ARTICLE

Doing an Ethnobotanical Survey in the Life Sciences Classroom

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Abstract

On the basis of an ethnobotanical survey that we conducted on plant use by descendents of the Khoi-San people in the Northern Cape Province in South Africa, we introduce biology teachers to an adapted rapid-appraisal methodology that can be followed in the life sciences classroom. Such a project addresses a number of the content standards in the National Science Education Standards*, such as science as a human endeavour, the nature of science, and the history of science. We also shed light on ethical considerations when engaging in an ethnobotanical survey, and address, among other issues, intellectual property rights. Examples are provided of how teachers in the United States can sensitize students to the rich ethnobotanical heritage of their country.*

Key Words: *Ethnobotanical surveys; indigenous knowledge; intellectual property rights; nature of science; life sciences teaching; medicinal plants.*

The term *ethnoecology* has in recent years received considerable emphasis in international literature. With this term, we refer to studies that describe local peoples' interactions with the natural environment (Martin, 1995). Ethnobotany is the part of ethnoecology that concerns plants and has been defined by Balick and Cox (1996) as "the study of the relationships between plants and people" (*ethno* refers to the study of people, *botany* the study of plants). Ethnobotany is therefore the study of the knowledge, skills, and daily uses of plants in a particular area that enable the people of the local community to get the most out of their natural environment. M. E. Jones and J. Hunter (unpubl. data) and M. Michie (unpubl. data) have identified a number of common themes embedded within indigenous knowledge that are intrinsic to its integration into the science curriculum, and they indicate that indigenous knowledge is characterized by the following:

- Based on experience
- Often tested over centuries of use
- Developed as a collective database of observable knowledge
- Adapted to local culture and environment
- Dynamic and changing: a living knowledge base
- Can be applied to problem solving
- Transmitted orally and sometimes encapsulated in metaphor
- Inseparably embedded in ethics, spirituality, metaphysics, ceremony, and social order
- Bridging the science of theory with the science of practice
- A holistic versus a reductionist (Western science) approach
- Ecologically based
- Contextualized versus decontextualized science

When dealing with indigenous knowledge (and ethnobotany) in the life sciences classroom, the danger always exists that one may unwittingly promote pseudoscience (De Beer & Whitlock, 2009). Howe (2009), in an article in *The American Biology Teacher*, provides a useful table of guiding questions that you can use in the classroom when discussing indigenous knowledge and the nature of science (refer to p. 401,table 2, in the September 2009 issue of *ABT*). Here, we provide you with a useful methodology to follow in the classroom, to incorporate ethnobotany in your teaching.

But why should we engage with such an ethnobotanical approach? There are three reasons: the preservation of indigenous knowledge for future generations, a curriculum-driven agenda, and a long-term economic perspective. The potential economic importance of plants cannot be overemphasized. Shelley (2009) refers to studies that indicate that 25–57% of prescription drugs sold in the United States or worldwide have at least one active compound that is derived or patterned after compounds isolated from natural products. Table 1 provides information on drugs that were discovered from ethnobotanical leads. However, in this article our focus will be mostly on the first two considerations, namely the preservation of indigenous knowledge, and curriculum considerations.

> *Ethnobotany is the study of the knowledge, skills, and daily uses of plants in a particular area that enable the people of the local community to get the most out of their natural environment.*

Ethnobotany is also important from a curriculum perspective. The development of the U.S. *National Science Education Standards* (National Research Council [NRC], 1996) was guided by several principles, one being that school science reflects the intellectual and cultural traditions that characterize the practice of contemporary science. Ethnobotanical surveys provide a useful vehicle to address this principle.

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Table 1. Examples of drugs discovered from ethnobotanical leads (Balick & Cox, 1996).

Drug	Medical Use	Plant Species	Family
Aspirin	Analgesic, inflammation	Filipendula ulmaria	Rosaceae
Atropine	Ophthalmology	*Atropa belladonna*	Solanaceae
Camphor	Rheumatic pain	*Cinnamomum camphora*	Lauraceae
Morphine	Analgesic	*Papaver somniferum*	Papaveraceae
Quinine	Malaria prophylaxis	*Cinchona pubescens*	Rubiaceae
Reserpine	Hypertension	*Rauvolfia serpentina*	Apocynaceae
Vinblastine	Hodgkin's disease	*Catharanthus roseus*	Apocynaceae

Table 2. Aligning an ethnobotanical survey with the national content standards (National Research Council, 1996: p. 107).

