Chapter 25
Wildlife trade

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Introduction

Wildlife trade and its effects

Wildlife trade is the trading of living or dead wild plants, fungi, or animals, either as whole organisms or as parts and the products derived from them. This varies from rare animal and plant species for collectors, to ingredients made of wild organisms for medicinal or cosmetic purposes, to wood for timber, paper, craftwork, and construction, and various animals, plants, and mushrooms for nutritional purposes. Although conservation concerns about the unsustainable use of wildlife became more prominent from the 1960s onward, evidence shows that large-scale wildlife trade is older than the Roman Empire and ancient Greek civilisations ('t Sas-Rolfes et al. 2019). International wildlife trade is a billion-dollar industry, and together with illegal wildlife trafficking, it has become a substantial threat to global biodiversity and the preservation of endangered species (Smith et al. 2017). In addition, the overall impact of wildlife trade on national economies as well as public health is largely underestimated (Kurland et al. 2017; Rosen and Smith 2010).

The impacts of wildlife trade are substantial with both conservation and socio-economic importance. Unsustainable trade could lead to (local) extinction of populations or even entire species. For plants that occupy a specialised niche, it can destabilise interactions with other species, with potential consequences for the entire ecosystem. Therefore, after habitat loss, wildlife trade is the second-biggest threat to species survival (WWF, 2020). Not only does illegal wildlife trade threaten biodiversity due to consistent overexploitation, it also competes with legal use of natural resources and results in a substantial loss of income for both local communities and governments (Cooney et al. 2015). Many source countries rely on the products and/or income generated from wildlife trade, meaning that the livelihoods of the people that depend on it would be compromised if these species go extinct or if trade would be banned. In some areas in Tanzania, for example, illegal chikanda orchid gathering is the primary economic activity for vulnerable HIV/AIDS-affected households (Challe and Price 2009), although resellers further down the supply chain actually profit the most from this trade (Veldman et al. 2014). The best-known examples of wildlife trade in plants can be found in timber commerce (e.g., rosewood and ebony wood), for which the legal market has an annual value of around $200 billion and the illegal market an estimated annual $30–$157 billion (Jenkins et al. 2018; World Bank 2019). Furthermore, it is estimated that 60–90% of medicinal and aromatic plants are harvested from the wild, among which several high-value species, such as sandalwood (*Santalum* spp.), agarwood (*Aquilaria* spp.), African cherry (*Prunus africana*), and American and Chinese ginseng (*Panax* spp.) (Jenkins et al. 2018). Moreover, several groups of plants are traded for ornamental purposes, including species from threatened taxa such as cycads, cacti, aloes, conifers, euphorbs, and orchids. An overview of the global hotspots for wildlife trade, with some examples of plant groups targeted, is given in Figure 1.

Regulating wildlife trade

In order to regulate the trade in vulnerable wildlife, the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) was established in 1975. Species at risk of overexploitation due to international trade are listed on one of three appendices depending on how much they are threatened by unrestricted trade. Appendix I lists the most endangered species, for which commercial trade is not permitted - except for pre-convention material - and for which non-commercial trade is strictly regulated. Appendix II lists the species that may become extinct if trade is not carefully controlled, which therefore requires a proper permit. Finally, Appendix III lists species that are protected in at least one country and other CITES Parties assistance is required to control the trade. Listing species on Appendix III helps to establish international cooperation in order to control trade in the species according to the laws and regulations of that country. Species can be added to Appendix I and II or removed from them, or shifted from Appendix I to II and vice versa only by voting at a Conference of the Parties (CoP), which is a meeting of the CITES Parties to review the implementation of the Convention. Species can be added to Appendix III or removed from it at any time and by any Party unilaterally (CITES, n.d.).

