Ethnobiology: the missing link in ecology and evolution

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Evolutionary biologists and ecologists increasingly appreciate the value of local knowledge of human communities for research on the past, present and future of biodiversity [1-3]. However, there are often significant problems accessing and interpreting this knowledge [3]. Here we argue that closer interaction with ethnobiologists, who study the relationship between humans and the natural world, will enable local knowledge to be better applied in ecological and evolutionary biological research. This will provide more comprehensive answers to the scientific questions being asked, and will result in improved engagement with both academic and non-academic communities.

Local knowledge encompasses historical and present beliefs, traditions, practices, and views developed by local human communities [4]. Much of this knowledge is about the natural environment, including agricultural and farming practices, the ways biodiversity is used for food, drink, medicine, fuel, housing and clothing, the ecology of species and communities, and local biodiversity and climatic patterns. We argue that collaboration between ecologists/evolutionary biologists and ethnobiologists is the most effective and meaningful way to incorporate local knowledge into biodiversity-related research. This interdisciplinary interaction can provide mutual benefits for ethnobiologists and biodiversity researchers.

Ethnobiologists, who often come from a social sciences background, are trained experts in gathering, filtering, and managing local knowledge, and in fostering engagement with local communities. All of these activities can be major obstacles for biologists wanting to access local knowledge and integrate it into their research for the first time [3]. Through collaboration, biologists can ensure issues such as prior informed consent, respectful use of local community members' time and resources, data ownership, and the sharing of results and benefits with local communities are managed properly, and in accordance with agreements like the Convention on Biological Diversity. For a number of reasons, it is important for

evolutionary biologists and ecologists to engage directly with local communities, but ethnobiologists can assist this process by helping communicate local concerns and needs, thereby enabling collaborative projects to be planned that benefit all parties. Additional benefits of collaboration may come from joint field work. Study destinations are likely to be similar for researchers from all these disciplines because regions with high biodiversity often coincide with regions of high cultural diversity [5]. Planning projects and conducting fieldwork collaboratively can maximise the outcomes from those efforts.

Synergies between ethnobiology, evolutionary biology and ecology are starting to appear more frequently in the literature and have resulted in remarkable outcomes. For example, ethnobotanical observations, coupled with DNA sequencing, have helped elucidate ecological preferences of poorly known species, such as the South American tapir (*Tapirus terrestris* Linnaeus, 1758) [6]. A combination of studies has shown how evolutionary biology and ethnobiology can collaborate to ensure food security. For instance, a study of genetic diversity revealed that the common bean (*Phaseolus vulgaris* L.) is of Mesoamerican origin and delineated local genetic groups in South America [7]. Ethnobiologists can use that knowledge to highlight cultural factors influencing the distribution of different local varieties, and this interdisciplinary knowledge can inform the efficient conservation of crop genetic resources, as has been done in cassava/manioc (*Manihot esculenta* Crantz) [8]. Similar approaches can help unearth past local knowledge. For example, ancient DNA amplification techniques helped identify the contents of a medical preparation found in a 1st century sunken Roman shipwreck [9], providing historical ethnobiologists insights into ancient practices. As these interdisciplinary approaches demonstrate the benefits of interdisciplinary projects, we encourage the three scientific communities to consider other directions for combined research efforts. These could include using local knowledge of biodiversity patterns to prevent loss of natural biotas, and synthesising modern and novel sequencing

technologies with ethnobiological knowledge to better understand crop and livestock domestication, as well as to identify species used and traded in traditional medicine [10]. Further, this interdisciplinary collaboration can include research from other disciplines, such as archaeology [11], as well as inform scientists from unrelated fields, such as those conducting research on natural products and drug development [12].

Interdisciplinarity is increasingly recognised as being important. This is reflected in funding agencies' programmes worldwide, including the National Science Foundation's CREATIV scheme (US), the FP7 Marie Curie Actions (EU), the Leverhulme Trust (UK) and the Australian Research Council. All these agencies call for proposals demonstrating interdisciplinarity, with some supporting high-risk proposals. Research efforts spanning ethnobiology, ecology, and evolutionary biology would successfully meet this criterion.

Ultimately, the proposed interaction can support the race against time to understand, conserve, and responsibly utilise both the natural world and local knowledge. We urge evolutionary biologists, ecologists and ethnobiologists to forge stronger and mutually beneficial links.

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