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PERSPECTIVE

The challenges, opportunities and future of comparative physiology in the Global South: perspectives of early-career researchers

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ABSTRACT

Researchers in the Global South (GS, developing countries) make valuable contributions to the field of comparative physiology, but face economic and scientific disparities and several unique challenges compared with colleagues in the Global North (developed countries). This Perspective highlights some of the challenges, knowledge gaps and disparities in opportunity faced by GS researchers, especially those at early-career stages. We propose collaborative solutions to help address these issues, and advocate for promoting investment and cultural and societal change for a more inclusive research community. Additionally, we highlight the role of GS researchers in contributing expert knowledge on local biodiversity and the environment; this knowledge can help to shape the future of comparative physiology, allowing us to achieve a better understanding of the evolution of physiological mechanisms and to develop innovative solutions to environmental and biomedical challenges. With this Perspective, we hope to highlight the need to foster a more diverse, equitable and inclusive research landscape in comparative physiology; one that empowers GS scientists to address the global challenges associated with biodiversity loss, climate change and environmental pollution.

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Introduction

The concept of the Global North (GN) and Global South (GS) (Heath, 1981) categorizes countries by socioeconomic and political development, distinguishing between traditionally imperialistic nations (the GN, developed countries) and those that were colonized (the GS, developing countries; Dirlik, 2007; Odeh, 2010; Prashad, 2013). Despite criticism, this concept remains relevant in scientific research, with more research outputs and accolades from the GN, thus corroborating the connection between scientific development and geopolitical power (Corbera et al., 2016; Quijano, 2000). Similar trends of disparity are observed across scientific fields, including in the field of comparative physiology (Zupanc et al., 2024), a discipline that integrates ecology, biochemistry and genomics to understand physiological mechanisms and how they evolved (Basile et al., 2021).

In comparative physiology, there is a bias towards greater development of the discipline and increased research outputs in the GN compared with the GS (White et al., 2021; Seebacher et al., 2015; 2023), which has implications for a range of policy areas. For example, comparative physiology can provide solutions to livestock management and biomedicine (Sørensen et al., 2012; Venthur and Zhou, 2018; Little et al., 2021), and is essential for addressing challenges associated with global climate change. Emphasis on research conducted in the GN adversely affects the range of species and habitats being studied, which has important implications for global biodiversity. For example, the effects of current global anthropogenic activity may differ between organisms as a result of adaptive variation in species' physiological tolerances and responses to climate and other environmental factors, and these adaptations can vary with latitude (Huey et al., 2012; Seebacher et al., 2015). The lack of physiological data from species that inhabit biodiversity hotspots at GS latitudes may lead to biased global conservation management strategies that consider physiological traits of species studied in the GN, rather than those that experience different environmental drivers in the GS (Cooke et al., 2021; Tomlinson et al., 2022).

As well as having implications for policy, the disparities in the field of comparative physiology also affect scientists in the GS at an individual level, especially those in the early stages of their careers (Bol et al., 2023). To address the disparity between GS and GN research, The Company of Biologists recently funded a workshop entitled 'How Global South Researchers Can Shape the Future of

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Glossary

Unconscious bias

Stereotypes are preconceived notions about certain groups of people that are formed outside an individual's conscious awareness. These stereotypes can cause positive or negative bias, and such unconscious bias results in discriminatory tendencies, harmful practices and outcomes (see Storm et al., 2023, for review). Take a test to discover your biases: https://implicit.harvard.edu/implicit/takeatest.html

Scientific colonialism

The process whereby the center of gravity for the acquisition of knowledge about the nation is located outside the nation itself (Galtung, 1967).

Parachute science

The practice whereby international scientists, typically from higher-income countries, conduct field studies in another country, typically of lower income, and then complete the research in their home country without any further effective communication and engagement with others from that nation (Stefanoudis et al., 2021).

Comparative Physiology'. The workshop focused on GS early-career researchers (ECRs) and also included senior researchers from the GS and GN to discuss the challenges and opportunities for comparative physiology in the GS. This Perspective summarizes these discussions from the ECR point of view, highlighting challenges, proposing strategies that will improve equality in the field and providing a framework to decrease potential biases in the production of scientific knowledge.