At the moment, roughly 39,000 species, including ca. 6000 species of animals and ca. 33,000 species of plants (395 species in Appendix I, 32,364 species in Appendix II, and 9 species in Appendix III) are protected by CITES (CITES, n.d.). In countries that are signatories to the convention, import and export permits must be issued for international trade of plants and animals listed in these appendices. Some countries set annual export quotas for certain species to ensure that they will not be traded beyond the sustainable limits for species survival. Non-compliance with CITES regulations can lead to confiscation of the material as well as fines and prison sentences, and in some cases trade sanctions against a country (CITES, n.d.). Since 2017, CITES has also facilitated the Wildlife Cybercrime Working Group that has coordinated national responses to the threat posed by online trade (Sajeva et al. 2013).

Other international and national regulations have been put into place to support the implementation of and in some cases expand on CITES regulations. Examples are the EU Action Plan Against Wildlife Trafficking (European Commission 2016), the EU Wildlife Trade Regulations (European Commission 2010), European Union Timber Regulation (EUTR), United States LEMIS wildlife trade data (Eskew et al. 2020), and the United States Lacey Act (Anderson 1995). Under the National Legislation Project (NLP), various domestic measures need to be implemented in order to meet the four CITES criteria, without which the CITES regulations are not in force at the national level: countries need to designate at least one Management Authority and one Scientific Authority; prohibit trade in specimens in violation of the Convention; penalise such trade; or confiscate specimens illegally traded or possessed. Diverse governmental and non-governmental programmes exist that implement enforcement in source, transit, and consumer countries, and are used to increase the risks of being involved in illegal wildlife trade as well as to decrease the rewards. In terms of global law enforcement, INTERPOL examines websites and social media posts offering wildlife products for sale. This happens annually and a number of seizures and arrests take place every year.

Challenges in combating wildlife trade

Despite the fact that plant species far outnumber animal species on the CITES appendices, in the public discourse on wildlife trade and conservation, charismatic mammals such as elephants, rhinos, tigers, and lions usually take centre stage. Smaller animals (e.g., insects, molluscs), but also most plant groups, receive less attention and generate less funding in discussions regarding wildlife trade and conservation. And although plants appear frequently in national and international regulations, regulatory enforcement and additional conservation measures still primarily target iconic megafauna (Margulies et al. 2019). The relative ‘invisibility’ of plants as organisms of importance for our lives and worthy of conservation is called “plant blindness”, and is one of the biggest challenges in combating illegal plant trade (Box 1).

Chapter 25: Box 1. Example of a challenge in depth: plant blindness

Plant blindness is a psychological bias that leads us to notice (large) animals, and take plants largely for granted, reducing them to background vegetation for other organisms. The term was coined by Wandersee and Schussler (1999) and refers to a number of common problems in the perception of plants: not noticing plants in one's environment; ignoring plants' aesthetic and unique biological features; not recognising the importance of plants (e.g., food production, absorbing carbon dioxide and releasing oxygen, etc.); and considering plants as inferior to animals. Plant blindness has both a physical and a psychological component. The human eye picks-up the colour green more easily than other colours, and hence does not focus on it quite as much (Knapp 2019). Green is also experienced as safe and therefore warrants limited attention. Furthermore, our eyes perceive movements more readily than static objects, which probably stems from an evolutionary function in spotting (attacking) predators and (fleeing) prey.

Plant blindness has been institutionalised throughout society, from (higher) education to governance and wildlife management (Margulies et al. 2019; Wandersee and Schussler 1999), leading to a focus on animals in biology courses, natural history museums, research funding, and conservation policies. Plant blindness is therefore one of the biggest challenges in combating illegal wildlife trade.

Apart from the limited attention that plants receive in research, education, and conservation, effective control of trade in plant species is hampered because some of the traded goods are difficult to recognise, either because they are processed or because they contain only parts of the organism, which lack the morphological characters needed for identification (Lavorgna et al. 2018). Plant products are therefore often harder to identify than living animals or animal parts, and to identify them routinely requires standardised and scalable technologies, many of which are still being developed (for more details, see Methods).