Science in personal & social perspectives	
Levels 5–8 Personal health Populations, resources, and environments Science and technology in society	Levels 9–12 Personal and community health Natural resources Science and technology in local, national, and global challenges
History & nature of science standards	
Levels 5–8 cience as a human endeavour Nature of science History of science	Levels 9–12 Science as a human endeavour Nature of scientific knowledge Historical perspectives

In South Africa, the study of life sciences provides rich opportunities for addressing one of the goals in the African National Congress's (ANC's) National Health Plan (1994), which states that "people have the right of access to traditional practitioners as part of their cultural heritage and belief system." Traditionally, Native Americans had similar views that spiritual and physical health are inseparable. Many communities in the United States still use plants for medicinal purposes. You might develop an interesting case study or two in your classroom, for instance the use of the peyote cactus (*Lophophora williamsii*), a hallucinogenic plant native to central and northern Mexico and the Rio Grande Valley of the southwestern United States. In one case, two Native Americans were dismissed from work because of their use of the peyote cactus (a controlled substance; Balick & Cox, 1996). The U.S. Supreme Court ruled in 1990 that the use of peyote was not constitutionally protected. Such a case can spark a lively debate on whether the government should ban the use of peyote by Native Americans.

○ Methodology

This article results from research done in the Northern Cape Province, South Africa. We conducted an ethnobotanical survey of plant uses among the descendants of the Khoi-San people, who live in an area known as the "Hantam" (the area surrounding the town of Calvinia). The Khoikhoi (Hottentot) herders and San (Bushman) hunter-gatherers are collectively referred to as the "Khoi-San people" (Schapera, 1930). Using a rapid-appraisal methodology (Martin, 1995), we first made contact with a traditional healer who lives in the area and knows the plants well. We collected plant specimens with him over a period of 3 days. Back at the university, we identified the plants and prepared herbarium voucher specimens. During our second visit to the Hantam, we took a mobile herbarium along and interviewed 16 people in the area about their use of indigenous plants for food and medicine. During these interviews we showed the participants the 120 plants we collected during phase 1 (as herbarium specimens). We developed a questionnaire that served to record whether the subject knows the plant, whether he or she has a name for it, and whether the plant has any uses. The aim of this research was to record this indigenous knowledge in a scientific way, so that it is not lost for future generations. We realized that this particular methodology might also be useful in project work in the life sciences classroom. Ethnobotany provides a vehicle to shed light on the history of science. An example is William Withering, who in 1785 published *An Account of the Foxglove and Some of Its Medicinal Uses*, in which he described how the foxglove plant (*Digitalis purpurea*) was used to treat dropsy, a condition caused by inadequate pumping action of the heart (Balick & Cox, 1996). We'll illustrate our methodology with South African examples, but we'll also provide suggestions for the American teacher.

○ Rapid Ethnobotanical Appraisal

As the name implies, a rapid ethnobotanical appraisal lasts a few days. The method borrows its tools from disciplines such as rural sociology, anthropology, and ecology and is an adaptation of participatory rural appraisal (PRA) (Martin, 1995). One of the disadvantages of this methodology is that it does not allow the researcher to develop a relationship with the community (Martin, 1995). Careful documentation of the cultural and biological aspects of local knowledge is not always possible, because there are time constraints for making voucher collections, transcribing local names, or talking with a range of informants. In most school settings, life-sciences students will probably be doing this research in their local communities, in order to get a feel for the practice of ethnobotany, and such school projects need not be complete surveys of a community's plant use. In this context, the advantages of rapid appraisal include that it can be done in a short time and without expensive tools.

In rapid ethnobotanical appraisal (and PRA), the people of the subject community are full participants in the study, rather than merely objects of investigation (Martin, 1995). This provides teachers an opportunity to introduce the ethical aspects of doing research.

○ An Ethnobotanical Survey as a Class Project

Giving the assignment

We suggest a manageable project in which students prepare 10 herbarium voucher specimens of the most commonly used plants and do a survey (if possible, in Native American communities) to see how these plants are used (for food, medicines, or arts and crafts).

