



**REVIEW OF THE ACCOMPLISHMENTS OF DR GEMA TRIGOS PERAL
IN CONNECTION WITH APPLYING FOR THE DOCTOR HABILITATED DEGREE
IN THE FIELD OF EXACT AND NATURAL SCIENCES, IN THE DISCIPLINE OF BIOLOGICAL SCIENCES**

LEGAL BASIS

This review was prepared based on the documentation of the scientific accomplishments of Dr. Gema Trigós Peral, who is applying for the award of the degree of habilitated doctor under the provisions of the Act of 20 July 2018 - Law on Higher Education and Science (Dz. U. z 2024 r, poz. 1571).

The received documentation includes (i) a cover letter, (ii) the applicant's details, (iii) a self-report, (iv) attachments with co-authors' declarations of participation in the publication, a list of works published in international and indexed journals and local scientific journals, as well as certificates confirming participation in research projects, scholarships received, and journal editing activities, (v) a copy of the diploma certifying the doctoral degree (with a translation prepared by a sworn translator), and (vi) copies of articles constituting the scientific achievements.

The criteria for awarding the habilitation degree, as regulated by Article 219 of the aforementioned Act, were assessed.

BASIC DATA ABOUT THE CANDIDATE

Dr. Gema Trigós Peral graduated with a degree in biology from the Faculty of Sciences of the University of Córdoba (Spain) in 2008. On October 20, 2015, she obtained her PhD in biological sciences from the same Faculty, with distinction, based on her dissertation, "The Role of Urban

Green Spaces in Global Strategies of Conservation Using Ants as Bioindicators," submitted in Spanish. Possession of a doctoral degree is equivalent to fulfilling the first requirement specified in the aforementioned Act.

In 2015, Dr. Gema Trigos Peral was employed as a specialist at the Museum and Institute of Zoology, Polish Academy of Sciences, and since 2018 she has been working at the same institution as an assistant professor in the Laboratory of Myrmecophilous and Social Insects.

REVIEW OF THE SCIENTIFIC ACCOMPLISHMENTS

Dr Gema Trigos Peral submitted two accomplishments for evaluation.

The main accomplishment entitled "Abiotic and biotic stressors shaping ant communities in urban habitats" includes a series of four [1-4] scientific articles published in 2020-2024. The articles were published , in the following journals:1/. Urban ecosystems, 2/. Biological Invasions, 3/. Science of the Total Environment, 4/. Myrmecological News, ranking quite high [1/. Q1-2019, Q2-2020; 2/. Q1-2020, Q2-2021, 3/. Q1, 4/. Q1] in such fields as ecology, entomology, biodiversity conservation, and environmental sciences. The total impact factor for the articles included in the series is 17.011 for the year of publication, slightly lower than the one indicated by the Habilitation Candidate, likely due to the release date of the 2024 impact factor (June 18, 2025). All the journals listed were in the first quartile in the year preceding the publication, indicating positive trends in the publishing strategy, which boils down to placing research results in highly ranked journals. The articles were prepared by groups of 3-11 authors; Dr. Gema Trigos Peral is the first and corresponding author of all the articles. According to the statements of the Candidate and co-authors, in each case the Candidate's contribution to the articles was similar and consisted of developing the main research hypotheses, planning the methodology, collecting data in the field and in the laboratory with the support of collaborators, analyzing the data, and preparing the first draft of the manuscript. To date, the publications have received 44 citations, excluding self-citations (WoS CC, 7/03/2026).

The choice of topic, as the Habilitation Candidate rightly emphasizes, was dictated by the still insufficient number of studies dealing with the impact of urbanization (with particular emphasis on thermal and light stressors) on the functioning of invertebrate animals populations.

The aim of the first publication [Trigos-Peral et al. 2020. Three categories of urban green areas and the effect of their different management on the communities of ants, spiders, and harvestmen. Urban ecosystems 23: 803–818] was to assess the impact of different categories of urban green spaces (botanical gardens, public parks, and urban forests) on the biodiversity of

