



Wrocław, 4.03.2026 r.

Prof. dr hab. Anna Rząsa
Katedra Immunologii, Patofizjologii i Prewencji weterynaryjnej

Review

of **Mr. Sunil Khatiwada's** doctoral thesis entitled:

„Exploring social complexity and the benefits of social relationships in domestic pigs”

under the scientific supervision of the supervisors:

dr hab. Irene Camerlink and prof. dr Simon P. Turner

The formal basis for this review is the Resolution of the Scientific Council of the Institute of Animal Genetics and Biotechnology of the Polish Academy of Sciences of 27 January 2026, as well as the guidelines specified in the review agreement.

Sunil Khatiwada is a PhD candidate at the Polish Academy of Sciences with a distinguished international academic background, including master's degrees from both the University of North Carolina at Chapel Hill and Tribhuvan University. His research expertise in behavioral ecology is supported by 12 peer-reviewed publications and several prestigious grants from organizations such as ASAB and the American Society of Primatologists.

Currently, his doctoral work investigates the social complexities and behavioral strategies of domestic pigs in order to better understand relationship maintenance. Having successfully completed rigorous academic programs across three continents, he is now finalizing his doctoral research with a proven track record of excellence in both field and laboratory work.

The research for this thesis was conducted at the Department of Animal Behavior and Welfare, Institute of Genetics and Animal Biotechnology of the Polish Academy of Sciences in Jastrzębiec, and at Scotland's Rural College, Easter Howgate. This research was carried out within the project titled: *The importance of social relationships and social bonds for animals' behavioural expression, health and fitness – pigs as a model to explore the underlying*

physiological mechanisms, funded by the National Science Centre (NCN), Poland (Project No: 2020/39/B/NZ8/02508).

Maintaining a high health status in animals reared on commercial farms is a fundamental prerequisite for achieving satisfactory production results. Contemporary livestock production faces increasing pressure to limit pharmaceutical interventions while simultaneously improving animal husbandry and welfare standards. Consequently, growing attention is being paid to the practical implementation of the principles of the Five Freedoms under commercial farms' conditions. In group-based and frequently artificial husbandry systems, particularly regarding group size and age structure, it is essential to understand the factors shaping social behavior and the dynamics of social interactions. Accurate interpretation of animal behavior enables the optimization of housing and management conditions, contributes to improved welfare, and supports the maintenance of physiological homeostasis. These factors, in turn, may translate into reduced disease incidence in animals exposed to lower levels of stress.

The doctoral dissertation submitted for evaluation addresses the analysis of behavioral processes in young pigs, with a particular emphasis on the mechanisms responsible for maintaining social relationships. Special attention is devoted to subtle affiliative and neutral forms of interaction.

The dissertation takes the form of a thematically coherent series of four scientific articles published in reputable peer-reviewed journals, with a total Impact Factor (IF) of **9.8** and **470** Ministry of Education and Science points:

1. **Khatiwada, S.**, Lee, V., Turner, S.P., Camerlink, I. (2025). Trade-offs between proximity and physical contact during group integration in pigs (*Sus scrofa domesticus*). *Current Zoology*.
2. **Khatiwada, S.**, Lee, V., Turner, S.P., Camerlink, I. (2025). Temporal social network structures based on snout contact during group integration in pigs. *Applied Animal Behaviour Science*, 292, 106838.
3. **Khatiwada, S.**, Turner, S. P., Farish, M., & Camerlink, I. (2024). Leadership amongst pigs when faced with a novel situation. *Behavioural Processes*, 222, 105099.

4. Khatiwada, S., Seddaiu, P., Jaszczuk, A. & Camerlink, I. (2025). Is social support mediated by social relationship strength in pigs? *Animal*

This series of publications is preceded by a seventy-five-page descriptive section consisting of: a list of publications (1 p.), a summary in English (2 p.), a summary in Polish (3 p.), Introduction (4 p.), Hypotheses and Objectives (2 p.), Materials and Methods (22 p.), Results (15 p.), General Discussion (9 p.), Conclusions (1 p.), and References (12 p.). Appendices include the author's contribution statements (4 p.) and copies of the four publications.

While the publications are multi-authored, the contribution statements indicate that the doctoral candidate played a leading role in their preparation. He participated in data collection, processing, and the drafting of the manuscripts. He is the first author of all publications, confirming his leading contribution and demonstrating scientific maturity, strong subject knowledge, and the ability to work effectively within a research team.

The presented publications were interesting and satisfying to read; I have no substantive critical comments. Both the content and the scientific value of the results were thoroughly assessed by the reviewers and journal editors who accepted the papers. The papers are clearly written, with well-defined objectives and detailed descriptions of methods and results. In my review, I would like to highlight the strengths and weaknesses of the methodology in relation to its application in industrial farming.

