





Peer-reviewed research based on the relationship between South African cultures and biodiversity



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Understanding past and present relationships of traditional cultures with biodiversity through biocultural research can help inform inclusive conservation policy and planning in a country seeking to undo past injustices such as South Africa. This review of 326 articles published between 1990 and 2019 maps the methodology employed in biocultural research, the focus of this research niche, ethical conduct and research recommendations to understand the state of biocultural research and make recommendations for biocultural research that is representative of South Africa's diverse cultural landscape. This systematic review of original research articles indexed on the Scopus database found South African biocultural research to exclude Swati and Ndebele cultures while having an unevenly strong focus on plants, human health sciences, rural areas, and three of the country's nine provinces. Some of this unevenness is likely because of utility of plants in human health and association of traditional practices with rural areas. Using a systematic review approach for this study not only ensured replicability but it also introduced a limitation of the results only being applicable to peer-reviewed articles indexed on the Scopus database.

Conservation implications: Biocultural research's strong focus on utilitarian use could encourage conservation policy that favours utilitarian use of wildlife. An even focus in biocultural research is recommended to avoid the knowledge pool for conservation policy being mostly focussed on utilitarian value.

Keywords: biodiversity; biocultural diversity; cultural diversity; cultural anthropology; ethnobiology; indigenous knowledge systems; integrative conservation; sustainability.

Introduction

South Africa's overarching conservation policy encourages consideration of traditional cultural practices and knowledge systems in conservation decision-making (South African Government 1998). Despite this inclusive overarching environmental policy, there are still concerns about inclusivity of the environmental sector in post-apartheid South Africa (Leonard 2013). The inclusion of traditional cultural practices and knowledge systems in conservation policy can be informed by biocultural research – investigations of traditional cultures' relationship with biodiversity (Maffi 2005). South Africa has many cultural practices that are based on wildlife (Department of Environmental Affairs 2015), and conservation in a place of high cultural diversity requires an understanding of cultures (IPBES 2018). Improved understanding of wildlife-based cultural practices improves knowledge of human activities that impact wildlife conservation (Phaka 2020). Biocultural research informs wildlife conservation policy by providing improved understanding of the connection between biodiversity and cultures and the related feedback mechanisms (Bridgewater & Rotherham 2019), and consideration of local communities' environmental perspectives (Cocks & Wiersum 2014). Conservation policy that is informed by research into biodiversity's relationship with cultures often considers benefits for people's cultures in addition to benefits for human wellbeing and biodiversity protection (Gavin et al. 2015). Linguistic diversity is often used as a proxy for diversity of cultures (Manne 2003). In South Africa's case, for example BaPedi (people of Pedi culture) speak the SePedi language, and the word Pedi is often used in reference to both the people and their language, while SePedi is used in reference to both the language and culture of BaPedi.

Biocultural research was inspired by an interest in the complex relationship between biodiversity and cultures (also called biocultural diversity) beyond their co-occurrence (Cocks & Wiersum 2014; Maffi 2005). The co-occurrence of biodiversity and cultures is a global phenomenon (Moore

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Note: Additional supporting information may be found in the online version of this article as Online Appendix 1 and Online Appendix 2.

et al. 2002), and many high biodiversity countries also have high linguistic diversity (Gorenflo et al. 2012; Harmon 1996). The African continent, in comparison to the rest of the world, has a high concentration of this biocultural diversity, and South Africa is in the mid-to-high categories of countries harbouring this diversity (Loh & Harmon 2005). The biocultural diversity concept and biocultural approaches in general recognise relationships between biodiversity and cultures while placing differing amounts of emphasis on ecological or anthropological contexts (Merçon et al. 2019). Cultures in the context of biocultural diversity refer to complex value-practice systems relating to how people live with and give meaning to biodiversity (Cocks & Wiersum 2014). The relationship between biodiversity and cultures was highlighted by international conservation discourse around the 1990s (Maffi 1999). The successful management of fisheries using biocultural approaches in collaboration with the indigenous communities of Canada and New Zealand (Stephenson et al. 2014) provides an example of the usefulness of biocultural research for conservation policy. The inextricable link between the two phenomena means the future of high biodiversity regions is generally linked to the future of the indigenous communities (FPP 2016).

Biocultural research, as argued by Maffi (2005), was a new field of investigation in comparison to fields such as conservation biology, and to understand the extent of this policy-informing research requires a review of relevant literature (Phaka 2020). This biocultural research can inform conservation planning by improving understanding of relationships between biodiversity and cultures (Maffi 2005). Reviewing biocultural literature can highlight gaps in our understanding of how cultures and biodiversity interact. When those gaps are filled, conservation policy will be better informed about human-related aspects of conservation. South Africa's high biodiversity (Mittermeier, Gil & Mittermeier 1997), the country's multiple cultures that are interacting with this biodiversity (Department of Environmental Affairs 2015), and its overarching environmental law that encourages consideration of traditional cultural practices in conservation policy (South African Government 1998), make it ideal for biocultural research. This suitability of South Africa for biocultural research is because of the known yet understudied relationship between biodiversity and cultures (Department of Environmental Affairs 2015), and policy that provides for the integrative conservation approaches (South African Government 1998) which are often recommended in biocultural research. South African biocultural research has not been synthesised to understand its current state, thus the current review study aims to provide an understanding of this knowledge pool. Objectives of the study were to: (1) systematically review the content of biocultural research articles (i.e., research that is based on the recognition of a relationship between biodiversity and cultures) focussed on South Africa, (2) provide a snapshot of the current state of this South African biocultural research knowledge pool that can inform democratic conservation policy, and (3) discuss gaps that are prevalent in this knowledge pool along with the importance of bridging those gaps.