Formulating a hypothesis

Hypothesis formulation and testing is important in the life sciences classroom. It is therefore essential that an ethnobotanical class project be embedded in a rigorous design, whereby students have to formulate hypotheses. Students' hypotheses might include that the ethnobotanical uses of plants in a particular area are not well recorded, or they might hypothesize that there is an erosion of indigenous knowledge among younger generations (and so test how well plants are known by people in different age groups). Another hypothesis might be that there is consistency in how plants are used for medicinal reasons.

Identifying a knowledgeable source (e.g., a traditional healer)

In our work in the Hantam, we identified Jan Baadjies (Figure 1), a traditional healer, as our primary source of information. We spent 3 days with Jan in the field, collecting specimens of the plants that he and his people were using as food or medicine or for other purposes.

Drying the plants

Plant specimens need to be pressed and dried before they are mounted on a piece of white cardboard (poster board) for the class herbarium. Commercial plant presses are available, but it is easy to manufacture a press using two wooden frames and two strong straps. Plant materials are placed in folded newspaper, and the newspaper with the enclosed plant is put between two sheets of absorptive paper. After every five or so plants (each in its own folded newspaper, with sheets of absorptive paper in between), insert a piece of strong cardboard to provide stability. Change the sheets every second day until the plants are dry. The specimen can then be mounted.

Figure 1. Jan Baadjies, during field work in the Hantam.

Identifying plants & preparing herbarium voucher specimens

We recorded the indigenous names for the plants (provided by Jan and other members of the community). Back at the university we had to identify each species. You can provide students with good field guides, and the Internet is also very useful in identifying plants. We encourage a trip for your students to the nearest herbarium. Many universities have herbaria, and there your students can compare their plant specimens with herbarium voucher specimens. Once a plant has been identified, the students should complete a label for the plant and mount it on a herbarium sheet (see Figure 2). The mounting process involves gluing the plant material and pressing it with small weights until it is dry. Any loose parts can be secured using strips of gummed paper. Although it is not normal practice to include photographs on such herbarium voucher specimens, we have found it useful during phase 2, in which we interviewed people and showed them the herbarium voucher specimens. The plant material often loses color as it dries, and in this flattened, colorless state it may not be easy for the untrained eye to identify the plant. A color photograph of the plant provides detail that may be lost on the herbarium voucher specimen. The label should include the information indicated in Figure 3.

Developing the questionnaire

In our Hantam survey, we included 120 mostly indigenous plants. On the instrument were columns where we could indicate whether the interviewee knew the plant, had a name for it, and could name any ethnobotanical uses for it (see Figure 4). We suggest that you limit this survey to 10 of the most commonly used plants.

Doing the survey

The students will have to decide on a sampling technique, and here you will have to provide them with background information on random sampling, convenience sampling, and other sampling strategies. We advise that the students put the herbarium voucher specimens in transparent plastic bags (A3-sized plastic folders are readily available), because the sheets are subjected to a lot of handling during the survey.

Ethical considerations

The instructor should discuss ethical issues before the students embark on this research. Basic principles of ethics in research are summarized in Table 3, with useful sources of information. For example, there may be legislation that governs the collection of plants (especially in nature reserves and National Parks). Some plants may be rare or endangered, and special permission may be needed to collect such plants. In any case, the permission of the landowner is a minimum requirement when specimens are collected. Students should realize that participation is voluntary and that they should clearly explain the aim of the research to participants and respect their privacy. Prior informed consent should be obtained. Compensation (monetary or otherwise) should be discussed in advance to avoid misunderstandings. When ethnobotanical surveys are aimed merely at recording cultural information for future generations, the ethical considerations are usually fairly uncomplicated. However, when a private company is doing the survey with the aim of developing commercial products, rigorous procedures in the form of a legal framework are required to ensure the protection of indigenous knowledge rights

