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Navigating the 'Anthropocene': Trends and opportunities in modern organismal biology

Significance:

In this Perspective, we reflect on the rich history of organismal biology in South Africa, particularly focusing on the manuscripts submitted to the *South African Journal of Science (SAJS)*. Some of our discussions highlight the evolution of organismal research in South Africa and its significance within the South African scientific community. A key contribution of this piece is its exploration of submission trends in *SAJS* and the identification of pressing research needs for the Journal. We also emphasise areas that warrant further investigation that could enhance the field of organismal biology.

An overview of organismal biology in South Africa

South Africa boasts extraordinary levels of biodiversity and endemism relative to many other countries worldwide.^{1,2} This diversity results from the country's unique habitats and a wide range of climatic zones and biomes, such as the beautiful Nama Karoo of the Northern Cape, the Savanna of the Limpopo, the humid coastal Mediterranean climates that boast of fynbos, and many others. Many European settlers and explorers in the 17th and 18th centuries recorded the region's diverse flora and fauna, laying the foundation for future scientific studies. These early records, primarily by nature enthusiasts, formed a baseline of how the region looked before the Anthropocene period. Most research was centred around natural history, behaviour, and species composition during this period.

With the rise of modernisation and industrial development, scientific research in South Africa saw notable advancements in organismal biology. The establishment of scientific journals like the *South African Journal of Science (SAJS)* in the early 1900s is a testament to the growth of scientific research in general. The late 19th and early 20th centuries saw the establishment of vital scientific institutions that advanced organismal biology. Similarly, when one thinks about the establishment of museums and various botanical gardens, such as the Kirstenbosch National Botanical Garden, one can see how these institutions provided crucial infrastructure for biological research. The University of Cape Town and other universities began offering programmes in biological sciences, fostering local expertise. The early 20th century saw the burgeoning of iconic wildlife protection areas such as Kruger National Park, Addo National Park, and many others, to protect against overexploitation of the dwindling wildlife.

Most documented organismal biology research during the early colonial period was conducted by researchers, enthusiasts, and explorers of British descent. However, South African universities, such as the Mammal Research Institute/Zoology at the University of Pretoria, the Botany Department at the University of Cape Town, and departments at the University of KwaZulu-Natal, were already conducting world-class research in Zoology and Botany well before 1994, despite being non-transformed.

After 1994, when South Africa became a democracy, scientific research in South Africa underwent significant transformation, with a new focus on addressing past inequities. This shift led to accelerated growth in both the quality and quantity of research, bolstered by increased international collaboration and improved funding. While researchers in South Africa had already begun engaging in global scientific discourse prior to 1994, this engagement expanded further post-apartheid, and many more of the country's top experts in ecology, conservation, and biodiversity are now recognised as leaders in their fields worldwide.

Despite this meteoric rise in biological research over the past century, the impacts of human activities have equally accelerated, primarily due to population growth and urbanisation. Consequently, there has been a shift in ecological research from exploratory and natural history studies to understanding the effects of climate change, habitat destruction, and invasive species on local biodiversity and ecosystem functioning. Furthermore, the country's unique position as a biodiversity hotspot, particularly in regions like the Cape Floristic Region, has driven research on conservation and sustainable management of natural resources.

The history of organismal biology in South Africa reflects the country's broader social and political changes. From its early beginnings to its current focus on addressing the challenges of the Anthropocene, the discipline has become a vital component of South Africa's scientific landscape. With its rich biodiversity and dynamic research community, South Africa continues to contribute significantly to our understanding of the origins of life on Earth.

An overview of submissions in Organismal Biology

As one of the authors (S.M.) is the *SAJS* Associate Editor for Organismal Biology, we have chosen to focus on submissions to *SAJS* during his tenure (2019–2024). These submissions have been on various topics and in various sub-disciplines of organismal biology (see Table 1). Below we give an overview of some of these submissions, highlighting those papers that were not handled jointly with other *SAJS* Associate Editors.