Strengths:

- a) **Clear Alignment:** There is a clear alignment between objectives and behavioral measures. The methodology directly addresses social structure and recognition through detailed observations (e.g., aggression, snout contact, proximity).
- b) **Causal Inference:** Social relationship strength was experimentally manipulated (strong vs. weak sibling familiarity), enabling causal inference regarding social bonds.
- c) **Controlled Experimental Design:** The balanced mixing of familiar and unfamiliar pigs, standardized observation times, and repeated measures support high internal validity.
- d) **Multi-method Approach:** The combination of behavioral observations, standardized tests (backtest, Human Approach Test), social support tests, and physiological measures (salivary cortisol) strengthens the interpretation of stress responses.

Weaknesses

- a) Small Group Sizes: While useful experimentally, this may not fully reflect commercial conditions (large groups, complex hierarchies, and higher stocking density).
- b) Limited Duration: Short observation periods may miss longer-term processes such as hierarchy stabilization or chronic stress effects.
- c) Aggregated Dominance Scores: Because aggression levels were low on a weekly basis, dominance scores were calculated across the entire study period, which represents a limitation for studying social dynamics.
- d) Single-Observer Design: While this reduces inter-observer variability, it carries a risk of systematic observer bias.

In discussing the strengths and weaknesses of the reviewed dissertation, I would like to emphasize the difficulty of conducting behavioural experiments with farm animals. It is sometimes easier to design and implement a study at an experimental scale to expand knowledge about subtle differences in animal behaviour, however, it may later be difficult or even impossible to apply the conclusions directly to large-scale commercial farming conditions. This is particularly relevant when considering the number of animals used, which in total was quite high in the presented dissertation. Nevertheless, small group sizes and limited replications reduce scalability to large farm conditions. Small experimental groups produce clearer social networks but reduce emergent phenomena observed in larger groups, such as subgroup formation, scaling of resource competition, and diffusion of leadership. In light of these observations, **I formally invite the candidate to discuss during the defense** how the transition from small experimental groups to large-scale commercial environments might alter the social networks he observed. Specifically, how might the „emergent phenomena” such as subgroup formation and the diffusion of leadership affect the practical application of his findings in an industrial setting.

The four conclusions adequately synthesize the research findings. The first two conclusions are particularly relevant for commercial implementation, as they highlight how subtle social behaviors may reflect underlying vulnerability and coping strategies. This has significant implications for interpreting problematic behaviors like cannibalism or tail biting. In field observations, the "ringleader" of cannibalism is often a vulnerable individual adopting



an offensive strategy to mask their own risk. The first conclusion of the dissertation suggests a pattern that contrasts with common field observations, where the „ringleader” of cannibalistic behavior is often seen as a vulnerable individual using aggression as a coping strategy. **I request that the candidate addresses this discrepancy during the public discussion**, providing his perspective on how his findings might reshape our understanding of the „initiator” in such problematic social interactions.

I positively evaluate Mr Sunil’s Khatiwada doctoral dissertation. It represents an original scientific achievement that is cognitively significant. My comments stem from an attempt to relate these results to industrial farm conditions where we usually have a higher group size and a higher density. I am impressed by the solid work that takes into account the multi-method approach, which I emphasized by pointing out the strengths of the research methodology. **And this moment I curious given the transition towards smart farming and automated monitoring, how does the candidate see subtle affiliative behaviours being integrated into automated welfare-monitoring systems in future?** The other strong side of this dissertation is fact that it was realised in frame of the project funded by Nationale Science Centre and the fact that it was carried out in two countries what increases cognitive qualities of the work. It also testifies to Mr Sunil’s Khatiwada high work skills and cooperation.

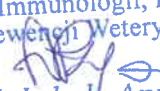
In conclusion, I evaluate the doctoral dissertation of Mr. Sunil Khatiwada very highly. The work constitutes a significant contribution to the field of animal behavior and welfare. I look forward to the candidate’s responses to the points raised in this review during the public defense. I hereby recommend that the candidate be admitted to the subsequent stages of the doctoral proceedings. In my opinion, the dissertation submitted for evaluation deserves distinction.

I would like to emphasize once again that the research was conducted in two different research centers and countries. The study was carried out by an interdisciplinary team using a variety of research methods. The candidate played a key role not only through active participation in the research but also through the preparation of manuscripts that were subsequently published in prestigious scientific journals.



I declare that the thesis meets the requirements for awarding the academic degree of Doctor, as specified in Article 187 of the Polish Act on Higher Education and Science of 20 July 2018 (Journal of Laws 2018, item 1668, as amended).

Accordingly, I hereby submit to the Scientific Council of the Institute of Animal Genetics and Biotechnology of the Polish Academy of Sciences in Jastrzębiec a request to allow Mr. Sunil Khatiwada to proceed to the next stages of the doctoral procedure.

KIEROWNIK
Katedry Immunologii, Patofizjologii
i Prewencji Weterynaryjnej

prof. dr hab. Anna Rząsa