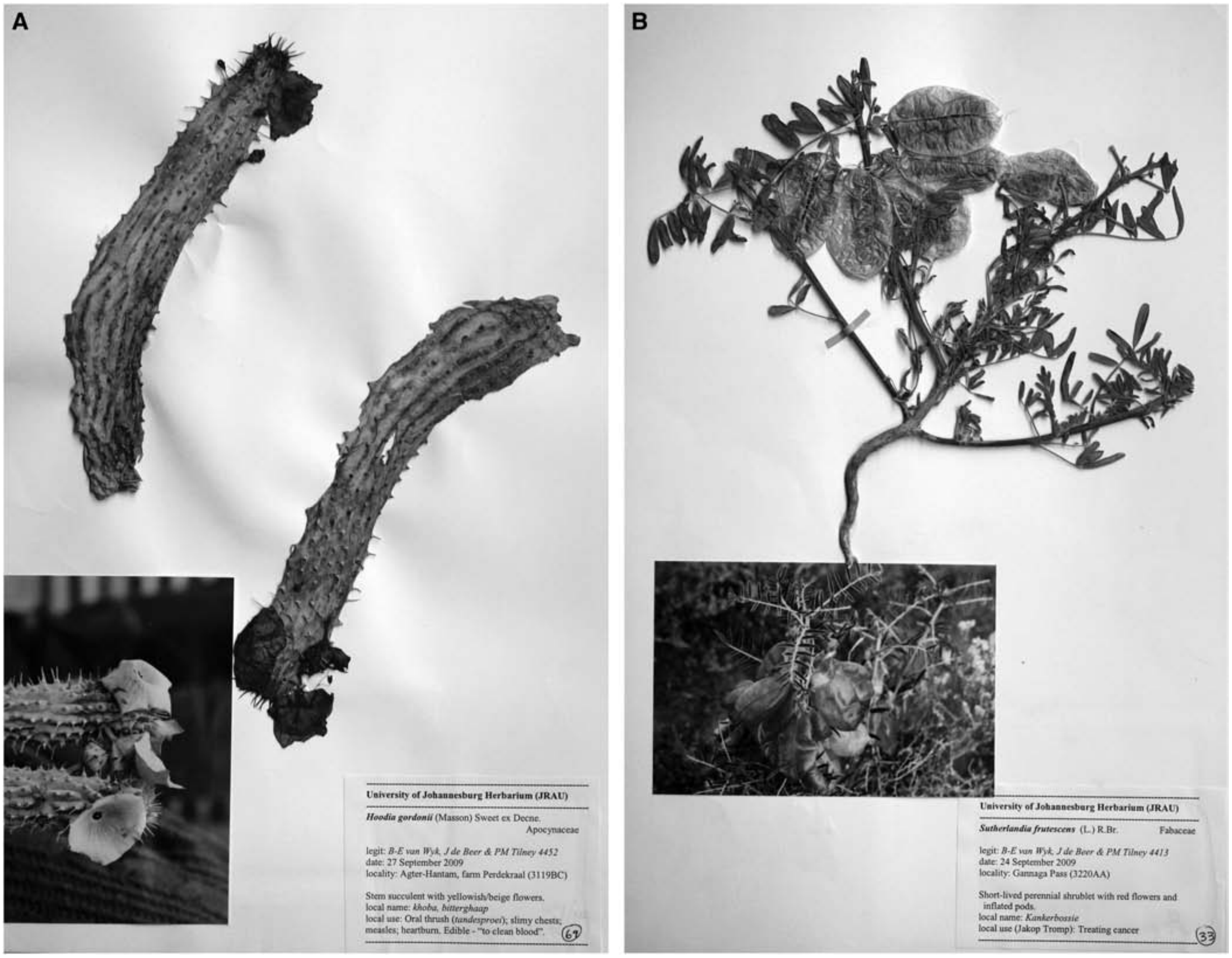

Figure 2. Herbarium voucher specimens: **(A)** *Hoodia gordonii* and **(B)** *Sutherlandia frutescens.*