three groups of arthropods (ants, spiders, and harvestmen), to identify tasks necessary to improve the maintenance and protection of urban greenery, and to examine the impact of invasive species on the biodiversity of native ants. The article was peer-reviewed, but I note some methodological flaws in its content that may impact the accuracy of the identifications. The selective selection of the trapping method, which exclusively included Barber traps—one of several methods commonly used to collect spiders and harvestmen—is puzzling. The identification of spiders and harvestmen, as stated by the co-authors, was not the responsibility of the Habilitation Candidate. However, given the Habilitation Candidate's leading role in the development of the study and the associated responsibility for the final form of the manuscript, it is difficult to ignore the lack of proper reference to identification keys, the use of which could have significantly influenced the obtained results. According to the information contained in the Material and Methods chapter, the keys by Haase and Balkenhol (2015) were used in the process of identifying spiders and harvestmen, as well as those by Oleszczuk (2017) for spiders, and by Nentwig et al. (2018) for harvestmen. The shortcomings boil down to several issues: i/. Haase and Balkenhol's (2015) paper concerns spiders occurring in peat bogs and does not contain a key; ii/. Oleszczuk's (2017) paper, like its predecessor, does not include a key; iii/. for Nentwig et al.'s (2018) paper, an incorrect web address was provided, making it impossible to redirect to the webpage; iv/. none of the cited works contain a key for identifying harvestman. The above comments do not apply to the process of identifying ants, and therefore, to the group that is the sole subject of research indicated in the title of the main accomplishment. Therefore, with respect to ants, all the objectives outlined in the introductory part of the study should be considered achieved. The relationship between the form of urban greenery management and the composition of ant communities was demonstrated. The obtained results also allowed for the identification of urban parks as the form of management most susceptible to biological invasions. It is regrettable that the "various hypotheses" to which the Habilitation Candidate refers in her self-report were not more strongly emphasized in the body of the article.

The topic of invasive species was expanded in the second publication [Trigos-Peral et al. 2021. Behavioral responses to numerical differences when two invasive ants meet: the case of *Lasius neglectus* and *Linepithema humile*. *Biological Invasions* 23: 935–953]. I consider this article the most interesting in the series constituting the main achievement due to the way in which the research problem was defined, which facilitated the formulation of several research hypotheses, the verification of which prompted further research. The aim of the study was to explore the mechanisms underlying the adaptations enabling the co-occurrence in urban areas of

two ant species considered invasive in Europe: the *Lasius neglectus* and *Linepithema humile*. The interestingly designed experimental setup used material from Spain and Poland, both from areas where both species co-occur and from areas currently inhabited by one of the species. Research has shown that the coexistence of both species may be the result of a "dear enemy" strategy, which involves limiting aggression, or a Bourgeois strategy, which involves the dominant ant monopolizing a territory. Given that these strategies can lead to the division of territories, the study concluded that the behavioral flexibility exhibited by both ant species may favor their local coexistence, thus increasing the likelihood of further "joint" expansion and the severity of the negative, cumulative impact on biodiversity in newly occupied areas.

The third article [Trigos-Peral et al. 2024. Urban abiotic stressors drive changes in the foraging activity and colony growth of the black garden ant *Lasius niger*. Science of the Total Environment 915: 170157] examined the effects of nocturnal warming and light pollution in urban habitats on foraging activity and locomotor traits in the synanthropic species *Lasius niger*. Field observations and laboratory experiments tested three hypotheses. The study showed that higher temperatures and light pollution in urban environments result in increased foraging activity of ants, that workers in urban populations are slower and less inclined to explore, and that the rate of colony growth in urban environments may be higher due to higher temperatures. An important aspect of the interpretation of the results, although requiring further research, is the suggested development of adaptation to urban conditions in urban *Lasius niger* populations.

The fourth article [Trigos-Peral G et al. 2024. Urban diet as potential cause of low body fat content in female ant sexuals. Myrmecological News 34: 181-190] assessed the impact of urbanization on the diet and fitness of *Lasius niger* ants. It was shown that ants in urban environments exhibited a preference for food with a higher carbohydrate content, likely due to the poorer composition of honeydew produced by aphids. Young queens from urban agglomerations had lower body fat reserves; however, a similar relationship was not found for workers. With some caution, hypotheses were formulated explaining that lower fat reserves in young queens may result in lower reproductive success or may be an adaptation to limit energy reserves due to reduced competition for nesting sites in urban environments.

The analysis of the articles content confirms the relevance of the Habilitation Candidate's choice of title for her main scientific accomplishment. It is important to emphasize the thematic coherence of the issues comprising the achievement. The latter is not only limited to the research object and the assessment of the impact of urbanization on animal functioning but also creates a cause-and-effect sequence aimed at explaining the research problems. The caution in formulating

scientific truths is noteworthy. The theses put forward highlight the scale of the problems requiring clarification, and the obtained results provide a solid reference point for further research.