Challenges to comparative physiology research in the GS

Comparative physiologists in the GS navigate a challenging research environment. Although some of these challenges are shared with GS scientists from other fields, many are unique to comparative physiology and lead to lower representation of GS comparative physiology work in the literature compared with that of GN colleagues. For example, out of the top 100 most influential authors in the *Journal of Comparative Physiology A* over the past century, only eight are women and only one is from the GS (Zupanc et al., 2024). From securing grants to publishing papers, GS researchers face economic and procedural as well as social and cultural barriers (Fig. 1).

Unique challenges specific to this discipline include the low number of comparative physiologists working in the GS; this limits networking opportunities and the formation and maintenance of local scientific societies, leading to a lack of integration among researchers (Hermes-Lima et al., 2007). Furthermore, GS governments often prioritize applied over basic research, which limits funding streams and leads to inadequate financial support and fewer job opportunities in comparative physiology (Hermes-Lima et al., 2008). This lack of investment stifles scientific innovation, knowledge generation and impact. It also drives immigration from the GS to the GN, perpetuating the cycle of underdevelopment (Zenteno-Savín et al., 2007; Paiva et al., 2017; Lopez-Verges et al., 2021).

Additionally, comparative physiologists frequently require specialized instruments that are often manufactured in the GN. Import fees, unfavorable exchange rates, shipping and lengthy procurement processes can significantly inflate the cost and time needed to acquire these tools in the GS, leading to a disparity in resource access between the two regions. In some GS countries, delivery can take several months and 15–30% must be added to the cost of obtaining equipment and reagents to cover import and shipping costs; for example, recently in India, import tax on some lab chemicals increased by 150% (authors' experience). All these challenges place further strain on budgets and perpetuate reliance on GN partners, reinforcing a cycle of scientific colonialism (see Glossary; Utset, 2023). In addition to specialized equipment, many comparative physiology studies require field data/sample collection (Navas and Freire, 2007). However, permitting procedures, laboratory infrastructure and technical support in many GS countries are still being developed. The inefficiency of regulatory agencies results in convoluted bureaucracy that must be navigated to obtain permits for field work and sample export, which influences collaboration opportunities (Alexander et al., 2021).

As well as meeting the challenges that are particular to their field, GS comparative physiologists are faced with many of the same issues that affect other GS scientists. For example, language barriers, publication processes and fees further limit knowledge access and the visibility of GS science (Vasconcelos et al., 2008; Beiter, 2023). Not all GS researchers are proficient in English, which hampers collaboration and the dissemination of research findings (Nuñez et al., 2019). Despite the availability of AI translation tools, which translate and copy-edit manuscripts, a basic knowledge of English is still necessary for proper communication of scientific results. Additionally, the GS is often under-represented in influential positions within academic journals, international societies and global decision-making entities (Dada et al., 2022; Hughes et al., 2023). Editors and reviewers, who are mostly from the GN, may unintentionally favor research(ers) from familiar institutions as a result of unconscious bias (see Glossary; Smith et al., 2023), perpetuating disparities in visibility and further limiting opportunities for GS scientists (Nuñez et al., 2019). It should also be noted that cultural and historical biases in the GS can act as systemic barriers that undermine minorities and under-represented groups (Field and Rajewski, 2021; Gewin, 2021; Fitzgerald-Russell and Kowalske, 2023; Fox Tree and Vaid, 2022; Maas et al., 2021; Maxwell et al., 2019), highlighting the importance of addressing these visibility issues. Considering the complexity of the challenges, we present a summary of individual and organizational actions that should be taken to promote an inclusive research landscape that empowers and promotes GS comparative physiologists (Fig. 2).

Opportunities for comparative physiology research in the GS

Despite the challenging research environment in the GS, these regions also provide unique research opportunities. The difficulties associated with accessing funding and equipment necessitate innovative thinking: researchers can generate solutions that – although not state-of-the-art – allow research to continue and meaningful data to be collected (e.g. Haim et al., 1990; Diele-Viegas et al., 2018). This problem solving builds capacity, develops multidisciplinary skills and often leads to new insights into the study system. It fuels a culture of innovation, entrepreneurship and grassroots initiatives that can drive impactful change. For example, because of a lack of appropriate equipment, researchers in Peru developed an indirect calorimetry system to measure greenhouse gas emissions and energy metabolism in alpacas. This innovative approach filled a critical gap in the available research tools and generated data to inform national emissions inventories. It has been the driver of impactful change for animal production practices for an economically important species in rural Andean communities (Rios Rado et al., 2023).