Methods

This study reviewed original peer-reviewed biocultural research articles published between 1990 – when biocultural research started gaining prominence (Maffi 2005) – and 2019 which is in the time period when the coupling of social and ecological systems received scientific recognition (Kareiva & Marvier 2014). Review articles are excluded from analysis as they synthesise original peer-reviewed research and are thus secondary sources. Articles investigating the various aspects of the relationship between people and the environment without factoring in people's cultures were excluded from analysis. A systematic review was chosen so that this study's methodology could be replicated (Littell, Corcoran & Pillai 2008) by researchers seeking to understand the state of biocultural research in other countries. The review methodology used here is adapted from guidelines provided by Collaboration for Environmental Evidence (2013). Similar methods using the Scopus database (<https://www.scopus.com>) have also been employed in previous review articles by Mukherjee et al. (2018), Nyumba et al. (2018) and Young et al. (2018), among others. Scopus performs better for multidisciplinary analyses in comparison to discipline specific or national databases (Mongeon & Paul-Hus 2016). Multidisciplinary search results gained from Scopus are especially important for a review of biocultural research articles which are not confined to one discipline.

We conducted a literature search on Scopus using a search query consisting of terms commonly used in biocultural research articles thus targeting articles we aim to synthesise:

TITLE-ABS-KEY (South AND Africa) AND TITLE-ABS-KEY (“Biocultural diversity”) OR TITLE-ABS-KEY (“Bio-cultural diversity”) OR TITLE-ABS-KEY (ethno*) OR TITLE-ABS-KEY (“Biocultural conservation”) OR TITLE-ABS-KEY (“Bio-cultural conservation”) OR TITLE-ABS-KEY (“Traditional conservation”) OR TITLE-ABS-KEY (“Indigenous conservation”) OR TITLE-ABS-KEY (“Traditional ecological knowledge”) OR TITLE-ABS-KEY (“Traditional environmental knowledge”) OR TITLE-ABS-KEY (“aboriginal conservation”) OR TITLE-ABS-KEY (“indigenous knowledge”).

To maximise the number of results obtained, the search query included 'TITLE-ABS-KEY' so that the search term matches the titles (TITLE), abstracts (ABS) and keywords (KEY) of articles on the Scopus database. Furthermore, the asterisk Boolean modifier (*) is attached to the term 'ethno' so the search results will include articles that have words beginning with ethno (e.g., ethnopharmacology and ethnobiology) in their title, abstract or keywords. This search was limited to original peer-reviewed research articles categorised in the following broad fields on Scopus: pharmacology, toxicology and pharmaceuticals, health professions, social science, agricultural and biological science, biochemistry, genetics and molecular biology, environmental science, and medicine. The search query returned 3649 results, and their abstracts, titles, and keywords were pre-screened by reading them to verify that the studies focussed on biocultural approaches, thus

excluding articles that are not based on the recognition of a relationship between biodiversity and cultures. Pre-screening narrowed the results to 326 articles (Online Appendix 1) whose basis is the recognition of a relationship between biodiversity and cultures. These 326 articles were subjected to full text screening (i.e., reading entire article) by the first author using a pre-determined review protocol (Online Appendix 2) to thematically code the reviewed articles into the following categories that would provide insights into the state of biocultural research: (1) Study discipline within which biocultural research is conducted and types of methods used. (2) Ethical consideration in research that used human-focussed research methods. (3) Taxonomic, cultural and spatial focus of biocultural research. (4) Recommendations made in the reviewed articles.

Review findings

Disciplines and methods of the reviewed articles

The reviewed research, analysed using qualitative and/or quantitative methods, was relevant to several study disciplines and similar practices across different cultures (Figure 1). Human health science was the most represented discipline in South African biocultural literature, with 79.2% (of the 326 reviewed articles) being relevant to this field, while only 20.8% of the review sample was relevant to 11 other disciplines (Figure 1a). The use of human-focussed research methods in biocultural research was slightly less in comparison to the non-human-focussed research methods which were used in 50.3% of the review sample (Figure 1b).

