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North-South Policy Brief

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Prospects for the molecular identification of CITES-protected timber species and origins

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES; www.cites.org) aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Within CITES, there is a need for both *identification of species* and *determination of origin*. At present, identification of timber species is usually performed using morphological characters. Unfortunately, suitable characters for species distinction are often missing in logged timber, and an additional identification tool is needed. The origin of timber is usually determined using tracking procedures, which trace the timber throughout the supply chain (chain of custody). Because tracking procedures are vulnerable to misuse, an additional tool is needed here as well. Our study demonstrates that molecular markers can be that additional tool.



1. Need for new tools to identify CITES-protected timber species

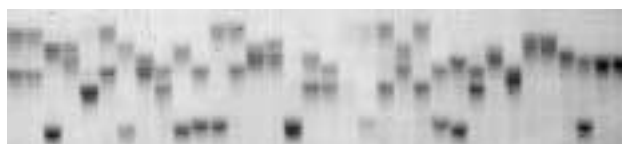
CITES regulations are species oriented, and the protection of timber species under CITES is restricted to those species listed on the CITES appendices. The timber trade on the other hand is product-oriented, and one timber may comprise multiple (not necessarily closely related) species. For a proper enforcement of CITES regulations, reliable identification of species is a prerequisite. At present, species identification is usually performed using morphological features. Most often, these are wood anatomical characters. Although wood (anatomical) characters are usually informative to distinguish families or genera, in many cases there are not enough differences to distinguish the species within one genus. In other genera, it may require specialist knowledge to distinguish the species, but this knowledge may not always be available. As a consequence, many species cannot be identified with certainty. Because several genera contain both protected and non-protected timber species, the lack of suitable characters for species distinction hampers the enforcement of CITES regulations. Clearly, an alternative suite of characters is needed. Molecular markers may provide these characters.



2. Need for new tools to determine timber origins

In many cases, legal trade in CITES protected timber species is restricted to timber from specifically described origins. These origins may be, for example, specified countries or large geographical areas, specified concessions within a country, or artificially propagated origins such as plantation timber. The need to identify timber origins is not restricted to CITES-listed timber species, but is important for all timber harvested under a Sustainable Forest Management

(SFM) regime. The origin of SFM timber is verified by tracking the timber throughout the chain of custody (COC), using COC and SFM certificates. Unfortunately, the supply of SFM certified timber from the tropical forest is still very limited. In contrast, a considerable amount of timber is illegally logged, and traded in violation of trade regulations. In some countries over 50% of the timber is from illegal sources (www.eia-international.org). Considering both CITES and non-CITES species together, it is estimated that illegal logging causes a loss of income to governments of \$10-15 billion worldwide (The World Bank, 2002). Under these circumstances, an independent identification system is needed to distinguish certified or otherwise legally logged timber from its illegal counterparts. Molecular markers could provide such a system.



3. Molecular markers as a tool

Molecular markers may be an alternative or addition to morphological characters for species identification, and to tracking methods for the identification of timber origins. In both cases, characteristics of the DNA are examined in wood samples taken directly from the timber of interest. The DNA characters are chosen in such a way that the variation detected is characteristic for a certain species or for a certain origin. Ideally, the variation detected should be unique to one species or origin, and readily identify this species or origin. Two types of molecular markers can be used: DNA sequence markers, or DNA fragment markers. In general, DNA sequence markers are less variable than DNA fragment markers and more suited to identifying species or large geographic areas such as countries. DNA fragment markers are more suited for identifying variation related to concessions or plantations. Although molecular markers hold great promise, there also are possible drawbacks. Most importantly: it has been proven difficult to isolate DNA from wood, and it may be difficult to find the proper DNA variation. Notwithstanding these drawbacks, success stories published for a number of species groups demonstrate the feasibility of using molecular markers for identification of timber species and for determination of timber origins.

4. Molecular markers to identify timber species

The possibility of identifying timber species was recently demonstrated by, amongst others, Brunner et al. (2001) and by Eurlings and Gravendeel (Submitted). Brunner et al. (2001) developed a method to identify fine roots of 30 Alpine forest tree species including 8 softwoods and 18 hardwoods. They used chloroplast DNA fragments as molecular markers. Based on the fragment patterns they constructed a key enabling the identification of 16 species and 7 species pairs. Although the species pairs could not be distinguished from each other, they still could be identified to the genus level.

Eurlings and Gravendeel (Submitted) examined nine species of *Aquilaria* (agarwood) and five species of *Gyrinops* in order to determine the possibility for molecular identification of these species. They used chloroplast DNA sequences as molecular markers, and were able to identify four *Aquilaria* species and three *Gyrinops* species (including two *Gyrinops* species that do not produce agarwood). The remaining seven species formed three groups of mutually indistinguishable species: *Aquilaria beccariana* + *A. malaccensis*; *A. khasiana* + *A. citrinicarpa* + *A. parvifolia*, and *Gyrinops salicifolia* + *G. podocarpa*.