The Habilitation Candidate's leading contribution to the publications comprising the series is unquestionable, although the nature of this contribution—presented rather generally and in a nearly identical manner—leaves some dissatisfaction. This latter result is largely due to the varying degrees of emphasis (compared to the unified formulation in the statements) on the research hypotheses themselves and the results of their verification.

The second scientific achievement falls within the mainstream of topics addressed by the Habilitation Candidate and concerns research on ant behavior. The main aspect of the research within this separate achievement is the search for factors shaping variability at the individual and colony levels. This achievement was documented by two articles, published in 2021 and 2023 in the journals 1/. Behavioral Ecology, and 2/. Insectes Sociaux, with a combined IF = 4.487, occupying an average position in the rankings [1/. Q3-2020, Q2-2021; 2/. Q3-2022, Q2-2023] for discipline areas such as entomology and ecology.

The articles are signed by 4 and 6 authors, respectively. In the 2023 publication, the Candidate serves as the lead author, serving as both the first and corresponding author. Dr. Gema Trigos Peral's contribution to the '2021' article included fieldwork, data acquisition, and participation in the creation of the first draft of the manuscript. In the case of the second article (2023), her additional contribution included data analysis and preparation of the first draft of the manuscript. The publications included in the second achievement received 24 citations, excluding self-citations (as per WoS CC, 7/03/2026).

The aim of the first publication [Maák et al. 2021. Habitat features and colony characteristics influencing ant personality and its fitness consequences. Behavioral Ecology 32 (1): 124–137] was to test the influence of habitat, colony size, worker body size, and nest density (intra- and interspecific aspects) on behavioral variability at various levels of social organization in *Myrmica rubra*. The study also aimed to determine the extent to which the above-mentioned factors influence colony productivity. It was found that habitat type does not directly influence behavioral traits, and the main factors shaping ant behavior are colony size and nest density. The authors emphasize that certain aspects of ant behavior (indirectly dependent on habitat type) indicate the importance of environmental pressure as a factor influencing colony productivity.

The study undertaken in the second publication [Trigos-Peral et al. 2023. Behavioral and morphological traits influencing variation in task performance of *Camponotus vagus* ants.

Insectes Sociaux 70 (4): 451-461] investigated the relationship between individual-level behavioral traits and task allocation in polymorphic *Camponotus vagus* workers. An attempt was also made to determine the extent to which morphological traits and worker lifespan influence task performance. It was found that behavioral traits influence the spectrum of tasks and the way workers perform them. An important observation, although requiring further support, is that differences between colony members may result in higher task performance among workers, thus positively impacting colony fitness.

Dr. Gema Trigos Peral's scientific accomplishments, presented as her main and secondary achievements, fit into the broad context of under-researched areas in ecology. Issues related to the impact of urbanization on the functioning of animal organisms have been given special prominence in her research. The results of her studies, which focused on ants as the objects of observation and laboratory experiments, shed new light on the mechanisms of insect evolutionary adaptation to conditions in urbanized environments; these findings will serve as an important reference point for assessing the impact of selected stressors, with particular emphasis on temperature and light, on other invertebrate groups. Important aspects of the Habilitation Candidate's research revolve around identifying factors that shape behavioral trait variability and exploring interactions involving invasive species. Dr. Gema Trigos Peral's scientific achievements are recognized internationally, as evidenced by back-citations. I declare that these achievements constitute a significant contribution to the development of biological sciences.

EVALUATION OF OTHER SCIENTIFIC AND RESEARCH ACTIVITIES

Dr. Gema Trigos Peral's scientific achievements are characterized by a high degree of coherence, determined not only by the research object but also by the logical interconnection of research procedures and techniques. Ecological issues are at the forefront of her work, including the impact of stressors in urban environments on ant behavior and the impact of urbanization on ant diet. Taxonomic issues remain somewhat in the background, demonstrating the Habilitation Candidate's expertise in identifying ant species.

As of the date of application submission, Dr. Gema Trigos Peral's research achievements included a total of 28 articles (22 excluding items constituting scientific achievements) published in journals indexed in the Journal Citation Reports database. All articles were published between 2016 and 2025, i.e., after the Candidate obtained her doctoral degree. The total IF of the papers (considering data available on the date of application submission) was 106,285, the total number of MEiN points was 2,370, and the Hirsch index was 9 (according to WoS, 7/03/2026). The

Habilitation Candidate's works have been cited 135 times (according to WoS CC, excluding self-citations, 7/03/2026). After excluding citations to articles that constitute scientific achievements, this number drops to 67. The number of citations is therefore relatively low, but it is worth noting that the most valuable works were prepared over the last few years, which somewhat postpones the prospect of receiving back citations. Since submitting the application to the time of this review, this number has increased by another 31 citations (according to WoS, CC, 7/03/2026, excluding self-citations).