Hotspots of biodiversity and endemism are primarily located in the tropics and, therefore, within GS countries (MEA, 2005).

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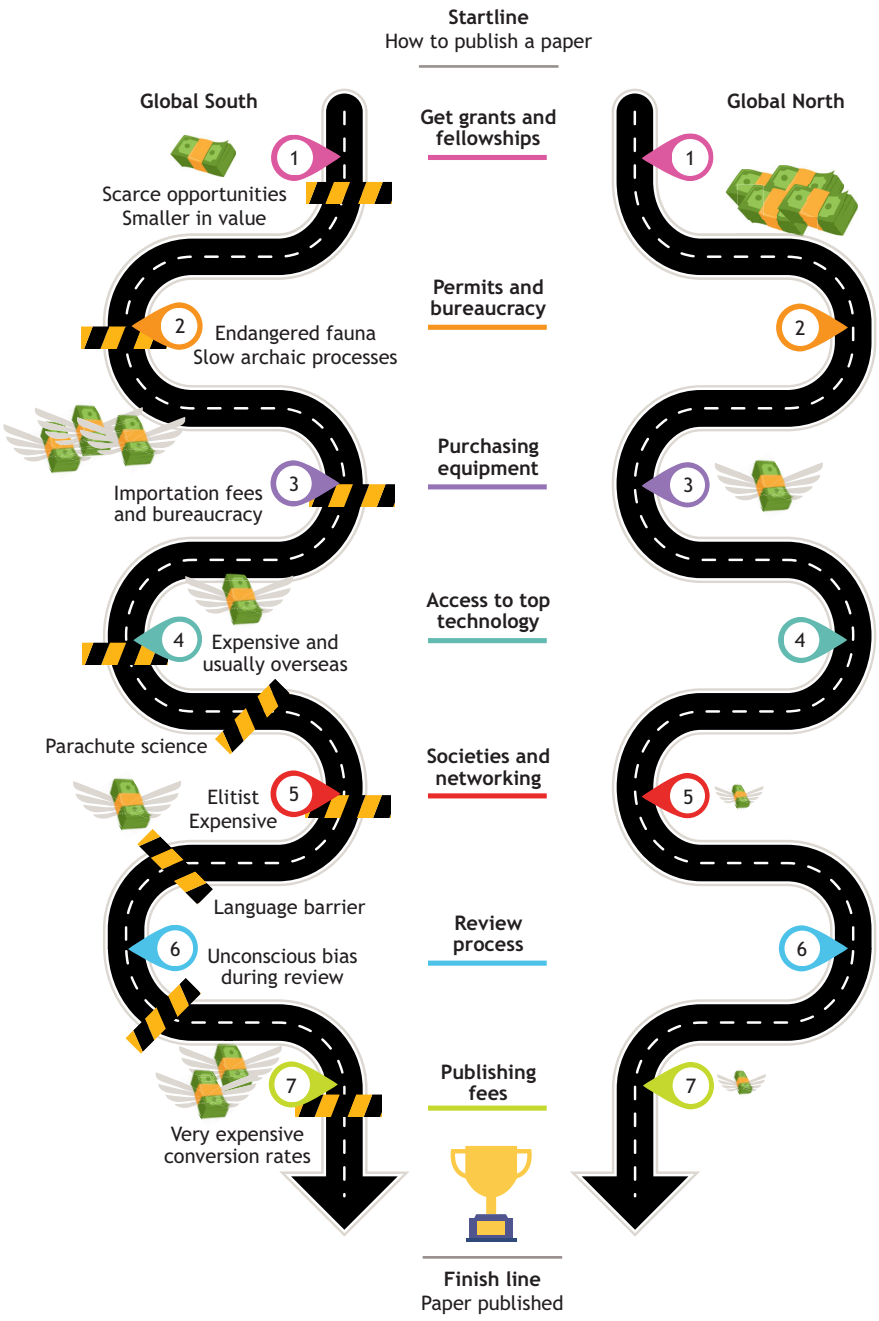