In this time, papers in the Organismal Biology portfolio have spanned the fields of ecology, conservation, environmental sciences, evolution, behaviour, genetics, and biodiversity. A paper in genetics utilised DNA-based methods to study zooplankton diversity in South African ecosystems.³ Similarly, some papers have shown how metabarcoding can give insights into South Africa's rich insect biodiversity.⁴ In ecology, research articles include one on an investigation into the impact of environmental factors on species distribution and population dynamics. Other studies have explored the genetic basis of adaptation and speciation in different organisms – for instance,

Table 1: Papers submitted to *SAJS* within the Organismal Biology, 2019–2024

Discipline	2019	2020	2021	2022	2023	2024
General ecology [†]	6	2	5	2	3	1
Behavioural ecology	0	0	0	0	0	0
Conservation & environmental sciences	2	0	2	1	1	0
Genetics & evolutionary biology	0	0	0	1	0	1
Manuscripts submitted	11	11	9	2	5	7
Articles published	8	2	7	4	4	2

[†]Includes organismal, population, community, and landscape ecology

Mungenga et al.⁵ collected data on insecticide resistance in various mosquito species. In the environmental sciences, research papers included the impacts of pollution, water quality, climate change, and land use changes on diverse South African ecosystems. For instance, some researchers⁶ explored the potential of using biochar to lessen the harmful effects of sewage effluent.

Some researchers⁷ studied land use changes in rural landscapes of South Africa and showed how vegetation cover changes could affect societies and biodiversity in South Africa. Other key contributions include a paper in which researchers used a novel method to provide spatially explicit information on ecosystem assets and their services to support natural resource management.⁸ Findings from studies that assess ecosystem services are useful because they inform ecosystem management and restoration efforts in South Africa and Africa. To a lesser extent, papers in anatomy and physiology have included those on the physical structure and form of organisms, including comparative anatomy across species or within a specific group. In a research paper published in 2022, Rossouw⁹ comparatively studied anatomical differences in two subspecies of springbok. Several manuscripts on behavioural ecology (see Table 1) included analysis of the behaviour of organisms in their natural environments, such as the mating behaviour, social structure, and foraging strategies of organisms. While these manuscripts were subsequently rejected after review, this field could contribute significantly to *SAJS*.

In the environmental sciences, very few studies have been submitted that assess strategies for sustainable resource management. Further, the Organismal Biology portfolio has not received reviews discussing emerging ecological monitoring and remediation technologies. It is also worth noting that very few interdisciplinary research studies have been submitted during the period 2019–2024. First, there is a dearth of collaborative projects bridging multiple disciplines, such as bioinformatics, biophysics, and computational biology. Second, articles exploring the interface between biology and other fields, including engineering, computer science, and social sciences, would be very welcome. Third, studies that integrate empirical data with modelling approaches to address complex organismal questions are also warranted in the Journal. Fourth, reviews synthesising knowledge from diverse disciplines to tackle global challenges like infectious diseases, climate change, and food security are also scanty. Last, within conservation biology, *SAJS* received a few submissions addressing conservation issues related to organisms, biodiversity and conservation strategies, threats to species, and conservation management practices. Conservation biology may be needed in organismal biology in *SAJS* (see comments below).

Though over a decade old, the seminal work of Schwenk et al.¹⁰ still rings true, as they identified five grand challenges facing the field of organismal biology. While I do not have time to delve into all the details of everything contained in Schwenk and collaborators' paper, the paper does highlight five key needs in organismal biology: (1) the need to unravel the role of organisms in their environment, (2) the need to study the functional diversity of organisms, (3) the need to integrate living

and physical systems in analyses of biological systems, (4) the need to understand how genomic changes create various phenotypes, and (5) understanding how organisms shift between stability and change in various ecosystems. *SAJS*, in terms of all the submissions received, still needs more submissions that study how genomes shape and produce new phenotypes in populations. As such, studies investigating how genes and genomes produce various complex phenotypes in African ecosystems are expedient.

During the 2019–2024 period, most biology papers submitted to the *SAJS* were primarily focused on South Africa, both in terms of the authors and the scope of the research. Overall, during this time, the Organismal Biology portfolio at *SAJS* reflects a commitment to advancing scientific knowledge across a broad spectrum of topics, fostering interdisciplinary collaboration, and promoting high-quality research with real-world applications.

The future of the field in South Africa and Africa

On the future of organismal biology in South Africa

In South Africa, organismal biology is a cornerstone of scientific inquiry, embracing diverse branches such as ecology, evolutionary biology, wildlife biology, biogeography, population ecology, and conservation. This expansive field is indispensable for unravelling the complexities of biodiversity, from the genetic level to entire ecosystems. Given our limited knowledge of Earth's biodiversity and the intricate relationships within natural ecosystems, there is no room for complacency – nature is perpetually in flux, and what we hold as true today may not stand tomorrow, especially in our era of rapid climate change and its profound effects on ecosystems and species.