In addition to articles published in JCR journals, the Habilitation Candidate's achievements also include two multi-authored chapters in monographs, which, for unknown reasons, were included in the list of achievements as meeting the requirement of Article 219, Section 1, Item 2a of the Law on Higher Education and Science. The Habilitation Candidate's scientific career path was linked to more than one scientific institution. The initial stages of Dr. Gema Trigos Peral's scientific activity, during her doctoral studies, were pursued at the University of Cordoba (Spain); the subsequent years of her career were associated with the Museum and Institute of Zoology of the Polish Academy of Sciences in Warsaw. Significant publication activity, evidenced by scientific achievements in indexed journals, therefore occurred after her doctorate, and her chosen career path, including joining the ranks of internationally recognized myrmecologists, demonstrates the Habilitation Candidate's professional passion and consistent pursuit of her goals.

Dr. Gema Trigos Peral demonstrates considerable activity in securing research funding. In 2019, she carried out research funded by the National Science Centre as part of the Miniatura 3 research activity. From 2020 to 2023, she was the principal investigator of a research project funded by the National Agency for Academic Exchange as part of the bilateral exchange program between Poland and Germany. In her list of research projects, the Candidate also lists the Fuga project, without specifying her role in the grant, which was led by Dr. Magdalena Witek. Dr. Gema Trigos Peral's expertise is also recognized through invitations to collaborate on numerous research projects. Her involvement in project activities has resulted in publications constituting a significant portion of the scientific achievements identified in the habilitation procedure.

Over the past few years, the Habilitation Candidate has completed a long-term research internship at the Biological Station in Seville and a short-term internship at the University of Paris. Numerous invitations to review scientific articles are a testament to the Habilitation Candidate's expertise. Throughout her career, Dr. Gema Trigos Peral has reviewed nearly 80

manuscripts of articles submitted to indexed journals. The Habilitation Candidate's active participation in national and international conferences is also noteworthy, although the list provided does not clearly indicate the conferences at which she presented.

TEACHING, ORGANIZATIONAL AND SCIENCE POPULARIZATION ACHIEVEMENTS

Achievements in the indicated areas are not formally assessed in the habilitation process. Furthermore, the opportunity to develop and thus document teaching achievements is less for individuals employed at Polish Academy of Sciences units compared to university employees. All achievements in teaching, organization, and science popularization were achieved after obtaining the doctoral degree.

According to the information provided in her self-report, Dr. Gema Trigos Peral was the second supervisor of the bachelor's thesis entitled "Interaction between invasive garden ants *Lasius neglectus* and native garden ants *Lasius niger* " at Cardinal Stefan Wyszyński University. However, this supervision was provided informally.

The Habilitation Candidate participated in the organizing committees of international myrmecological congresses three times (Taxomara 2019, 2020, 2021).

The report also includes information about serving as editor-in-chief of the journal *Insectes Sociaux* from 2024, although it is highly likely that this was the Associate Editor position, which the Habilitation Candidate reports in the English version of the self-report.

Dr. Gema Tribos Peral's achievements in the field of science popularization are worth emphasizing, as she delivered 11 lectures addressed to members of societies, scientific institutions, and universities in Poland, Spain, Hungary, and France.

CONCLUSION

Dr. Gema Trigos Peral's scientific achievements have significantly expanded since obtaining her doctoral degree. The Habilitation Candidate's achievements submitted for evaluation make a significant contribution to the development of biological sciences, and her research activity has been carried out, outside her home university, at several foreign scientific institutions.

In summary, I positively assess the scientific value of Dr. Gema Trigos Peral's achievements and declare that these achievements meet the requirements for the award of the habilitation degree, as outlined in Article 219 of the Act of 20 July 2018, the Law on Higher Education and Science.

Considering the above, I am submitting to the Scientific Council of the Museum and Institute of Zoology of the Polish Academy of Sciences an application for admitting Dr. Gema Trigos Peral to further parts of the conduit of the habilitation process in the field of exact and natural sciences, in the discipline of biological sciences.

 Podpisano przez/ Signed by:
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/Prof. dr hab. Joanna Mąkol/