Fig. 1. Publishing challenges faced by researchers in the Global South (GS) versus the Global North (GN). (1) GS researchers have limited grants and fellowship opportunities. (2) Lengthy permitting processes and inefficient bureaucracy extend research time frames in the GS. (3) Unfavorable exchange rates and import fees inflate costs and extend time frames for procurement of equipment in the GS. (4) The GS lacks funding and infrastructure, reducing access to new technology. (5) The lack of GS comparative physiology societies forces researchers to attend costly international conferences, requiring them to comply with visa requirements that are expensive and time consuming. (6) Language barriers limit dissemination of research, and the unconscious bias of GN editors/reviewers limits GS research visibility. (7) Prohibitive costs associated with publishing fees and access to journal content further limit GS visibility.

Furthermore, some habitats in the GS are less disturbed by human influences than those in the GN, offering unique opportunities to study animals in more ‘intact‘ ecosystems (Hannah et al., 1994, 1995; Kennedy et al., 2019). From a physiological perspective, this provides opportunities for groundbreaking scientific discoveries and studies that broaden our understanding of physiological mechanisms across species. Understanding physiological variation and plasticity is essential to determining species’ vulnerability in the Anthropocene (Cooke et al., 2013). Although model animals can yield useful insights into broader physiological mechanisms, desert and tropical GS ecosystems and species represent unique opportunities to investigate the resilience and vulnerability of species in a changing world (Krogh, 1929; Wang et al., 2007). Tropical species seem more vulnerable to global warming than temperate ones (Vinagre et al., 2019), and the unpredictable frequency of warming events in the tropics is expected to influence/affect the survival of these species. Thus, organisms that are endemic to the GS represent an important opportunity to focus research efforts (Vinagre et al., 2016). Improving our knowledge of GS species would also allow a more thorough comparison across different regions, which could provide important insights into animal function, given the substantial variation in environmental conditions and species physiology.

Additionally, the GS has a large proportion of threatened and endangered species, making the study of comparative physiology in the GS an urgent conservation issue. For example, hotspots of human impact on ecosystems and declining populations of specific taxa have been identified in southeastern Asia, South America and Africa, whereas North America and Europe show more optimistic signs of population recovery (Allan et al., 2019; WWF, 2022). The