Consider the plight of an emblematic species like the African elephant, whose migratory patterns are increasingly disrupted by shifting rainfall patterns and human encroachment. Without the meticulous work of conservation biologists, our understanding of these changes and how to mitigate their impacts would be severely limited. If this is the case for the elephant, how about less emblematic species such as amphibians, small mammals, reptiles, invertebrates, and countless microorganisms? Their essential roles in ecosystem health, encompassing functions, interactions, and vulnerabilities, frequently escape notice. Two decades into the 21st century, E.O. Wilson's poignant observation remains relevant: less than 1% of all named species have been studied beyond basic habitat preferences and diagnostic anatomy.¹¹

This glaring knowledge gap underscores the pressing need for intensified research efforts in conservation biology. The urgency cannot be overstated. This field offers insights into addressing critical challenges such as species extinction, habitat degradation, fragmentation, and the complex impacts of climate change. This work is not merely about preserving Africa's unique ecological heritage; it is also about safeguarding livelihoods and guiding sustainable development in South Africa and across the continent.

Advancing the relevance of organismal biology

Several critical actions must be prioritised to amplify the influence and impact of organismal biology in South Africa and beyond. First, imagine a world where every species or ecosystem is meticulously monitored from space, and vast data sets are analysed in minutes instead of years. This is not science fiction; it is the reality that advanced technologies like satellite imaging and artificial intelligence (AI) can bring to conservation biology. We can enhance our understanding of ecosystem dynamics and species interactions by allocating resources to support cutting-edge research in genetics, remote sensing, and modelling techniques. For instance, AI can automate the analysis of camera trap images or acoustic recordings, identifying species and uncovering patterns in ecological data that might otherwise go unnoticed.

Second, the future of conservation biology rests with South Africa's young, tech-savvy generation. Imagine passionate students, guided by experienced mentors, venturing into the field to study endangered species and pioneer solutions for harmonious human-wildlife coexistence. These youths bring fresh perspectives and a deep commitment to environmental stewardship. To empower this next generation of conservation biologists,



robust academic programmes, mentorship initiatives, and hands-on field experiences are essential. However, achieving this vision is hindered when millions of young people in South Africa have never visited a national park. By engaging and inspiring young people in conservation efforts, we steer the interest and nurture future scientists and policymakers dedicated to environmental sustainability.

Third, fostering the relevance of conservation biology requires a harmonious blend of policy integration and community engagement. Imagine a roundtable where researchers, policymakers, and local community members unite to make inclusive decisions about research priorities, conservation approaches, and strategies. Strengthening these partnerships is crucial for ensuring that conservation efforts are equitable and effective. Incorporating local knowledge and community perspectives into research, planning, and policymaking promotes social equity and enhances the practical application of research and conservation insights.

Last, the investment and promotion of frontier research are increasingly crucial in conservation biology, especially in an era that prioritises the immediate applicability of scientific findings over exploration for the sake of discovery. We must purposefully support and invest in biological research that pushes boundaries. As Neil deGrasse Tyson once emphasised, while such discoveries may not yield immediate benefits today or in the foreseeable future, many innovations we enjoy today originated from what was once frontier research in past decades.

Critical research needs in Africa for ecology, conservation, and biodiversity

Critical research needs in Africa for ecology, conservation, and biodiversity encompass several essential areas. While substantial cutting-edge research is already being conducted on these topics, including significant contributions by African researchers, there remain critical research needs in Africa for advancing ecology, conservation, and biodiversity. First, there is a continuing pressing need to assess and monitor species diversity and ecosystem health using advanced methodologies such as remote sensing, DNA barcoding, and machine learning. Understanding the impacts of climate change on species distribution and ecosystem dynamics is crucial, as well as identifying and protecting critical biodiversity hotspots and corridors. Research on the interactions between invasive species and native flora and fauna is vital for developing effective management strategies.

Additionally, socio-ecological research integrating local knowledge and community engagement is essential for creating sustainable policies addressing human impacts and promoting biodiversity conservation. Collaborative efforts to build robust data-sharing platforms and comprehensive databases are also necessary to effectively support regional and global conservation efforts. These research needs, while already being addressed to some extent by ongoing studies in South Africa and other parts of Africa, require continued focus and expansion to fully enhance Africa's capacity to conserve its diverse biological heritage and promote sustainable development across the continent.