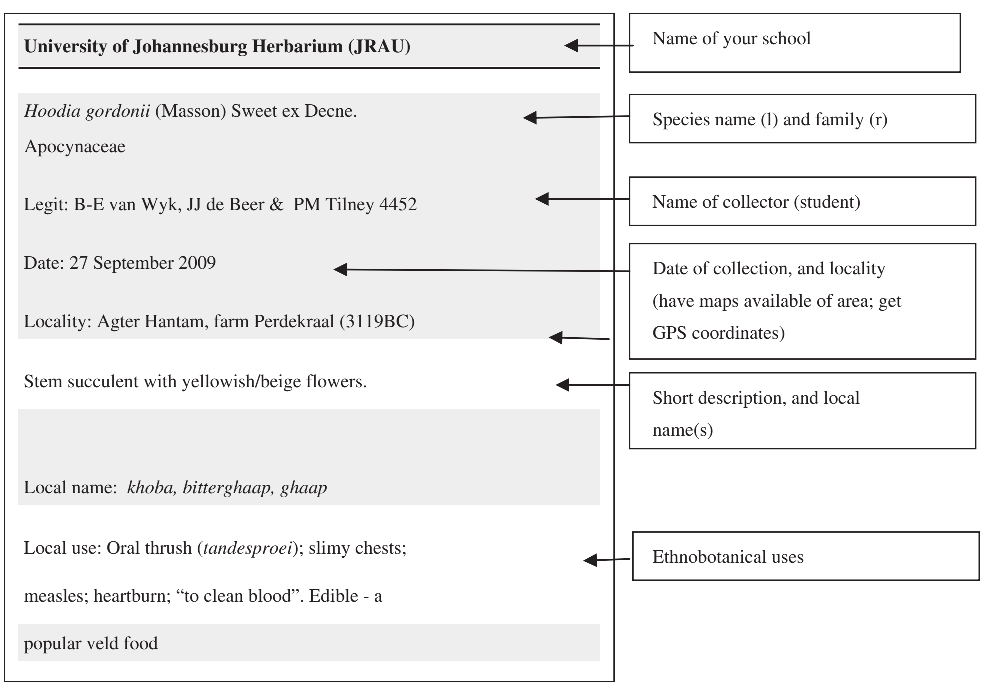

Figure 3. Herbarium voucher specimen label.

and a clear provision for the equitable sharing of the benefits to be derived from the use of the knowledge (see the *Hoodia* example discussed below). Ideally, the participants should be involved in all aspects of the collection and dissemination of the information. It is in any case important to provide feedback to the participants – this may take the form of copies of the project report or any publication(s) that result from the study. At the very least, contributors of knowledge should be acknowledged by name in the project or publication, as is common practice in academic writing.

Analyzing the results

Which are the most commonly known and used plants? Is there consistency in the names of plants, how they are used, and, in the case of medicinal use, how it is prepared and how the doses given? In our own survey in the Hantam, we found that around 40 of the 120 plants are known by most of the participants, Name: .... Pseudonym: ....

Date of birth: ....

Where did you grow up?…………………………………………………………....

How well do you know the plants of the Hantam? ....

How/where did you obtain your knowledge of plants? ....

Plant	Use(s)	Know plant?	If yes, do you have a name for it?	Use(s) of plant?
Galenia africana (geelbos)	Wash yourself with it- skin diseases/ fungal infections			
Pelargonium antidysentericum (aree)	Used to treat dysenteric fevers			
Viscum capense (voëlent; mistletoe)	Drink as a tea			
Sutherlandia frutescens (kankerbos; kalkoenbos)[1]	Treating cancer, back ache, stomach problems, kidneys, diabetes & high blood pressure.			
Hoodia gordonii (ghôba; bitterghaap)	Used for oral thrush; edible- suppresses appetite.			
Hydnora africana (kanniekan)	Edible; used especially to conquer thirst.			

Figure 4. The Hantam instrument (an excerpt; our instrument included 120 plants).

and we were surprised by the consensus regarding the use of the plants and eventhe ways in w hich the medicinal plants were used, which plant parts were used, and how the decoction was prepared.

Writing the report

Students should submit a scientific report in which they explain their methodology and analyze their data. This is also an ideal project for reflecting upon the nature of science (including the role of novel ideas, methodology, cultural influences, publication, ethics, intellectual property, plagiarism, and many other important considerations). Are the findings based on empirical evidence? Have any of these plants been tested in a laboratory for safety and efficacy? (Refer to the article by De Beer & Whitlock in the April 2009 edition of *ABT* for more information on testing for antimicrobial activity.) Next, we would like to focus on a few controversial aspects, which may form part of students' reports.

○ Aspects to Consider in Students' Reports

The science vs. pseudoscience debate

We refer you again to the article by Howe (2009) – his table 2 should be most useful in guiding student thinking. Science demands empirical evidence. How did local people (or traditional healers) come to know that these particular plants are edible or of medicinal value? Does "Western Science" support these claims? Perhaps you could share a vignette or two with your students. In our case (Hantam region), we could mention the use of *ghaap* or *ghôba* (*Hoodia gordonii*), which is a popular food item (Figure 5) that is used locally to suppress hunger and thirst and also to treat stomach pain. (The Khoi-San hunters had to endure hunger and thirst on their hunting expeditions.) The appetite-suppressant properties of the

Table 3. Basic principles of ethics in research, with sources of information (adapted from Tapela et al., 2009).