Other challenges are posed by the growing use of the internet for transactions, which makes wildlife material more readily accessible and at lower costs, while preserving anonymity. The internet is not only increasingly used to sell and obtain specimens, but even to organise poaching events (Lavorgna 2014). Rare and exotic plant species can be ordered with ease from a range of online retailers, shipping of plants in the postal system is relatively easy and the search for plant material in these systems is limited. In addition, the scale of the internet and speed at which online marketplaces proliferate make the monitoring of online criminal activities costly and time consuming (Lavorgna et al. 2020; TRAFFIC, 2019). The online market thus facilitates participation in illegal wildlife trade, making it more attractive due to potentially high sales and profits and reduced detection rate (TRAFFIC, 2019). The challenges for curbing illegal online trade are therefore manifold, and only exacerbate existing challenges with law enforcement by enabling covert activities and thereby increasing the volume of illegally traded goods. Distinguishing legal from illegal trade is difficult even with specialist knowledge or extensive training (Vaglica et al. 2017). Mixing legal and illegal shipments, nontransparent supply chains and lack of institutional monitoring capacity in biodiversity rich countries are some of the practical challenges underpinning this difficulty (Engler and Parry-Jones 2007). International conventions such as CITES can also have unintended loopholes that allow wildlife traffickers to circumvent restrictions or to present their information in a way that gives the impression of legal trade. For example, newly discovered rare species that have not yet made their way onto one of the CITES appendices can often be traded freely, despite detrimental effects, if there is no national legislation in place to protect the species. Another commonly observed practice is the export of wild harvested or poached wildlife as captive bred (in the case of animals) or artificially propagated (in the case of plants) organisms. Verification of legal acquisition can be challenging without sufficient documentation, opening up space for laundering of illegally obtained specimens.

Lastly, since international wildlife trade per definition transcends borders, enforcement of legal trade requires coordinated action between multiple countries to address the whole supply chain. While there are already many institutional collaborations that work across international borders to help track and catch illegal wildlife trafficking syndicates - including financial institutions, NGOs, customs and police forces and online tech platforms - one of the main bottlenecks to combating wildlife trade will be to sustain sufficient international attention to allow the detection and prevention, not just of single illegal transactions, but of organised trade networks operating at larger scales.

The importance of wildlife and the impacts of unsustainable trade on biodiversity are undeniable, which highlights the urgency of developing high-throughput methods that are widely applicable. The next section presents some of the most commonly used methods in illegal trade identification today. In the final section, we provide recommendations on which techniques to use for the identification and tracking of illegally traded plants, and discuss future developments that could improve global wildlife trade monitoring and control.

Methods for identification of plants in trade

Traded plant materials come in all shapes and sizes and in different stages of processing, ranging from complete living plants to raw timber logs and to engineered wood products. There is a wide variety of molecular and non-molecular methods for illegal wildlife trade monitoring, from DNA (meta) barcoding and genetic methods, to chemical identification, and computer vision and pattern recognition tools. Each of these methods is applicable to certain types of materials and requires knowledge about different aspects of the traded product that determines its legality, including species identity, geographic origin, source population (wild or cultivated), and the sample age. Here we describe the most commonly used methods to identify each of these aspects, and why they are important.

Species identity

Methods for species identification are used to ascertain whether the organism being traded is CITES-listed or not. Depending on the taxonomic rank that is listed, it may be necessary to identify the exact species (e.g., *Panax ginseng*), genus (e.g., *Aloe* spp.), or family (e.g., Orchidaceae) to which an organism belongs. Species identification methods include genetic based methods (based on DNA sequencing information), chemical methods (based on molecular mass spectra), and computational methods (based on image recognition). Each of these methods require suitable reference data against which to query an unknown sample. The availability of reference data and the nature of the sample will dictate which method is most suitable for species identification.