Final musings from the SAJS Associate Editor

As an Associate Editor of SAJS (S.M.), I see a significant rise in organismal research in South Africa, which speaks to the Journal's success over the last 120 years. I am happy to be part of this process and am grateful to all the authors (and reviewers) whose contributions to organismal biology have made this Journal what it is today. Many of my

invited contributors have raised essential suggestions and perspectives about organismal biology and conservation in South Africa, with which I fully agree. I would also like to mention that journal editors and reviewers at SAJS continue to contribute extensively to the journal's growth. We achieve this through the review process and by being constructive, polite, respectful, friendly, rigorous, and timely. As an Associate Editor, I aspire to uphold these standards, whether asking authors for revisions, gently declining their work, or congratulating them on their exemplary contributions. In addition, as an interdisciplinary journal, the SAJS publishes articles palatable to a broad audience. Even though we publish articles for a wide audience, we seek methodologically sound articles that contribute to South African and African knowledge. I am excited and enthused to be a part of SAJS as it grows as an interdisciplinary journal and continues to publish quality research.

Declarations

S.M. is the SAJS Associate Editor for Organismal Biology. There are no competing interests to declare. There is no AI or LLM use to declare. All authors read and approved the final version.

References

1. Nicolau GK, Edwards S. Diversity and endemism of southern African gekkonids linked with the escarpment has implications for conservation priorities. *Diversity*. 2023;15(2), Art. #306. <https://doi.org/10.3390/d15020306>
2. Driver A, Sink KJ, Nel JL, Holness S, van Niekerk L, Daniels F, et al. National Biodiversity Assessment 2011: An assessment of South Africa's biodiversity and ecosystems. Synthesis report. Pretoria: South African National Biodiversity Institute and Department of Environmental Affairs; 2012.
3. Huggett JA, Groeneveld JC, Singh SP, Willows-Munro S, Govender A, Cedras R, et al. Metabarcoding of zooplankton to derive indicators of pelagic ecosystem status. *S Afr J Sci*. 2022;118(11/12), Art. #12977. <https://doi.org/10.17159/sajs.2022/12977>
4. Stewart RD, van der Bank M, Davies TJ. Unveiling South African insect diversity: DNA barcoding's contribution to biodiversity data. *S Afr J Sci*. 2024;120(5/6), Art. #16448. <https://doi.org/10.17159/sajs.2024/16448>
5. Munchinga G, Oliver SV, Lobb LN, Mazarire TT, Sekgele W, Mashatola T, et al. Malaria risk and receptivity: Continuing development of insecticide resistance in the major malaria vector *Anopheles arabiensis* in northern KwaZulu-Natal, South Africa. *S Afr J Sci*. 2022;118(3/4), Art. #11755. <https://doi.org/10.17159/sajs.2022/11755>
6. Dlamini NP, Otomo PV. Use of biochar to improve sewage sludge quality in Maluti-A-Phofung Municipality, South Africa. *S Afr J Sci*. 2024;120(5/6), Art. #15521. <https://doi.org/10.17159/sajs.2024/15521>
7. Mogonong BP, Fisher JT, Furniss D, Jewitt D. Land cover change in marginalised landscapes of South Africa (1984–2014): Insights into the influence of socio-economic and political factors. *S Afr J Sci*. 2023;119(7/8), Art. #10709. <https://doi.org/10.17159/sajs.2023/10709>
8. Taljaard S, van Niekerk L, Adams JB, Riddin T. Advancing ecosystem accounting in estuaries: Swartkops Estuary case study. *S Afr J Sci*. 2023; 119(3/4), Art. #14303. <https://doi.org/10.17159/sajs.2023/14303>
9. Rossouw L. Morphological variation in the distal phalanges of the springbok, *Antidorcas marsupialis* (Zimmermann, 1780) (Mammalia: Bovidae). *S Afr J Sci*. 2022;118(3/4), Art. #10452. <https://doi.org/10.17159/sajs.2022/10452>
10. Schwenk K, Padilla DK, Bakken GS, Full RJ. Grand challenges in organismal biology. *Integr Comp Biol*. 2009;49(1):7–14. <https://doi.org/10.1093/icb/icp034>
11. Wilson EO. Editorial: On the future of conservation biology. *Conserv Biol*. 2000;14(1):1–3. <https://doi.org/10.1046/j.1523-1739.2000.00000-e1.x>