Those human-focussed research methods employed in biocultural research gathered data by using three sampling strategies: total population sampling, purposive sampling to seek out the most knowledgeable respondents on a topic of interest, and random sampling that interviewed anyone who consented regardless of their knowledge of the research topic (Figure 1b). Pre-testing of the human-focussed research methods is only mentioned in two of the 162 articles (49.7% of the review sample) that relied on such methodology. Non-human-focussed research methods included laboratory analysis (e.g., investigating antimicrobial activity) and botanical surveys to answer research questions that stem from a different field of study and/or have extra-scientific origin such as traditional medicine (Figure 1b).

Consideration of ethics in human-focussed research methodology

Biocultural research that employed human-focussed research methodology only started including ethics statements in 2005 (Figure 2). From this study's sample of 326 articles, 162 articles employed human-focussed research methods and 58.6% of the articles with human-focussed research methods did not have statements about ethical consideration for their respondents.

Taxonomic, cultural, and spatial focus

Most of the reviewed articles solely focussed on plants with minimal focus on animals, ecosystems, and their abiotic components (Figure 3a). Within this review sample, articles

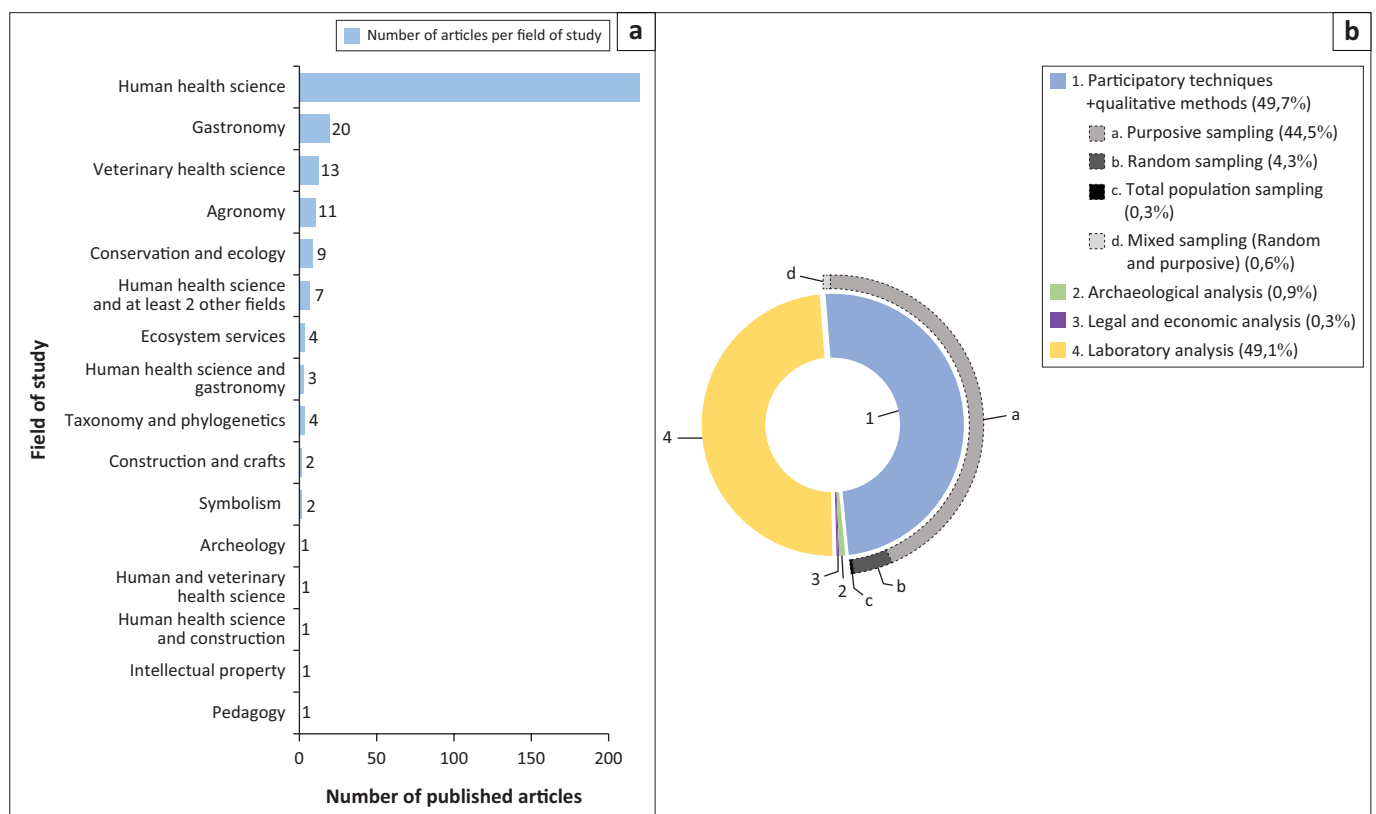


FIGURE 1: South African biocultural research (a) spans over 10 research disciplines, and (b) uses both human-focused research and methods that do not interview people.

generally had multicultural focus while isiXhosa received greater focus for articles that concentrated on a single culture. There was minimal focus on religion as a form of culture (Figure 3b). IsiNdebele and SiSwati were the only two of South Africa's nine officialised indigenous languages that were not represented in studies that focussed on a single culture. Spatial focus of biocultural research was mostly on rural and urban areas simultaneously (52.8%) and on rural areas solely (42%), while urban areas solely received the least attention (5.2%) among this study's sample. Of the 326 reviewed articles, 133 focussed on multiple provinces while the rest had single provincial focus with Limpopo and Eastern Cape being the most common research locations for articles with a single provincial focus (Figure 4).