Mass spectrometry

The main chemical method used to identify species is Direct Analysis in Real Time (DART) coupled with time-of-flight (TOF) mass spectrometry (DART-TOF MS). DART-TOF MS consists of two parts: DART is an ionisation source that ionises ambient atmospheric molecules by using electronically excited-state helium which reacts with the molecules in the investigated sample to produce analyte ions (Gross 2014). These ions are then sucked into the AccuTOF mass spectrometer. Spectral data on molecular masses and their relative intensities (so called chemical fingerprint) can be analysed to identify timbers (Deklerck et al. 2020; Evans et al. 2017; Lancaster and Espinoza 2012), keratin fibres of camelids (Price et al. 2020), rhinoceros keratin (Price et al. 2018), explosives (Lennert and Bridge 2018), and narcotics (Lian et al. 2017). DART-TOF MS is fast and has a simple sample preparation procedure. The accuracy of the result is however dependent on the reference database - as is the case for all other species identification methods - and whether the investigated samples have enough variation in molecular composition to be distinguished with their chemotype (Deklerck et al. 2017).

Computer vision and pattern recognition

Thanks to machine learning and computer vision, expert systems are playing an increasingly important role in identification of a wide variety of wildlife related objects, such as medicinal leaves (Sabu et al. 2017), herbarium specimens (Lorieul et al. 2019; Pearson et al. 2020), wood identification (Lens et al. 2020), mulberry ripeness detection (Ashtiani et al. 2021), pollen grains (Polling et al. 2021), corn seed varieties detection (Javanmardi et al. 2021) and wildlife monitoring (Di Minin et al. 2019, 2018). The concept of this method is pretty simple: train a model using a reliable database (usually an image database) to recognise specific objects such as humans, cars, trees, etc, in an image that the model has not seen before. Not only images (e.g., light microscopic images) can be used as input data, but also Near infrared (NIR) spectroscopy and X-ray micro computed tomography (CT) data can be used for automated pattern recognition. These are nondestructive alternative methods that can be useful when the conventional methods (such as light microscopy or DNA-based methods) are not acceptable or difficult to use, as is often the case in the investigation of registered cultural objects (Kobayashi et al. 2019). The main advantage of using computer vision methods is that it is accurate and applicable on a wide range of materials, such as wood, leaves, flowers, and pollen grains. The main drawback of computer vision, apart from a general lack of reliable databases, is the insufficient resolution of many morphological traits for species recognition, especially amongst closely related species. In some cases, better algorithms, more powerful machines, and high-quality reference databases can mitigate this challenge. However, in the cases where morphological traits do not provide distinctive features, pattern recognition cannot be used.

DNA barcoding and metabarcoding

DNA-based identification methods can use different genomic markers that offer different levels of identification, from universal loci such as conserved genes or intergenic spacers, to neutrally evolving markers with sufficient variation to resolve specific taxa, such as microsatellites and genome-wide Single Nucleotide Polymorphisms (SNPs). In addition to these markers, which require information about genomic context, it is also possible to identify species and populations using alignment-free shotgun data (see Chapter 17 Species delimitation).

For species identification, DNA barcoding (see Chapter 10 DNA barcoding) is often the method of choice. It can effectively identify traded plant species in a number of cases, including the identification of rosewood (*Dalbergia* spp.), species used in Ayurvedic medicine (*Decalepis* spp.), and cycads (*Encephalartos* spp.) (Hartvig et al. 2015; Mishra et al. 2017; Williamson et al. 2016). In addition, DNA metabarcoding (see Chapter 11 Amplicon metabarcoding) detects multiple species in mixed products such as traditional medicine and processed foods (Arulandhu et al. 2017; Veldman et al. 2017). An advantage of DNA barcoding is that, for the core land plant barcodes such as *rbcL*, *matK*, and nrITS, reference data is readily and freely available in public databases such as NCBI's GenBank or BOLD (barcodinglife.org). Tropical species are generally under-represented in these databases, and NCBI GenBank is known to contain erroneous sequences due to limited quality control. Species-level discrimination using standard barcodes has proven to be difficult among closely related and hybridising species, as well as taxa with low rates of evolution (Hassold et al. 2016; Veldman et al. 2017). An alternative in these cases is to develop custom barcodes. This provides researchers with more control over choosing genomic features that are informative for their plant group, but requires generating novel reference data, raising both the financial costs and time investment.