The fact that many of the above species could be identified to the species level indicates that molecular markers are promising tools for species identification. The fact that in both studies there were groups of mutually indistinguishable species indicates that further development of these markers is needed.



5. Molecular markers to determine timber origins

The possibility of identifying timber origins was recently demonstrated by, amongst others, Cavers et al. (2003) and White et al. (2000). Cavers et al. (2003) studied 580 individuals of *Cedrela odorata* in 29 populations throughout Mesoamerica: four populations from each of Mexico, Guatemala, Honduras and Nicaragua, three populations from Panama, and 10 populations from Costa Rica. The genetic variation was studied using chloroplast DNA fragments and the results indicated a strong geographical pattern. Three groups of populations were detected: one group confined to Mexico and Guatemala, one group confined to Honduras, Nicaragua, and northwestern Costa Rica, and one confined to eastern and southwestern Costa Rica and Panama. Considering the restriction of the DNA groups to specific geographical regions, it can be concluded that chloroplast DNA markers can be used to determine the geographical origin of Mesoamerican *Cedrela odorata* timber.

White et al. (2000) demonstrated the power of identifying single individuals in a forest crime prosecution case in western red cedar (*Thuja plicata*). Illegal logging is a growing problem in British Columbia forests, but the huge area, the abundance of forest roads, and the long forested coastline make it difficult to patrol efficiently. Illegal loggers are seldom caught red-handed, and suspect batches of timber are usually only spotted well after logging. As an instrument for legal prosecution, White et al. (2000) developed DNA fragment markers (microsatellites) suitable for the identification of individual red cedar trees. The markers can be employed to match the individual logs from suspect batches of timber to the stumps or roots left at the illegally logged site. Legal evidence is produced

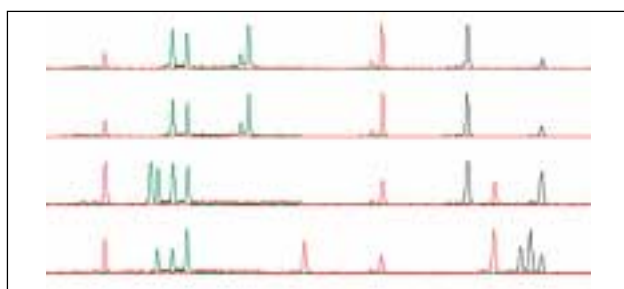
when the genotypes of suspect trunks match the genotypes of stumps or roots at the site. The above examples indicate that molecular markers can be successfully employed to determine the origin of timber, and that this can be done at spatial scales ranging from countries to sites of individual trees.

6. What's new?

Morphological identification of timber species and conventional timber tracking procedures are valuable tools for the implementation of CITES regulations. However, both have considerable drawbacks: morphological identification suffers from a lack of suitable characters, and tracking procedures are far from watertight. With the development of the molecular marker technology, a whole new set of tools is becoming available that lack the conventional drawbacks. Although the development of molecular identification tools has only just started, already a wide range of applications is available. Molecular markers may provide added value in:

- Combatting illegal logging
- Implementing Sustainable Forest Management
- Independent testing of certification systems
- Identification of Plantation Timber

Further developments will undoubtedly lead to new solutions in cases that previously were thought to be impossible to solve.



7. What's next?

Wageningen University and Research Centre is a leading international knowledge institute in the fields of nutrition and health, sustainable agricultural systems, environmental quality, and processes of social change. The specific expertise of our two research groups has been brought together in the study of molecular biodiversity in both flora and fauna, with a focus on

molecular identification and sustainable management of natural resources.

There is wide experience in the application of molecular markers in environmental issues, such as the genetic differentiation and trade among populations of Peach Palm (*Bactris gasipaes*) and its implications for genetic resource management (Adin et al., 2004); the genetic diversity in nine gene bank collections of Black Poplar and its value for nature development (Storme et al., 2004); the origin of an otter (*Lutra lutra*) found on the Knardijk in the Netherlands (Jansman et al., 2003); and the Illegal trade of Eurasian badgers (Marmi et al., submitted).

We are ready to study further actual questions from the policy and implementation arenas in the timber trade, using our combined expertise.



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The figure in section 1, showing the wood anatomy of *Pericopsis elata*, is taken from the "CITES Identification Guide - Tropical Woods", 2002. Wildlife Enforcement and Intelligence Division, Enforcement Branch, Environment Canada.