Recommendations made in biocultural research

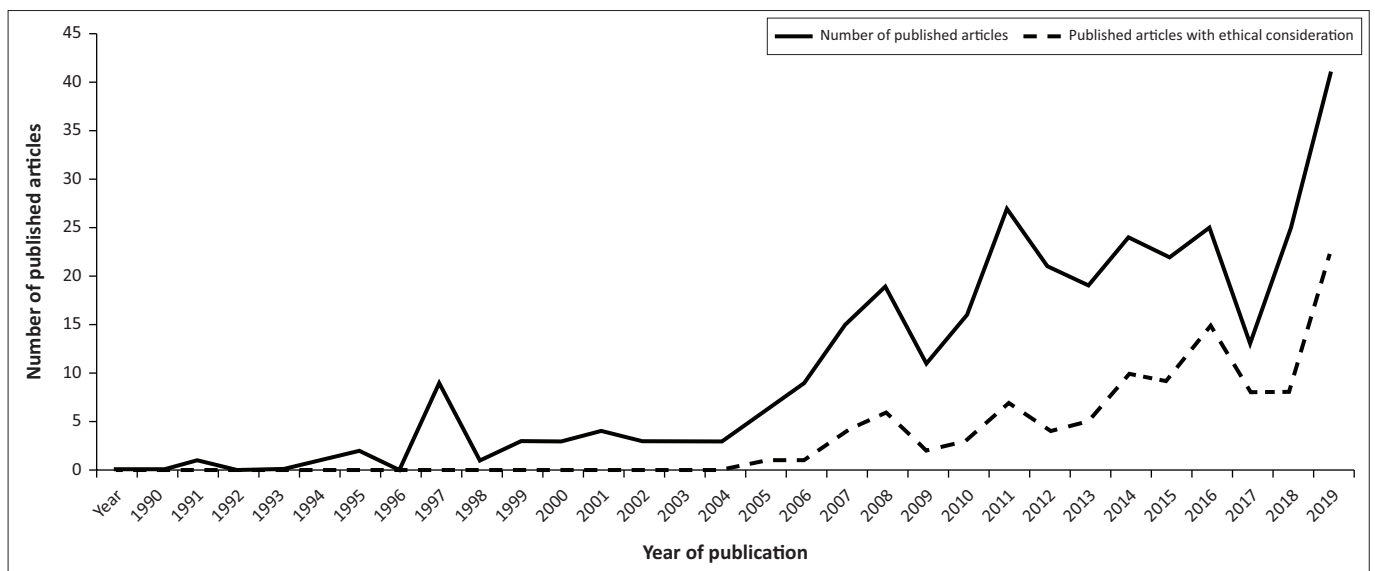
Most of the reviewed articles made recommendations for improving analyses to bridge knowledge shortfalls,

translating research findings to benefit the public at large, and using research outcomes for biodiversity conservation and/or preservation of cultures (Figure 5). The combinations of recommendations made in respective studies can be grouped into eight categories including articles with no recommendations to those with recommendations on how research outcomes can benefit conservation planning or improve future research as illustrated in Figure 5.

Discussion

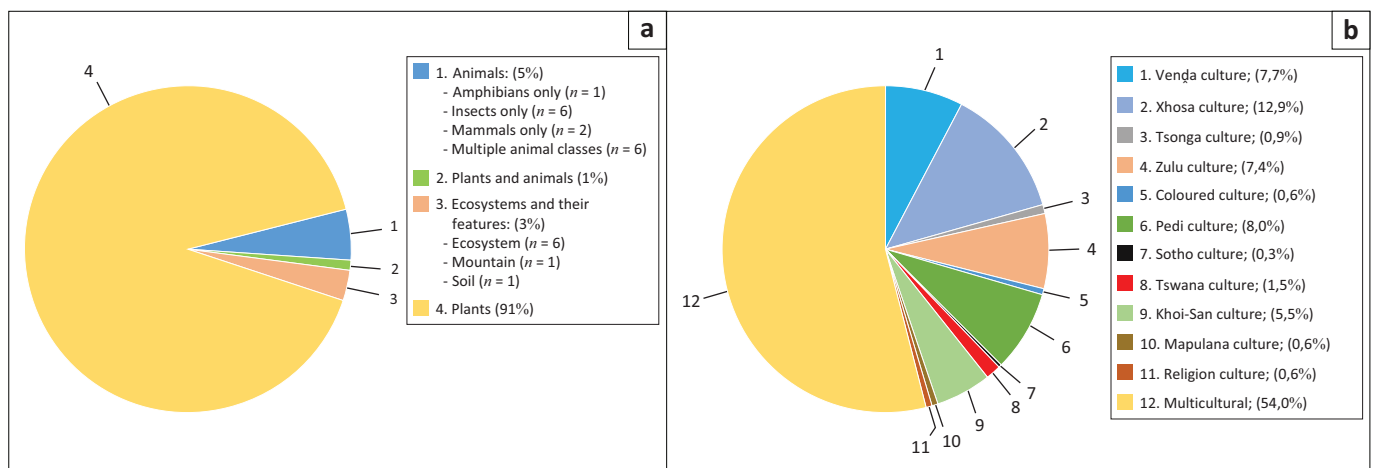
Disciplines and methods of the reviewed articles