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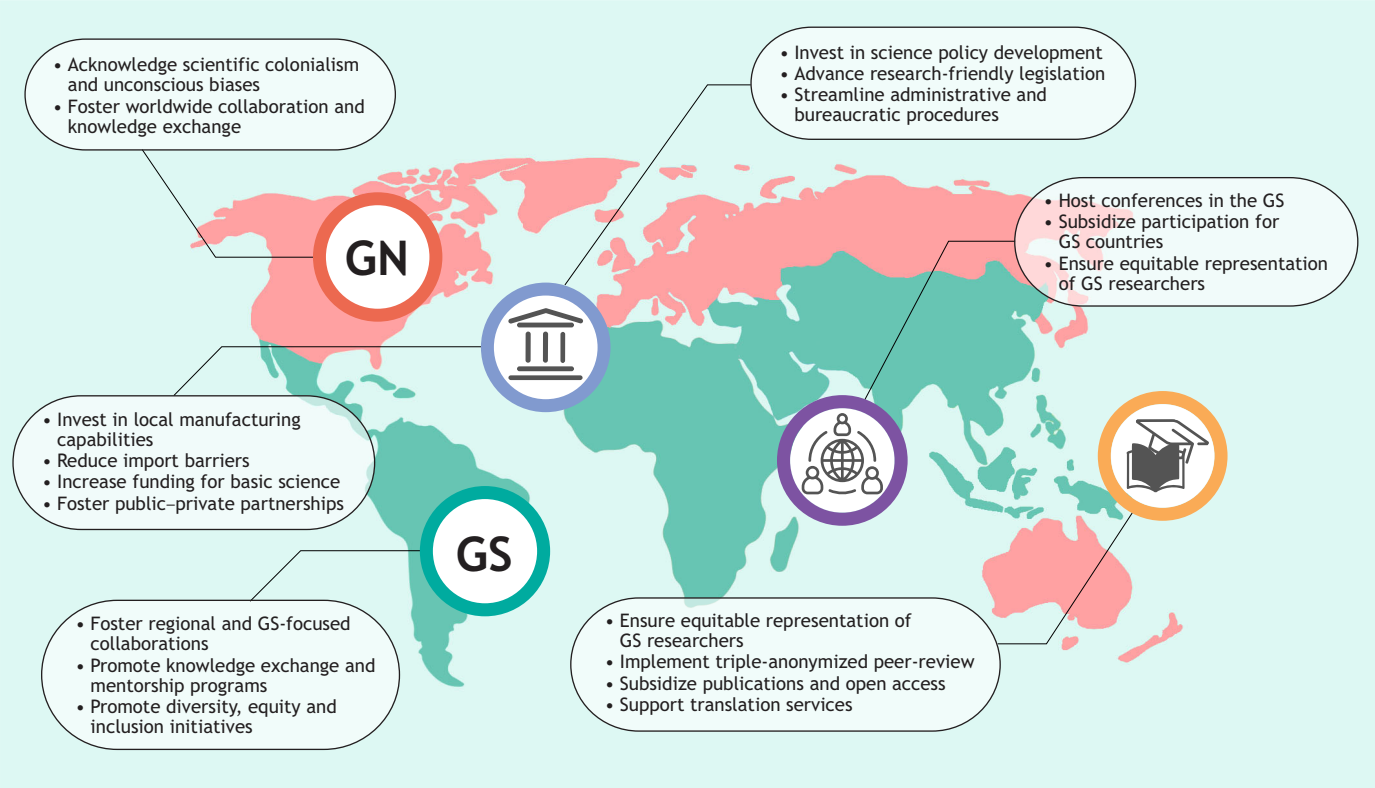

Fig. 2. Recommendations for individuals and organizations to support comparative physiologists in the GS and promote a more equitable research landscape. Red icon, actions for GN scientists. Green icon, actions for GS scientists. Blue icon, actions for GS government agencies. Purple icon, actions for scientific societies and conference organizers. Orange icon, actions for journals and editors.

clock is ticking for GS biodiversity, and physiological studies are paramount to addressing issues of conservation concern.

The current challenges for biodiversity are considerable, and addressing them requires collaborative and inclusive research coordinated between the GS and GN for the benefit of global biodiversity and to inform appropriate conservation actions (Asase et al., 2022). Equitable collaboration between GS and GN scientists can result in impactful research, with GS researchers bringing expert local knowledge of biodiversity and environments, and an understanding of cultural and social perspectives, while the GN has greater access to specialized equipment and funding (Haelewaters et al., 2021; Nakamura et al., 2023). Furthermore, collaborative research projects highlighting GS scientists would help restore equity in historical power imbalances in research (Miller et al., 2023; Ocampo-Ariza et al., 2023).

Approaches to support ECRs

The GS offers exciting and diverse research opportunities for ECRs, as a result of its hotspots of biodiversity (discussed above), coupled with unexplored geographic and taxonomic landscapes (Di Marco et al., 2017). Also, the need to develop conservation and management plans provides enormous potential for comparative physiology expertise in this region. However, shifts in the academic landscape driven by technological advances, and societal, cultural and institutional parameters, along with very few job opportunities can be overwhelming to navigate, even for ECRs in the GN (Bandichhor et al., 2023). In this research climate, it is essential to provide resources that support ECRs in the GS in order to foster inclusivity, academic growth and leadership in the field of comparative physiology (Table 1).

To promote professional development, improve scientific visibility and support more equitable representation in the scientific environment, the participation of GS ECRs in peer review and editorial processes should be encouraged (Ainsworth, 2019). Furthermore, government-independent funding opportunities targeting researchers from the GS, such as those provided by non-governmental organizations, philanthropic foundations and societies, would help to ensure continuity and development of independent research despite potential socio-economic instabilities. To improve networking and collaboration opportunities, agencies, societies and private and public enterprises could offer research and training grants, exchange programs, visiting fellowships and funding for publication fees that are dedicated to GS researchers (Jackson et al., 2022; Inouye et al., 2020) (Table 1). The opportunity to work in diverse and collaborative environments is crucial for ECRs in supporting the development of personal, research and professional skills.

