, Witkowska investigated seasonal variation in body mass of displaying males and linked variation in water levels in the Pripyat River to seasonal variation in the body mass. Witkowska reported that body mass of males by 4 grams over the season, a decline of 3% per month. Drops in body mass were interpreted as an energetic cost of display. Alternatively, drops in mass might not be costly and could benefit males if lighter mass allows males to be more agile and efficient in flight during migratory movements. A limitation of the field study was that variation in earthworm abundance was not measured directly with soil cores or other sampling. Witkowska builds a strong argument that water levels in the river were a good index of food abundance. Experimental protocols with controlled manipulations are a strong approach for testing the effects of food availability. Witkowska used an observational approach in her field study but took advantage of annual variation in water levels over two decades as a natural experiment in variation in food resources. A new contribution from the work was the discovery of thresholds in environmental conditions. Figure 2 shows that

body mass of male snipe is unaffected by low water levels, increases with more hydric conditions but is then negatively affected by flooding and loss of food resources. Witkowska successfully linked her new findings to the role of water management in river valleys for protecting the breeding habitats of Great Snipe and other meadow birds.

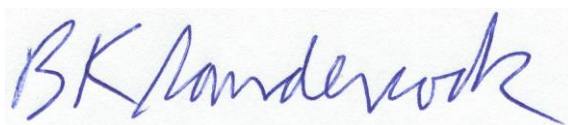
*Tradeoffs among energetically costly activities.*—A challenge for many migratory birds is how to avoid overlap of energetically costly activities including migratory movements, breeding, and regular moult and replacement of wing and body feathers. In Chapter 2, Witkowska presents new data on partial wing moult that is completed on the breeding ground by Great Snipe before they depart on autumn migration. The data and findings are quite novel. Wing moult has not been investigated in the Scandinavian population of Great Snipe because the birds are too challenging to capture before departure. The new data from the population in Belarus are therefore a new discovery for the breeding ecology of Great Snipe. The evidence for partial and suspended moult is an unusual tactic that occurs only in a few species of waders, including Dunlin. The new results from Witkowska would benefit from comparison to the other species where the same pattern of feather moult has been reported. A related question is that the flight performance of birds is usually most affected by the condition and shape of the outermost wing feathers. Nevertheless, Figure 2 demonstrates that snipe begin to moult and replace the innermost primary feathers first and then depart on migration with suspended moult.

*Sex differences in moult of wing feathers.*—In Chapter 2, Witkowska presents interesting differences in patterns of wing feather moult between female and males. Figure 3 shows sexual differences in timing of feather regrowth. A strength of the analysis is that it is based on the Underhill models of feather regrowth but the regressions are extrapolated beyond the range of the data and might differ if birds could be sampled at later stages of the season. The variation in start date of moult was 2.5 times greater for females than males which is consistent with sex differences in mating behavior and parental care. It might be possible to investigate causes of variation for females such as timing of nest loss which might be correlated with degree of feather regrowth in the brood patch. Witkowska notes that Great Snipe have female-biased sexual size dimorphism where females are the large sex which is the pattern presented in Figure 1S in the supplemental materials for Chapter 2. It is puzzling that the pattern is reversed if body mass is scaled by body size and Figure 4 shows that scaled mass index is greater for males than females over the course of the season. It is unclear why sex was a significant factor affecting body mass but not the scaled mass index if the 95% CI for the relationships do not overlap between the sexes in Figure 4.

*Annual survival of a lekking bird.*—The concluding Chapter 3 links the variation in body size and condition to the demographic performance of Great Snipe. Estimates of demographic parameters for the species are rare and the article is one of the first applications of mark-recapture statistics for the species. Witkowska shows that the annual survival of Great Snipe is moderate with an average rate of apparent survival = 0.43, which is an interesting finding for a polygynous (not polygenic) species with fast pace-of-life. In comparison with many other species of migratory waders, the annual survival of Great Snipe is relatively low. The results include the surprising finding of directional selection of body size on apparent survival in Figure 3. Witkowska notes in the Discussion that losses can include either mortality or permanent emigration so that the

pattern in Figure 3 could indicate that larger-bodied males have stronger site fidelity and are more effective at holding and defending territories on the lek than small-bodied males. The considerable variation in apparent survival among years in Figure 4 might also have been influenced by emigration in years of poor conditions. Witkowska used posthoc regressions to compare the probability of encounter to number of capture events (Fig. 2) and annual variation in apparent survival to year (Fig. 4). The results would unlikely be changed but a stronger approach would have been to set up mark-recapture models that included covariates for effort or linear trends and formally test them in the set of candidate models in Table 1. Overall, Witkowska's new findings for survivorship are important because the estimates could be combined with reproductive data and used in future models for population viability for the different populations of Great Snipe.

**Recommendation:** This document presents my written evaluation of the PhD dissertation of Marta Witkowska MSc. as part of the examination for her PhD program at the University of Gdańsk in Poland. **I recommend that Marta Witkowska be awarded a doctoral degree in the field of natural sciences and the discipline biological sciences** under the terms of the Act of 20 July 2018 - Law on the Higher Education and Science (Journal of Laws of 2018, item 1668, as amended). **In addition, I recommend that Marta Witkowska be awarded the special recognition of distinction for outstanding scientific achievement.** Witkowska has led a collaborative team and successfully published two articles in *Journal of Ornithology*, a top-ranked journal in ornithological sciences. She has been highly innovative and has used modern statistical methods based on generalized additive models, specialized models for feather moult and modern mark-recapture statistics to extract new findings from a 20+-year study of a focal species of migratory bird. Her dissertation is novel because she has successfully addressed three separate elements of the breeding cycle of migratory birds: first the links between food resources and body condition (Chapter 1), next the tradeoffs among events in the timing of the annual cycle (Chapter 2), and finally the demographic consequences of events during the breeding season for annual survival (Chapter 3). Many of her findings are quite novel, including some of the first evidence for partial wing moult as a rare life-history strategy and also surprisingly low estimates of annual survival for a migratory wader. Great Snipe are highly unusual among migratory species for their lek-mating strategy, long-hop migratory movements and specialized diet of earthworms. The new scientific discoveries in Witkowska's dissertation have made a valuable contribution to understanding the life-history of a remarkable species of a migratory bird characterized by a fast pace-of-life. Her new work is essential for comparative studies investigating the diversity of life-history strategies in waders and ongoing conservation efforts for declining species in different global flyways.



Brett K. Sandercock, PhD  
February 19, 2024



