ABSTRACT

The relationship between human activity and the environment has created ecological, socio-economic and cultural patterns and feedback mechanisms that govern the presence, distribution and abundance of plant species assemblages. The trade in traditional medicinal plants in South Africa is estimated to be worth approximately R2.9 billion per year with 27 million consumers throughout the country. Bulbous species compose about 14% of the traded medicinal plant species in South Africa, however the majority of research at the species or generic level has concentrated on a limited number of life forms and plant parts and the ecological consequences of harvest and use of commonly used bulb species is poorly known. Ethnobotanical studies generally focus on 'ethnospecies' – i.e. the traditional name that a species may be known by. Species-specific evidence of the effects of trade and harvest is needed to provide more clarity on the implications of trade, especially since increased commercialisation of medicinal plants has often resulted in over-harvesting and, in severe cases, near extinction of valued indigenous plants. The overall aim of this study was to determine the ecological consequences, as well as some of the economic implications of harvesting important bulb species for the regional medicinal plant trade.

Traditional medicinal bulb species are susceptible to over-exploitation because they are destructively harvested in large quantities. Four perennial bulbous genera were surveyed: two within the Amaryllidaceae (*Boophone* and *Crinum*) and two in the Hyacinthaceae (*Bowiea* and *Drimia*). Some discrepancies were noted where traders and traditional healers recognised species that have been synonymised by taxonomists. In order to understand the impacts of all recognised forms, original nomenclature was used to describe different bulb forms that had been synonymised. The proposed 'functional taxonomy' does not aim to re-examine the taxonomic revisions by previous taxonomists but rather provides a way to identify forms that have no accepted species name. In this way, the impacts on harvesting of different bulb forms can be quantified. Based on this functional taxonomy, the genus name *Urginea* has been used although *Urginea* is currently synonymised under *Drimia*. However, this is only to describe the different bulb form and is not meant to replace the current taxonomic nomenclature. Surveys were conducted in two national level and two small regional level markets to determine the impacts of trade. Bulb characteristics were described and used together with taxonomic literature to produce a key to bulbous species commonly traded in the markets of South Africa. Distribution data and other important information were collected and combined to provide species-specific information. Identification based on vegetative characteristics was possible, with certain features being more useful than others for creating a key. The most useful identification characteristic was the bulb scale type in the Hyacinthaceae together with bulb shape and colour, while bulb size was least useful. For the Amaryllidaceae, bulb colour and characteristics such as tunics cannot always be used due to similarities between species. However, bulb size and shape are helpful indicators and can group species into classes of similar species. Leaf characteristics are very important and may be the only way to accurately identify some species. The adaptation of taxonomic information and previous keys into more 'vegetative' friendly keys can provide ethnoecologists with an identification tool not solely based on ethnospecies name. The ability to identify species will allow ethnoecologists to provide more comprehensive assessments on the impact of the trade.

The diameter of bulbs sold at Faraday market (Johannesburg), Warwick market (Durban) and smaller Free State markets were recorded for four genera (*Bowiea, Boophone, Crinum,* and *Drimia* – including *Urginea* forms), and the data were used in a variety of ways to determine the effects of trade. Populations of species of anthropogenic importance should show a corresponding decrease in the frequency of individuals in large size-classes and a decreased number of size-classes with time. Size-class distributions of *Drimia delagoensis* and *Bowiea volubilis* followed an inverse J-shaped curve, often indicative of a regenerating population (high frequency of small bulbs); however, in this case intense harvesting pressure has resulted in a highly skewed population structure. High rates of harvesting will ultimately result in regeneration failure because smaller bulbs are unable to reach maturity before harvest. All species studied tended towards smaller mean market bulb diameters over time. These trends suggest that without appropriate mitigation, bulb populations will be further

impacted in the future. Bulb diameters in the market were also smaller than diameter records collected from herbarium material and literature records. *Bowiea volubilis* is the most severely impacted by the medicinal plant trade, with approximately 87% of bulbs <4cm in diameter, and significantly smaller than both bulb diameters in medicinal plant markets in 2001 ($p<0.0001$) and pressed bulbs from several herbaria ($p<0.0001$). The large bulbed Amaryllidaceae species *Boophone disticha* and *Crinum* species also showed a decrease in bulb diameter between the 2001 and 2007 Faraday surveys (by 1.5cm and 2.7cm, respectively), while *Urginea epigea* (Hyacinthaceae) showed a 1.2cm decrease in mean size in 6 years.

Traditional healers, traders and harvesters can provide a wealth of information on species populations in the wild. Trader and harvester preferences may affect the impact of harvesting and trade on wild populations. Information on trader/harvester preferences and perceptions was gathered from Warwick and Free State markets. Overall, the average earnings per month per trader selling medicinal plants were low (approximately R833 in Warwick and R2,100 in Free State). Bulb species contributed 10-40% of the total earnings per trader at Warwick and 10-50% in the Free State markets. The relatively large contributions of bulb species to trader incomes emphasise the importance of popular bulb species economically and socially. The number of bulbs (equivalent in size to the mean bulb diameter) harvested annually was large and provides an order of magnitude estimate of harvesting impacts on medicinal plant species populations. The number of *Drimia elata* harvested was greatest in the Free State (between 600,000 and 1,400,000 dependent on estimation method). In Warwick, species sold in the largest quantities were *D. robusta*, *Crinum* species, *B. volubilis* and *U. epigea* (approximately 400,000 – based on actual volume). The high variability of number of bulbs harvested between traders suggests that these numbers should be treated with caution.

The number of populations required and the rate of population regeneration needed to sustain harvesting for the traditional medicine trade is extremely high; and, without mitigating factors, the increased commercialisation of the medicinal plant industry may have potentially dramatic, negative implications on popular bulb populations. Social surveys and ethnobotanical work in local markets are the first steps in understanding patterns of demand for particular plant species, and integrated with population structure and size-class distributions, it allows for an amalgamated and complex awareness of the impacts of resource harvesting. With over 30,000 species of animals and plants that are detrimentally affected by trade worldwide, market surveys are increasingly important to provide information on the extent of trade. The varied data collected in this study included: size-class distributions, temporal changes in bulb diameter, volume and number of bulbs harvested, economic value and trader perceptions. Overall, the results suggested that all species studied were negatively impacted by harvesting to various degrees. In South Africa, harvest and trade is sometimes the only form of income generation and harvest can threaten species populations. By quantifying the volume, value and the number of individuals harvested for bulb species, together with perceived scarcity and popularity and place of harvest, a better understanding of the state of the resource-base has been provided. Continued use of market surveys as monitoring tools is important, because in the current (2011) socio-economic context of South Africa, trade and harvest is likely to increase.