Principle	What it means for students doing field work
1. Respect	Researchers should show respect for the background, culture, and life choices of the people they work with.
2. Historical awareness	Researchers should be aware of the historically disadvantaged social, political, and economic positions of many communities.
3. Reciprocity, mutual benefit, and equitable sharing	Both parties in the research should benefit from the interaction.
4. Process	A fair process of negotiation should be used that foregrounds flexibility rather than rigidity.
5. Full disclosure	Communities should be fully informed of the nature and purpose of the research.
6. Communication and due acknowledgment	Communities have the right to receive the printed (or written) outcomes of the research. (If possible, invite members to class when research presentations are held.)
7. Acknowledgment of different types of knowledge	Researchers should grant equal status to formal (e.g., scientific knowledge) and informal (e.g., local or traditional indigenous) knowledge.

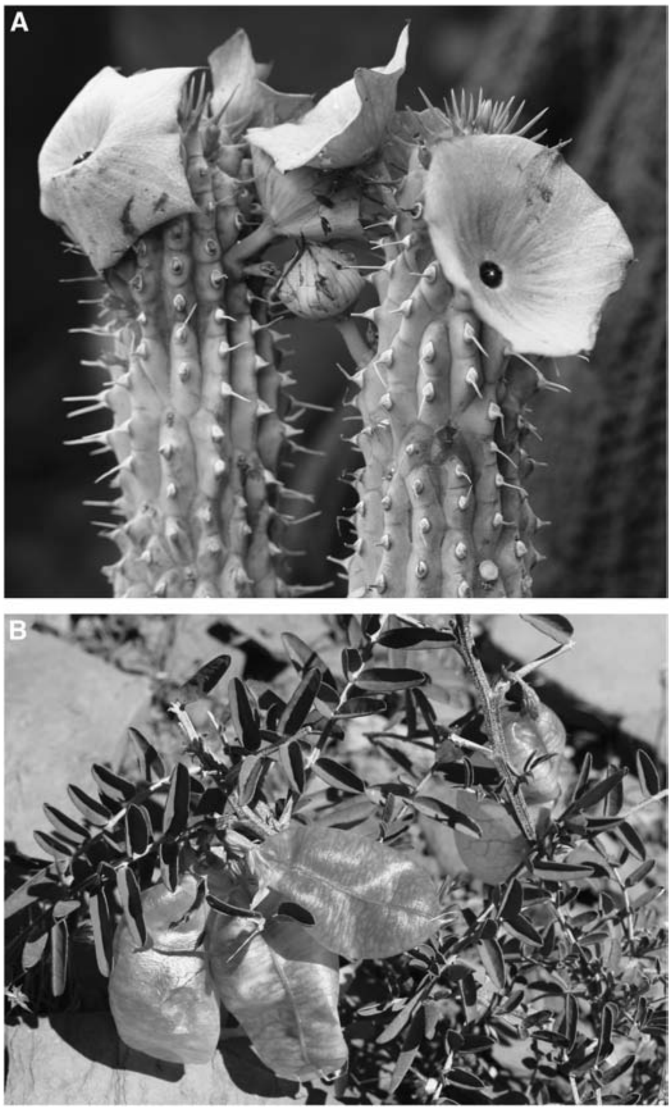

Figure 5. (A) Hoodia gordonii and (B) Sutherlandia frutescens.

plant have been studied scientifically and are ascribed to a chemical compound in the plant known as P57 (Van Heerden et al., 1998). This plant, sometimes incorrectly referred to as the "South African desert cactus," has become internationally famous as a potential anti-obesity drug. The economic implications are huge: the current market potential for dietary control of obesity is $3 billion per annum in the United States (Wynberg, 2004). Another example is the woody shrub *Dodonaea viscosa*, commonly known as *basterolien*. The tips of the leafy branches are used locally to treat colds, influenza, and stomachache (often as part of a mixture with other herbs). It is interesting to note that scientific (pharmacological) studies have clearly shown that leaf extracts of the plant have substantial antimicrobial and anti-inflammatory activity (Khalil et al., 2006). A famous example from North America is the purple coneflower (*Echinacea purpurea*), which is widely used as supportive treatment for colds and influenza. Most of the clinical studies done on extracts of this plant have shown statistically significant improvements in cold symptoms (Van Wyk & Wink, 2004).