Literature reviewed in this study shows that South African biocultural research transcends study disciplines. Research that is not confined to one discipline can relate societal problems to scientific problems and produce integrated outcomes that contribute to both societal and scientific objectives (Jahn, Bergmann & Keil 2012). Although the research reviewed spanned multiple disciplines, focus on



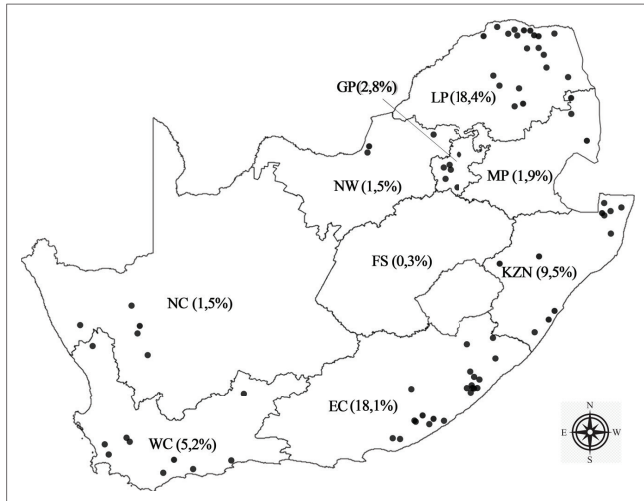
Source: Phaka, F.M., Hugé, J., Vanhove, M.P.M. & du Preez, L.H., 2023, 'Frog and reptile conservation through the lens of South Africa's nature-based cultural practices', *African Journal of Herpetology* 72(2), 190–206. <https://doi.org/10.1080/21564574.2023.2261021>

FIGURE 2: Biocultural research in South Africa published between 1990 and 2019 with and without ethics statements.



Source: Adapted from Phaka, F.M., Hugé, J., Vanhove, M.P.M. & du Preez, L.H., 2023, 'Frog and reptile conservation through the lens of South Africa's nature-based cultural practices', *African Journal of Herpetology* 72(2), 190–206. <https://doi.org/10.1080/21564574.2023.2261021>

FIGURE 3: Focus of South African biocultural research; (a) biodiversity focus and (b) cultural focus.



Source: Phaka, F.M., Hugé, J., Vanhove, M.P.M. & du Preez, L.H., 2023, 'Frog and reptile conservation through the lens of South Africa's nature-based cultural practices', *African Journal of Herpetology* 72(2), 190–206. <https://doi.org/10.1080/21564574.2023.2261021>
 EC, Eastern Cape; FS, Free State; GP, Gauteng; KZN, KwaZulu-Natal; LP, Limpopo; MP, Mpumalanga; NC, Northern Cape; NW, North West; WC, Western Cape.

FIGURE 4: Provincial focus of biocultural research in South Africa.

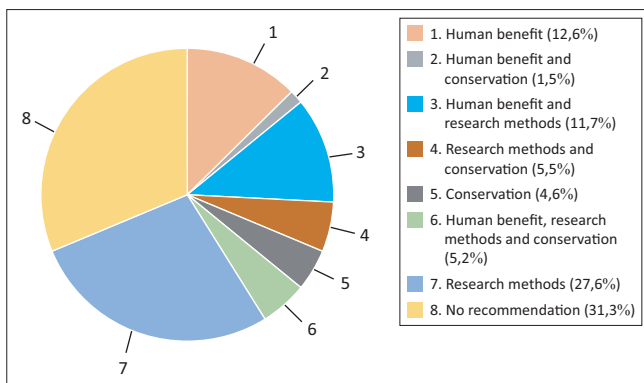


FIGURE 5: Recommendations made in 224 of 326 articles reviewed in this study.

human health science was noticeably higher, perhaps caused by the high frequency of traditional medicine use as highlighted in a report by the World Health Organization (WHO) (2019). Traditional medicinal practices are common throughout the world (WHO 2019), hence data would be more readily available for researching this particular wildlife-based cultural practice. Focus on other disciplines, besides human health science, can be increased even when preference is given to research with potential benefit for people. For instance, increased focus on veterinary health science would benefit the livestock that people depend on; more research focussed on ecosystem services and conservation could also help people derive benefits from nature while increased focus on agronomy can improve food security. Biocultural research's uneven focus on human health sciences may create an impression that cultural practices mostly place utilitarian value on wildlife when this is not the case. Wildlife in cultural practices has value that ranges from entertainment to spiritual and totemic (Phaka et al. 2023). This understudied non-utilitarian cultural value of wildlife would be highlighted by an increase of biocultural research in other fields besides human health sciences. With the increased understanding of wildlife's non-utilitarian value, there would be an update to

the knowledge pool of human activities that depend on wildlife (directly and indirectly).