Source population and geographic origin

Neutral genetic markers

An advantage of DNA barcoding is that the sequence data is universally comparable among labs and large numbers of species. But since DNA barcoding was originally meant to distinguish between species and not within species, this method often falls short when higher resolution is needed. Identification below the species level may be useful if the legality of trade is determined by the source population. In some cases, the country of origin determines the legal status of traded plants, which requires population level data for a collection of reference samples spanning the species range. Cost-effective traditional population genetic methods use a number of species-specific variable markers, typically simple sequence repeats (SSRs) or inter simple sequence repeats (ISSRs), which can be highly variable and show fine-grained population structure. More recently developed high-throughput sequencing methods cover larger sections of the genome, such as reduced representation sequencing methods (RAD-seq, target capture, or low coverage whole genome shotgun sequencing (also known as genome skimming, see Chapter 16 Whole genome sequencing).

These methods can generate large numbers of SNPs that allow inference of geographic origins at various scales. Although the increased costs for library preparation and sequencing means that these methods are not economically feasible in all cases, they offer the added advantage that functional analyses of genes or markers linked to genes with adaptive significance is possible.

Geographic origins have even been identified at the level of continents using genome skimming (Schroeder et al. 2016), at the level of countries with SNPs generated by target enrichment of nuclear loci (Manzanilla et al. 2022) and RAD-seq (Blanc-Jolivet et al. 2017; Pakull et al. 2020), and even at the level of individual forest concessions with microsatellites (Vlam et al. 2018). Population genetic methods could potentially also be useful in detecting laundering of illegally harvested plants that are claimed to be cultivated. Genetic diversity analysis of the same neutral markers that are used to infer geographic origin, could then point out whether the plants were indeed sourced from a particular plantation or rather from the wild - in which case their genetic composition would be much more diverse than expected from artificially propagated material.

Stable isotope analysis

While population genetic markers can offer unmatched resolution of spatial variation, a general disadvantage is that many of them (with the exception of those used in RAD-seq and shotgun sequencing) need to be tested or developed specifically for each species, and reference data must be generated for populations across the distribution range to be tested. Stable isotope analysis can also infer geographic origin of samples, and does not depend on species-specific reference data to the same extent as genetic methods do. Stable isotope analysis is based on the principle that the presence of stable isotopes in the environment depends on both climate and geography. This creates a correlation between the stable isotope profile and its geographic location (Hermes et al. 2018). Since plants generally incorporate the stable isotopes into their tissue at the same ratios as they occur in their environment, stable isotope analysis of plant material can be used to infer its geographic origin and be a tool in wildlife forensics (Matos and Jackson 2019). Stable isotope analysis however does not have a geographic resolution as high as population genetic methods have (Gori et al. 2015; Horacek et al. 2009). Georeferenced data is also required for stable isotope analysis, and global isotope databases are currently not freely available yet (Camin et al. 2017), limiting broad application of this method.

Harvesting pre- or post CITES legislation

Radiocarbon dating

There are two methods to measure radiocarbon abundance: radiometric dating and accelerator mass spectrometry (AMS). These methods can be used to date samples based on the decay of carbon isotopes. The estimated age gives an indication of whether or not the traded sample is a pre-convention material, meaning that the traded material predates the convention or listing of the species (e.g., Kalt-O'Bannon 1994; Uno et al. 2013; Cerling et al. 2016). While both radiometric dating and AMS provide high quality results, they are fundamentally different. AMS quantifies the number of carbon 14 (^{14}C) atoms in the investigated samples, while radiometric dating methods are based on the detection of beta particles resulting from the ^{14}C decay. AMS requires a much smaller sample size (20–500 mg) compared with radiometric methods (10–100 g). AMS is also faster and usually gains higher precision results than radiometric methods. Samples can be analysed in a few hours with AMS, while it can take one or two days with radiometric methods.