Intellectual property rights

Hoodia gordonii (see Figure 5) also provides an interesting example of some of the ethical issues encountered in science (Wynberg, 2004). The earliest people in South Africa, the Khoisan, used it as an edible plant, and the fleshy stem provided needed water in a very dry part of the country. Research by the Council for Scientific and Industrial Research (CSIR) in South Africa showed that this plant, through the active ingredient P57, is an effective appetite suppressant. In the late 1990s, the American firm Pfizer was given the rights to develop *Hoodia* tablets as a commercial undertaking. However, questions were asked about the intellectual property rights of the indigenous (San) people, who have used this plant for many decades or perhaps many centuries. The CSIR therefore signed an agreement with a particular San group in the Kalahari, whereby they will receive royalties from the sales of this plant product. However, this also created problems – only one San community was acknowledged, whereas the plant is widespread in the drier areas in South Africa, and other communities were not advantaged by this contract. This may be one reason why Pfizer announced that it will no longer develop the commercial use of *Hoodia*, though restructuring of the company was given as official reason for withdrawal from the project. However, illegal trade in *Hoodia* has led to the plant becoming a threatened species.

Historical anecdotes

The importance of accurate documentation of historical data is also exemplified by the *Hoodia* example. Few South African plants have a more explicit early record of traditional use. The famous South African pharmacologist and botanist Rudolf Marloth recorded the following in his *Flora of South Africa*, volume 3:

> This is the real ghaap of the natives, who use it as a substitute for food and water.

Table 4. Ethnobotanical uses of plants in the United States (Dweck, 1997; Hoareau & DaSilva, 1999).

Scientific Name	Popular Name(s)	Uses	Medicinal Properties/Chemicals
Eupatorium perfoliatum	Boneset	Used by American Indians as a laxative and tonic	Contains volatile oil, tannic acid, and eupatorin
Podophyllum peltatum	Mayapple, Indian apple, umbrella plant	Used to treat gastrointestinal disorders, rheumatism, and intestinal worms	Podophyllin resin
Panax quinquefolium	Ginseng	Used to boost the immune system and relieve stress	Ginsenosides and protopanaxadiol; commercially available for relief of colds and flu
Thuja occidentalis	Thuja, cedarwood	Once used for treatment of psoriasis, rheumatism, and warts; American Indians made a tea of the bark to promote menstruation and to relieve headache	Contains high concentration of vitamin C, and essential oil that is used as a disinfectant
Echinacea angustifolia	American coneflower, Kansas snakeroot, hedgehog	Used to prevent inflammation (antiseptic), to relieve pain (analgesic), and to boost the immune system; the Omaha-Ponca used the root for toothaches and to treat snake bites; in recent times used to fight colds and flu	Echinacin extract has been found to have antifungal activity
Sanguinaria canadensis	Indian paint, red root, sweet slumber	Used to treat ringworm, fungal infections, ulcers, and skin diseases	Alkaloids such as sanguinarine, protopine, cholerythrine; and chelidonic acid
Simmondsia chinensis	Jojoba	The Apache Indians used it for healing wounds	Recent research has indicated that the oil is anti-inflammatory
Grindelia robusta	Gum plant	California Indians used the plant to purify blood; today it is used for treating dermatitis	Cerotic acid, phenolic substances, tannins
Helianthus annuus	Sunflower	The oil is used to treat psoriasis, relieves the pain of arthritis, and is used on bruises	Triglycerides of linoleic acid (fatty acid needed for good skin condition)

> The sweet sap reminds one of liquorice, and when on one occasion thirst compelled me to follow the example of my Hottentot guide, it saved further suffering and removed the pangs of hunger so efficiently that I could not eat anything for a day after having reached the camp. (Marloth, 1932)

Indigenous knowledge is fragile, because it is subject to modification and modern interpretation. Accurate records like this one are therefore of considerable cultural importance. The history of quinine (obtained from *Cinchona* bark) is extensively described by Balick and Cox (1996: p. 30). Few today know that on the Asian front during World War II, more American soldiers died from malaria than from Japanese bullets. The identities of the high-yielding strains of the *Cinchona* tree were never accurately recorded, and so the strategy to overcome a worldwide shortage of the alkaloid quinine met with mixed success. When doing their projects, students should also pay attention to the historical background and artifacts of the studied plants, as this can enrich the value of their research.