The low focus on traditional ecological knowledge in South African biocultural research is in line with Brook and McLachlan's (2008) study showing that the African continent, in comparison to the rest of the world, has less research on traditional ecological knowledge. There has been a reported increase in studies of African traditional ecological knowledge (Aswani, Lemahieu & Sauer 2019). However, large parts of the continent remain understudied; therefore, we have an incomplete picture of the state of African traditional ecological knowledge (Sinthumule 2023), and incidentally an incomplete knowledge base of protective cultural practices that conservation planning can draw from. Traditional ecological knowledge contained in indigenous knowledge systems (IKS) is being increasingly recognised as having scientific merit (Paneque-Gálvez et al. 2018; Wilson 1992), thus there is potential conservation benefit to be derived from biocultural research that investigates ecological knowledge. Focus on traditional ecological knowledge in biocultural research highlights cultural practices that encourage protection of wildlife and have potential synergies with conservation planning. A study by Sinthumule and Mashau (2020) demonstrated traditional ecological knowledge's potential contribution to conservation planning with results showing that South Africa's VhaVenda (people of Venda culture) have positive attitudes towards the conservation of a natural forest which was protected by their cultural beliefs of the forest being sacred. Although South African law provides for inclusion of traditional ecological knowledge into modern conservation planning, there is no clear evidence of such integration on a large scale (Phaka et al. 2023).

While there was no major difference in the number of studies that used human-focussed methods and those that did not interview people in this review sample, there was a lack of pre-testing for human-focussed research methods. This pre-testing is vital to the development and refinement of interview methods (Beatty & Willis 2007; Young et al. 2018). Pre-testing allows for verification of whether human-focussed research methods will be effective before research in undertaken (Perneger et al. 2015).

Consideration of ethics in human-focussed research methodology

It is important for research with human-focussed research methods to uphold ethical conduct to protect research respondents' rights, but this was not the case for most of human-focussed research in this study sample published before 2005. Human-focussed research without ethics statements does not provide assurance that those studies considered respondents' rights and protected their intellectual property as is encouraged by the International Society of Ethnobiology (2006). The traditional knowledge (i.e., the intellectual property) of indigenous communities has often been exploited (Longacre 2002), hence the necessity for ethical consideration in human-focussed research to avoid exploitation

of indigenous knowledge that is recorded during research. Consideration of ethics promotes research integrity. The lack of ethical consideration goes against guidelines provided by South Africa's Bioprospecting, Access and Benefit Sharing Regulations (Department of Environmental Affairs 2012) which mention that research involving IKS should at least obtain traditional knowledge custodians' permission and prior informed consent, and also inform the environmental affairs ministry about the research. Exploitation of IKS is a problem occurring in South Africa (Amusan 2014) and many other countries including India (Udgaonkar 2002), Perú (Landon 2007), and Canada (Oguamanam & Koziol 2018). This IKS exploitation will continue unabated if research involving IKS continues to overlook ethical consideration thus depriving IKS custodians any benefits derived from their knowledge systems.

It is unclear why the reviewed articles that used human-focussed research methods did not have formal ethical consideration prior to 2005 when guidelines that could be used for the protection of biocultural diversity were already available in 1988 from the Declaration of Belém (International Society of Ethnobiology 1988). The International Society of Ethnobiology's code of ethics (International Society of Ethnobiology 2006) is unlikely to be a factor in inclusion of ethics statements by research published from 2005 onwards as the code was adopted in 2006. Ratification by South Africa of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits arising from their utilisation to the Convention on Biological Diversity (UNEP 2011) in 2013 provided additional guidelines for protection of research respondents and their rights. The Nagoya Protocol provides countries with a means of protecting IKS and there is an example of this from Burundi where a Nagoya Protocol framework was set-up to protect and valorise IKS to prevent exploitation of indigenous communities (Janssens De Bisthoven et al. 2017). Incorporation of existing ethical safeguards (e.g., Declaration of Belém and Nagoya Protocol) into the processes of ethics review boards for research institutions can help decrease the biocultural research ethical oversights highlighted above.