Recommendations to improve wildlife trade monitoring

Currently, no genetic methods for inferring sample age can compete with radiocarbon dating, and while DNA fragment sizes tend to be shorter for older and more degraded plant tissues, this alone cannot be used to determine the plant age (see Chapter 2 DNA from museum collections). For other purposes, genetic markers are the method of choice to infer species identity and geographic origin, whenever DNA extraction is a realistic option. Any genetic method will however be limited by the quality and quantity of DNA that can be extracted, which can be notoriously difficult for some materials, especially timber and processed products (Jiao et al. 2020; Lo and Shaw 2018). The obtained DNA quality and quantity will influence the range of techniques that can be applied downstream. High-copy regions such as chloroplast markers or nuclear ITS, for example, are easier to retrieve from samples with highly degraded DNA than low copy nuclear markers. For applications that require broader genomic coverage, amplification of low copy nuclear target regions can be achieved even with highly fragmented DNA, making target capture preferable over untargeted RAD-seq or genome-wide shotgun sequencing for degraded samples. However, for fresher material RAD-seq or WGS libraries may be easier to prepare and require less time for the bioinformatic analyses needed to develop markers prior to sequencing.

Despite significant progress in methods and computational analyses, applications for most methods are still limited by the lack or incompleteness of suitable reference data. As shown in Table 1, reference databases are currently under development or need further development for nearly all the methods currently used. The ForeST database for CITES protected timbers, the U.S. Fish & Wildlife Service Forensics Laboratory (Ashland, Oregon, USA), CITESwoodID by the

Thünen Institute (Hamburg, Germany), and the ebony wood microscopic database (Jahanbanifard et al. 2020, 2019) are examples of ongoing projects that are developing databases for the identification of CITES protected species.

When one method lacks sufficient reference data or is not sensitive enough to infer species identity or population of origin, multiple identification techniques tools (e.g., DNA barcoding, machine learning, and DART-TOF MS) can be combined to improve identification accuracy. Developing an integrated identification framework, which links reference databases and connects multiple sources of data for taxa of interest, is expected to play a major role in the future of regulating wildlife trade, though this would rely on standardisation and equitable distribution to enforcement agencies around the world. Coupled with new technologies that ensure quality control and compliance across the supply chain of wildlife products, the tools available for wildlife trade monitoring can aid not just the detection and confiscation of illegally traded goods, but also the transparency and traceability of legally traded commodities.

With blockchain for example, it may eventually be possible to develop a secure and robust infrastructure to register and track wildlife-related products from source to destination (Chang et al. 2020; Pournader et al. 2020). A blockchain is a database, consisting of several distributed nodes called blocks that are connected to one another using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data (Narayanan et al. 2016). Blockchain provides an immutable and decentralised network which increases its reliability and security as no single party has full control of the system and no one can manipulate the transactions (Aimin and Yunfeng 2019; Saurabh and Dey 2021; Zheng et al. 2020).

The technology has already proven its relevance in agriculture and fisheries, where the WWF Blockchain Tuna Project demonstrates it is possible to track the history of a fishing product from ocean to plate with just a QR Code (WWF, 2018). The customisable and scalable features of blockchain make it a promising technology for application to traded timber and other wildlife-related products (MoonX, 2019). Once it is possible to keep track of all steps taken throughout the commercialisation of wild harvested plants, the checkpoints for identification will no longer be restricted to points of entry or sales, enabling monitoring of wildlife trade from the source.

Table 1. A comparison of the methods used for identifying plants in trade with an indication of their applications and limitations.