Building a community that is more diverse, equitable and inclusive of under-represented groups and minorities is essential to boost innovation and provide a wider range of perspectives and experience to the field, especially for ECRs (Carroll et al., 2022). The transition from ECRs to independent researchers could be facilitated by mentorship, targeted fellowships and collaborative peer network platforms (Santucci, 2004). Such programs can serve as channels for open, positive communication and multidirectional interactions, where ECRs can discuss issues related to their career development in low- and middle-income countries (e.g. FRiENDs: Pegg et al., 2015; the Ford Foundation Postdoctoral Fellowship for Minorities: National Research Council, 2006; FIRST: Eisen and Eaton, 2017). Additionally, these peer networks can provide a

Table 1. Overview of challenges, requirements, benefits and supporting bodies needed to address some of the obstacles to early-career researchers in the Global South

Challenges	Solutions	Benefits	Proposed supporters
Networking and mentorship opportunities	GS ECR-led independent research opportunities	Profile ECRs from the GS	International societies, continent- and country-specific funding agencies, philanthropic organizations, private enterprise and industry
	Increase the number of travel awards to attend workshops, conferences and training events	Improve representation of GS ECRs at international events regardless of exchange rates	Organizations, private enterprise and industry
	Host networking, mentorship, conferences, workshops and training events in the GS	Inclusive of GS ECRs; facilitates knowledge exchange to GN researchers; skills transference to GS researchers; reduces parachute science (see Glossary); gives access to GN mentors and collaborators; gives opportunities for both GS and GN research; generates awareness of local research initiatives; gives GN researchers first-hand experience of GS challenges and solutions	Local, national and international societies
Capacity building and skills transference	Collaborative workshops with a focus on grant writing, project and financial management, research, technical skills development, expansion of ECR databases	Places GS ECRs on a more equal footing in terms of project management and grant applications; develops specialized skills for research, training and capacity building	Research institutes, academic institutions, government departments, industry
Fellowships and exchange programs	Well-resourced international institutions ideally situated to host GS ECRs	Gives opportunities for international collaboration, mentorship, exchange of ideas and skills transference	GN-based research institutions, academic institutions and governments
Publication support	Access to English translation and editing services at affordable exchange rates	Ensures high quality, competitive manuscripts for publication from GS researchers	Journals and publishing bodies, particularly those based in the GN

ECR, early-career researcher; GN, Global North; GS, Global South.

platform for ECRs to connect and share expertise, equipment and opportunities associated with GS research (Table 1). These supporting strategies would strengthen ECRs' professional development and motivation, while allowing them to develop international collaborations that increase the visibility and impact of comparative physiology research in the GS. Additionally, support for technical training to upskill and increase expertise, as well as tailored career guidance for overcoming challenges with career progression, would help improve the representation of minorities and under-represented groups in science (Brizuela et al., 2023; Marshall et al., 2022).

Conclusion and future directions

The unique challenges faced by GS researchers, especially by ECRs, can be overwhelming. Despite these barriers, GS researchers clearly make valuable scientific contributions. Comparative physiology in the GS holds immense potential: GS researchers are well placed to lead multidisciplinary and multi-continental collaborations investigating the physiology of non-model organisms, resulting in innovative solutions to pressing environmental and biomedical challenges. For this potential to be realized, we strongly recommend the creation of a robust GS comparative physiology society that could provide technical and professional support and skills development, as well as networking and collaboration opportunities for GS scientists. We encourage our GN colleagues to help address these imbalances and inequalities by fostering equitable collaborations, and we suggest that GS colleagues in other regions should be vocal in highlighting their challenges. As a more diverse, equitable and inclusive landscape of comparative physiology research emerges, we hope to address the knowledge gaps associated with the unique environmental challenges faced by the GS.

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Competing interests

The authors declare no competing or financial interests.

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