Taxonomic, cultural, and spatial focus

The strong biocultural research focus on plants in this study sample, which is linked to strong interest in human health science, is not unique to South Africa. Ethnomedical research globally is more focussed on plants (Solovan et al. 2004), even in places with well-recorded traditional medicine usage such as India (Betlu 2013). Kepe (2008) attributed the strong research focus on plant usage to the lack of contextual analysis of plants' social and ecological value. A strong focus on traditional medicine research may be motivated by the prospects of monetisation of such results in cases where plants are found to be beneficial to human health. Furthermore, research emphasis on medicinal plants may be because of plants being easier to collect, store, and trade (Alves et al. 2011). A broader focus on the non-medicinal uses of plants would expand research in disciplines beyond

human health science. Use of animals in traditional medicine was found to be less frequent (Williams & Whiting 2016), hence the dominance of plants in traditional medicine research. A disproportionately stronger focus on practical usage value (traditional medicinal use of plants in the case of this study) can inevitably influence environmental policies to overemphasise the utilitarian value of biodiversity (Hugé et al. 2017). It would thus be important to increase research focus on non-utilitarian cultural norms to avoid having a knowledge pool skewed towards utilitarian value informing conservation policy that favours utilitarian use of wildlife. Utilitarian uses of wildlife are lethal to wildlife in comparison to non-utilitarian uses and thus pose higher conservation risk to wildlife (Phaka et al. 2023). Non-utilitarian, wildlife-related cultural norms that are underrepresented in this review sample and can potentially receive increased attention include: folk taxonomy (Phaka et al. 2019), folklore (Osemeobo 1994), and totemism (Clemence & Chiminge 2015). Decreasing this unevenness of biocultural research broadens the scope of topics for researchers and would result in a knowledge pool that equitably focusses on utilitarian and non-utilitarian value of wildlife.

The broad multicultural or national focus of some of the reviewed articles is beneficial for revealing the multicultural importance of certain taxa, but it can result in local nuances of different cultures and undocumented cultural practices being overlooked, hence the need for more biocultural research with a single cultural focus. The overlooking of local nuances by broad cultural focus studies was demonstrated by high-resolution (single cultural focus) studies of Zulu culture in the Amandawe locality (KwaZulu-Natal province) which reported 110 new medicinal plant species, 60 newly recorded IsiZulu names for medicinal plant species, and 1106 new usage records for medicinal plants, when Zulu medicinal plant usage was already believed to have been adequately studied previously (Mhlongo & Van Wyk 2019). Another high-resolution study in the KwaNibela Peninsula (KwaZulu-Natal province) added to the Zulu traditional medicine knowledge pool with a discovery of previously unrecorded medicinal plants, and 61 novel uses of medicinal plants alongside 15 variations to recorded medicinal plant remedies (Corrigan et al. 2011). Corrigan et al. (2011) and Mhlongo and Van Wyk (2019), through the discoveries of unrecorded cultural practices, demonstrate what can potentially be revealed when biocultural research zooms in on a single culture and considers cultures that were overlooked. Since different cultures tend to be dominant in respective South African provinces (Statistics South Africa 2011), increasing the focus on single cultures would subsequently improve the traditional knowledge pool and increase focus on underrepresented provinces. This knowledge pool can be improved by encouraging researchers to focus on underrepresented cultures in biocultural research. Furthermore, the scope and expertise of some higher education institutions can be widened so they contribute to an even focus on cultures in biocultural diversity research.

The noted unevenness in cultural focus can also be diminished by increasing the focus on urban areas. Research by DeJong

(1991), Marsland (2007), and Wiersum and Shackleton (2005) among others, shows that urban residents of sub-Saharan African countries attach cultural significance to wildlife by maintaining their rural cultural practices. Evidence of traditional cultural practices in urban areas can also be found in European cities (Elands & Van Koppen 2012). Culturally motivated consumption of wildlife in urban areas is generally increasing in frequency (Marsland 2007). Increases in urban usage of biodiversity could result from rural-to-urban migrants' continuation of traditional cultural practices (from their rural homes) in urban areas (Hardon et al. 2008; Gurney et al. 2017). Lesser biocultural research focus on urban areas is likely because of rural areas being generally associated with traditional cultural practices as they are the source of the practices that biocultural research is interested in. Increasing attention on urban areas would be feasible as for instance South Africa's most urbanised province, Gauteng, has the highest diversity of cultures when compared to the more rural provinces (Statistics South Africa 2011).

The uneven taxonomic, cultural, and spatial focus of biocultural research can be explained by a number of factors including research on traditional medicine and plants used in traditional remedies, and a higher number of studies being carried out in rural areas. The two cultures that did not feature in articles with a single cultural focus (Ndebele and Swati) are most dominant in the Mpumalanga province (Statistics South Africa 2011) and the first university in Mpumalanga was formally promulgated in 2013 (Department of Higher Education and Training 2013). Thus, it was only possible for a local university to conduct research on cultures in Mpumalanga without the expense of travelling between provinces from 2013 onwards, but other universities were not prohibited from undertaking this research. Accessibility was unlikely to be a limiting factor in researching Tswana, Sotho, and Tsonga cultural practices as they are underrepresented, yet they predominantly occur in provinces with well-established universities in the Free State and Limpopo respectively. People's reluctance to share details of their culture with outsiders (i.e., researchers), as was reported in a traditional medicine study by Whiting, Williams and Hibbitts (2011), may also contribute to underrepresentation of cultures. Another possible contributor to the unevenness of biocultural research focus is the differences in the proportion of the population belonging to various South African cultures (Table 1) as cultures that make up larger percentages of the population might be expected to feature more in biocultural research. There is, however, no clear correlation between the amount of research focussed on a certain culture and the proportion of the population belonging to that cultural group. BaPedi, amaXhosa and amaZulu are the largest cultural groups in South Africa (Table 1), and they are also three of the four cultures that received unevenly strong research focus within the sample. The fourth culture which received unevenly strong research focus is Venda, yet this is the second smallest cultural group in the country. Ndebele and Swati, which did not receive sole focus in any of the reviewed articles, are the smallest and third smallest South African cultural groups respectively (Table 1).