	DNA (meta) barcoding	Population genetic markers	Computer vision and pattern recognition	DART-TOF MS	AMS/ ^{14}C dating	Stable isotope
Material input	Whole plants, organs, tissues, powder	Whole plants, organs, tissues, powder	Timber, leaves, flowers, pollen	All	Anything containing organic matter	Anything containing organic matter
Purpose of application	Determine taxonomic identity from genus to species level	Determine population or region of origin	Determine taxonomic identify, from genus to (sometimes) species level	Determine taxonomic identity at species level	Determine age of material	Determine the region of origin
Availability of reference data	Well-developed for temperate species, less for tropical species and regions	Needs to be developed and referenced for each species separately	Being developed for CITES protected timber and plants	Being developed for CITES protected timber	Calibration might be required depending on the sample	Needs to be developed for each region separately

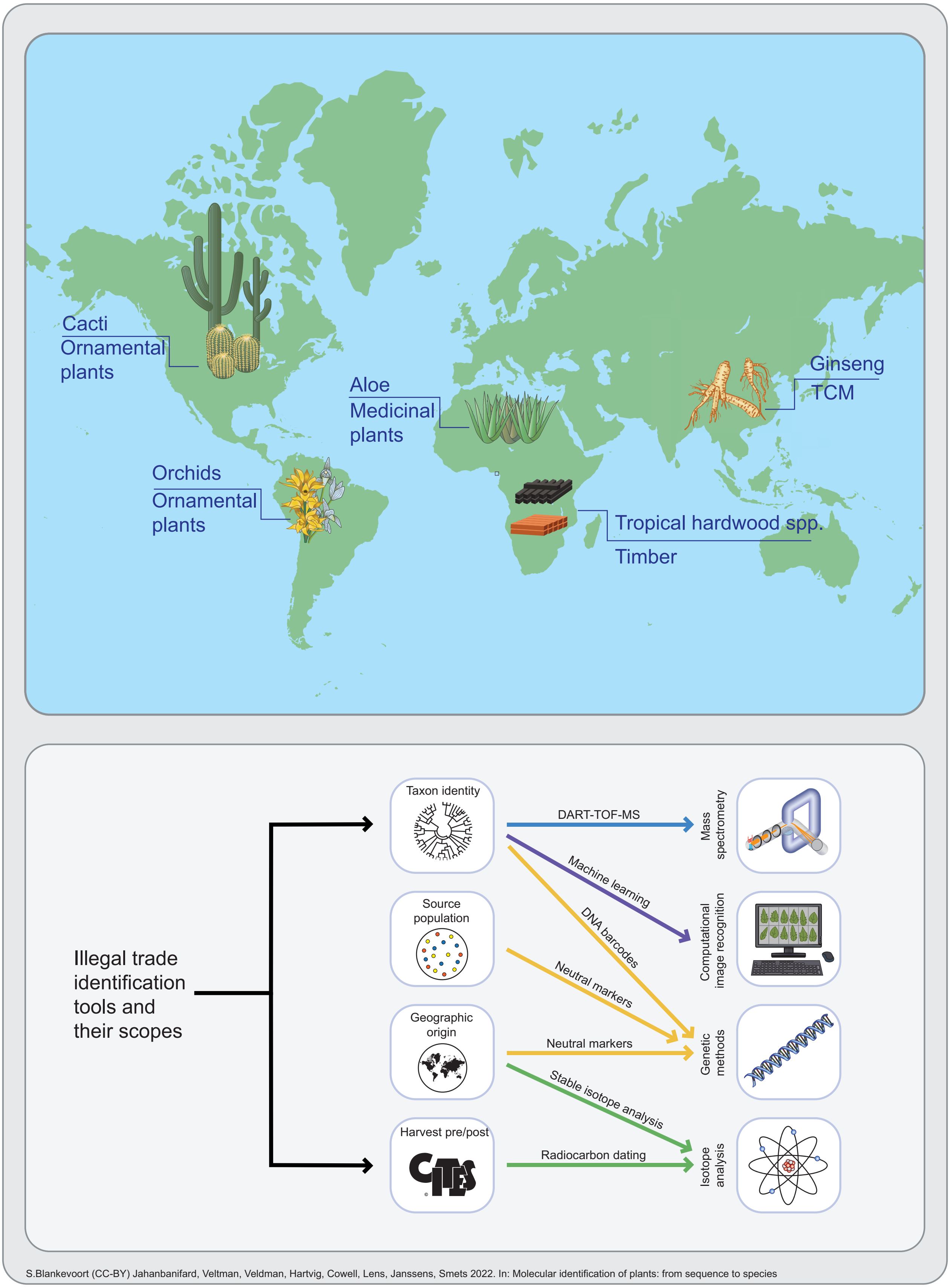

Figure 1. Chapter 25 Infographic: Global wildlife trade hotspots and some examples of traded plants from those areas, and their respective uses (ornamental, medicinal, or timber).

Questions

1. Customs officers often come across cultural heritage such as sculptures made from economically costly, legally protected wood (such as Brazilian rosewood). Which method could they use to find out whether the sculpture is made from CITES-listed species? Motivate your answer.
2. What is "plant blindness" and why is it hampering the battle against illegal plant trade?
3. Provide two advantages of AMS over radiometric dating when investigating illegal wildlife trade. Motivate your answer.

Glossary

Accelerator Mass Spectrometry (AMS) – A form of mass spectrometry that accelerates ions to extraordinarily high kinetic energies before mass analysis.

Ayurvedic medicine – A medical system from India that aims to cleanse the body and to restore balance to the body, mind, and spirit by using diet, herbal medicines, exercise, meditation, breathing, physical therapy, and other methods.

Blockchain – A decentralised and distributed network that is used to record transactions across many computers.

Computer vision – An interdisciplinary scientific field that deals with how computers can gain high-level understanding from digital images or videos.