○ Using This Approach in the American Classroom

Although we have discussed indigenous plants that occur in the Hantam area, the approach can be adapted with ease for any area in the United States. Table 4 gives some examples of the ethnobotanical use of plants in your country – some of these are common plants, and not all are endemic or indigenous to the United States.

○ Conclusion

The methodology we have presented shows how the practice of contemporary science, as described in the following passage in the *National Science Education Standards* (NRC, 1996), can be complemented with an incorporation of indigenous knowledge:

> Science is a way of knowing that is characterized by empirical criteria, logical argument, and sceptical review. Students should develop an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to culture.

Implementing an ethnobotanical survey in the life sciences classroom can put students in touch with the cultural roots of science. The Relevance of Science Education Study showed that a very high negative correlation exists between students' perceptions of the relevance of science and the development index of the country (Sjøberg & Schreiner, 2006). The more developed a country, the more irrelevant students often find the curriculum. A possible reason for this is that curricula in developed countries subscribe to what C. A. Odora Hoppers (unpubl. manuscript) has called "cosmopolitan knowledge," anchored in Western philosophies and scientific discoveries that may be alien to some students. This "westernized" focus on biology is often at the expense of indigenous knowledge – a practice that Odora Hoppers (2004) has called "knowledge apartheid." Although indigenous knowledge is most often marginalized in the biology classroom, it sustains millions of people economically, socially, and spiritually. We believe that the described ethnobotanical survey provides an opportunity to address the latter, but also provides a vehicle to reflect on the nature of science.

References

Balick, M.J. & Cox, P.A. (1996). *Plants, People, and Culture: The Science of Ethnobotany.* New York, NY: Scientific American Library.

Brendler,T. & Van Wyk, B.-E. (2008). A historical, scientific and commercial perspective on the medicinal use of *Pelargonium sidoides*. *Journal of Ethnopharmacology*, *119*, 420–433.

De Beer, J. & Whitlock, E. (2009). Indigenous knowledge in the Life Sciences classroom: put on your De Bono hats! *American Biology Teacher*, *71*, 209–216.

Dweck, A.C. 1997. Ethnobotanical Use of Plants. Part 4: The American Continent. Available online at http://www.jojocare.co.nz.

Hoareau, L. & DaSilva, E.J. (1999). Medicinal plants: a re-emerging health aid. *Electronic Journal of Biotechnology* 2, August.

Howe, E.M. (2009). Henry David Thoreau, forest succession & the nature of science: a method for curriculum development. *American Biology Teacher*, *71*, 397–404.

Khalil, N.M., Sperotto, J.S. & Manfran, M.P. (2006). Anti-inflammatory activity and acute toxicity of *Dodonaea viscosa*. *Fitoterapia*, *77*, 478–480.

Marloth, R. (1932). *The Flora of South Africa, with a synopsis of the South African Genera of Phanerogamous Plants, Volume III*. Cape Town, South Africa: Darter Bros.

Martin, G.J. (1995). *Ethnobotany – A 'People and Plants' Conservation Manual*. London, UK: Chapman & Hall.

National Research Council. (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

Schapera, I. (1930). The Khoisan Peoples of South Africa. London, UK: Routledge & Kegan.

Shelley, C.L. (2009). Ethnobotany and the process of drug discovery: a laboratory exercise. *American Biology Teacher*, *71*, 541–547.

Sjøberg, S. & Schreiner, C. (2006). How do learners in different cultures relate to science and technology? *APFSLT: Asia-Pacific Forum on Science Learning and Teaching*, 7(1).

Tapela, B., Buscher, B., Maluleke, L., Twine, W & Steenkamp, C. (2009). Guidelines for negotiating social research in communities living adjacent to transboundary protected areas: Kruger National Park. Johannesburg, South Africa: University of Johannesburg.

Van Heerden, F.R., Vleggaar, R., Horak, R.M., Learmonth, R.A., Maharaj, V.J. & Rory, D.W. (1998). CSIR, South Africa. Patent Application WO 9846243 Al.

Van Wyk, B.-E. & Wink, M. (2004). *Medicinal Plants of the World.* Portland, OR: Timber Press.

Withering, W. (1785). *An Account of the Foxglove, and Some of Its Medicinal Uses.* Kessinger Publishing.

Wynberg, R. (2004). Rhetoric, realism and benefit sharing: use of traditional knowledge of *Hoodia* species in the development of appetite suppressant. *Journal of World Intellectual Property*, 7, 851–876.

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