TABLE 1: South African population grouped language and/or culture (Statistics South Africa 2011) compared to cultural focus of reviewed articles.

Language	Proportion of population (%)	Cultural focus in review sample† (%)
Afrikaans	13.5	0.0
English	9.6	0.0
IsiNdebele	2.1	0.0
IsiXhosa	16.0	12.9
IsiZulu	22.7	7.4
SePedi	9.1	8.0
SeSotho	7.6	0.3
SeTswana	8.0	1.5
SiSwati	2.6	0.0
TshiVenda	2.4	7.7
XiTsonga	4.5	0.9
Other	1.9	0.0

Note: Names for South African languages and cultures are generally used interchangeably.

†, Cultural focus of reviewed studies did not always match language or culture groupings: 54% of reviewed studies had a multicultural focus, 0.6% focussed on members of the coloured community, 0.6% focussed on people of Mapulana culture, and another 0.6% focussed on religion.

Recommendations made in biocultural research

Recommendations are not compulsory for all research articles but some recommendations from this study's sample help clarify the role of the research topic in real-world contexts. When articles contain recommendations, they are mostly general and thus lose their potential value (Brown et al. 2006). In the context of the biocultural research articles, recommendations can demonstrate how people may benefit from research findings similar to how a multidisciplinary study by Mphahlele et al. (2016) recommended the use of antiparasitic traditional herbal remedies for livestock based on results of biological assay experiments showing antiparasitic efficacy of traditional livestock methods used by BaPedi. Recommendations from a study by Mongalo and Makhafola (2018) which combined ethnography and botany methods were meant to improve future research by suggesting increased research on wild food plants as their study found a lack of data on that topic. Another example of how recommendations emphasise the role of biocultural research in real-world contexts is the plant conservation recommendations that resulted from a study of traditional medicine dynamics by Williams, Balkwill and Witkowski (2000). With improved research recommendations there can be improved clarification of the benefits people can derive from research findings. Furthermore, this can promote continuity with suggestions to optimise current methodology, and increased conservation-related recommendations promote evidence-based protection of both biodiversity and people's cultures which in some instances may be endangered.

Limitations of current research

It is worth noting that the current review also has its own limitations. A systematic review of literature ensured replicability of this study, but it limited the research's scope by excluding suitable books and postgraduate dissertations. Original peer-reviewed articles may have also been unintentionally omitted if they did not have the search query keywords. Articles that match inclusion criteria, but are

published in journals that were not indexed on the Scopus database did not appear in the search results. The number of suitable articles and journals that are excluded from Scopus database are unknown. The search query used on Scopus consists of terms associated with biocultural approaches and there is a possibility that various synonyms were unintentionally overlooked in this study or suitable articles did not use any of the words associated with biocultural research.

Conclusion

Investigations of the relationship between South Africa's biodiversity and cultures are increasing but there are knowledge gaps that necessitate further biocultural research. The unevenness of biocultural research can lead to misinterpretation of South African cultures' relationship with wildlife through their cultural norms thus limiting this research's ability to fully inform the inclusive conservation policy envisaged by the country's overarching environmental legislation. Furthermore, the current review highlights the need to be cognisant of ethical issues related to biocultural studies with human-focussed research methods and to place greater emphasis on recommendations made in biocultural research articles to promote continuation of research by addressing issues identified by current research. In the interest of research continuity, the current research recommends the highlighted unevenness in biocultural research be reduced by increasing research focus on other taxa besides plants, exploring other topics beyond human health, and considering practices of other cultures in addition to BaPedi, AmaXhosa and AmaZulu. To address the unevenness of biocultural research noted here and for a knowledge pool that can equitably inform both utilitarian and non-utilitarian aspects of conservation policy, future biocultural research should increase focus on investigating non-medical uses of plants, veterinary health uses of plants, medicinal and non-medicinal uses of animals, cultural practices that are protective of wildlife, and increase focus on cultures and areas that were noted to be underrepresented in this literature review.

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Competing interests

The authors have declared that no competing interest exists.

Authors' contributions

F.M.P. conceptualised the study, collected data, performed analysis, and wrote the first draft of this article. L.H.D.P., J.H.

and M.P.M.V. conceptualised the study, supervised the analysis, and edited subsequent drafts of this article.

Ethical considerations

Ethical clearance to conduct this study was obtained from North-West University Animal Care, Health and Safety Research Ethics Committee (No. NWU-00185-18-S5).

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

Disclaimer

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