Expert systems – In artificial intelligence, an expert system is a computer system emulating the decision-making ability of a human expert.

Inter-simple sequence repeats (ISSRs) – ISSRs are regions in the genome flanked by microsatellite sequences. PCR amplification of these regions using a single primer yields multiple amplification products that can be used as a dominant multilocus marker system for the study of genetic variation in various organisms.

Near infrared spectroscopy – A spectroscopic method that uses a certain range of the electromagnetic spectrum from 780 nm to 2500 nm which is called the near infrared region.

Pattern recognition – The automated recognition of patterns and regularities in data.

Restriction site Associated DNA Sequencing (RAD-Seq) – A fractional genome sequencing strategy, designed to interrogate anywhere from 0.1% to 10% of a selected genome.

Simple sequence repeats (SSRs) – SSRs are DNA tracts in which a short base-pair motif is repeated several to many times in tandem. These sequences experience frequent mutations that alter the number of repeats.

Spectroscopy – The study of the interaction between matter and electromagnetic radiation as a function of the wavelength or frequency of the radiation.

X-ray microtomography – A 3D modelling method uses X-rays to create cross-sections of a physical object that can be used to recreate a virtual model without destroying the original object.

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Answers

1. Any non destructive method would be potentially usable such as near infrared spectroscopy or X-ray micro CT, to preserve the samples in their original form.
2. Plant blindness is the bias towards animals, and taking-for-granted plants, which are not recognised as anything but background. The downside of plant blindness is that illegal plant trade is considered as relatively harmless as compared with illegal animal trade.
3. AMS requires a much smaller sample size (20–500 mg) compared to radiometric methods (10–100 g). It is also faster and usually produces higher precision results than radiometric methods. Samples can be analysed in a few hours with AMS, while it can take one or two days with radiometric methods. In case confiscated organisms are still alive, a fast verdict increases the chances of survival as rescued animals or plants can quickly be transferred back to the wild before they die.