CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES
OF WILD FAUNA AND FLORA

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Hybrids and cultivars under the Convention

OVERVIEW HYBRIDS AND CULTIVARS UNDER THE CONVENTION

1. This document has been prepared by the Secretariat.

2. At its 14th meeting (The Hague, 2007) the Conference of the Parties adopted Decision 14.147 directed to the Committee on *Taxus cuspidata*, as follows:

   The Plants Committee shall discuss hybrids and cultivars, and other entities recognized in horticulture (e.g. forms and varieties), and provide recommendations to the Conference of the Parties at its 15th meeting regarding their treatment under the Convention, particularly with regard to Article I, paragraph (b).

3. The Secretariat contracted Dr Reto Nyffeler to produce a document that would serve as a basis for the discussions of the Committee on the subject mentioned above. His report, annexed to the present document, explains that the identification of hybrids and cultivars is not as difficult as often believed. It further explains the relationships between the Botanical Code and the Cultivated Plant Code, governing the naming of both cultivated and wild plants (and hybrids) and the rules that they provide for naming different groups. The report also elaborates on concerns about practical aspects of CITES implementation. Definitions of the terms 'hybrid', 'cultivar' and 'variety' have not been formally adopted by the Conference of the Parties but have been provided in biodiversity glossaries developed by UNEP and others.

4. The Committee is invited to review the report attached in the Annex and the definitions proposed in each Code, and to consider whether one would be appropriate for CITES purposes. The Committee may also prefer to formulate a different definition. However, there are two arguments in favour of choosing a definition that already exists. First, it would be more practical from an implementation point of view, and second, the Conference of the Parties has expressed its encouragement for harmonization of practice between MEAs, such as in Decision 14.18 which addresses the taxonomy and nomenclature of species covered by various agreements. Although this Decision is directed to the Secretariat, it is relevant not only to the harmonization of the taxonomy and nomenclature of the species included in CITES but also to the treatment of hybrids thereof, cultivars and other entities recognized in horticulture (e.g. forms and varieties). The Committee is invited to note that UNEP-WCMC serves all biodiversity MEAs and that its glossary has been cited as a source by the Convention on Biological Diversity.

5. Regarding recommendation III at the end of the report, it is worth mentioning that cultivars have been systematically treated in CITES as the same as hybrids, and therefore could be exempted from CITES controls if annotated as per Resolution Conf. 11.11 (Rev. CoP14) on Regulation of trade in plants.

6. Finally, the Committee is invited to note document PC17 Doc. 19.2 on *Summary of CoP14 Decisions*, and decide on a way forward as to implement Decision 14.147.

TREATMENT UNDER THE CONVENTION OF HYBRIDS AND CULTIVARS, AND OTHER ENTITIES RECOGNIZED IN HORTICULTURE (E.G. FORMS AND VARIETIES)

1. Past and current use of the concepts "hybrids" and "cultivars"

a) **Overview**

Introduction

Variation in organismal life is, to a large extent, discontinuous. Therefore, distinct groups of organisms can be differentiated and named. In biology, such groups are recognized as 'taxa' (sing. 'taxon', = taxonomic group of any rank), but the vernacular terms 'entity', 'group' or 'unit', sometimes in combination with the adjective 'taxonomic', are often used as well. These taxa are classified and arranged into a hierarchical classification system of predefined categories (i.e., species, genus, or family). The rules for providing names to these ranked taxa are provided by the International Code of Zoological Nomenclature (ICZN; Ride et al., 2000) for animals and the International Code of Botanical Nomenclature (ICBN; McNeill et al., 2006) for plants, also known as the Botanical code (ICBN). The Botanical Code governs the naming for both cultivated and wild plants, as well as hybrids. The International Code of Nomenclature for Cultivated Plants (ICNCP; Brickell et al., 2004), also known as the Cultivated Plant Code, provides rules for naming groups of cultivated plants, whose origin or selection is primarily due to the intentions by humans, recognized either as 'cultivars' or 'Groups' (i.e., cultivar groups) (ICNCP, principle 2).

The Botanical Code (ICBN) is primarily (but not exclusively, see below) used for wild plants, while the Cultivated Plant Code (ICNCP) is exclusively used for cultivated plants.

Species are one of the fundamental units of biology. In general, access to knowledge on organismal diversity is by species name. Therefore, agreed names for this category of the scientific classification system of organismal life is relevant to all aspects of nature, including the enforcement of regulations in the international trade of animals and plants (i.e. CITES). Today, species are conceptualized as separately evolving metapopulation lineages, acquiring different properties during the course of their diversification (e.g. reproductive isolation, diagnosability, monophyly; de Queiroz, 2007). This unified species concept places the focus on the diversity of criteria for species delimitation. Most species are still recognized based on structural properties that represent morphologically coherent groups of individuals.

More widely distributed species are often composed of genetically, and often also morphologically, distinct subgroups (i.e. populations and groups of populations). These patterns of variation may be very complex and closely intertwined (e.g. due to ecological gradients, disjunct distribution or different habitat preferences, polyploidy). Such subgroups may be formally recognized in the biological classification system as infraspecific (= intraspecific) taxa. In practice, these infraspecific taxa are often more difficult to differentiate and identify. For animals, only the rank of subspecies is officially regulated by the Zoological Code (ICZN), while for plants the Botanical Code (ICBN) recognizes five different subordinate categories of infraspecific taxa (i.e. subspecies, variety, subvariety, forma and subforma).

Hybrids

Hybridization is the interbreeding of individuals from genetically distinct taxa (Allendorf et al., 2001), leading to a genetic admixture in the descendant individuals. Interspecific hybridization may play an important role in the evolution of organisms in nature, but may also, if induced by human activity (i.e. translocation of organisms and habitat modification), lead to the extinction of rare species. Furthermore, artificial crossing of distinct infra- and interspecific parental taxa is an old, long established method of breeding and domestication used by humans.

A hybrid formula designates the parental taxa of a hybrid with a multiplication sign placed between them (e.g. *Platanus orientalis* x *Platanus occidentalis*).

Hybrid swarms are groups of individuals that all hybridize by a varying degree through backcrossing with parental individuals (unidirectional or bidirectional introgression) and crossing with other hybrid individuals. In contrast, hybrid taxa are independently evolving, historically stable groups of populations possessing a unique combination of heritable characters derived from two ore more discrete parental taxa (Allendorf et al., 2001). Depending on the taxonomic status of the parents, either infraspecific, interspecific, or intergeneric hybrids may be formally recognized for these entities. For plants, these hybrid taxa may receive nothotaxon names as outlined in the Botanical Code (ICBN; Appendix I). In order to formally describe a nothotaxon (e.g. ×*Agropogon*, *Salix* × *capreola*, *Polypodium vulgare* nothosubsp. *mantoniae*), at least one parental taxon must be known or can be postulated (ICBN, Art. H.3). The Zoological Code does not recognize nothotaxa. Hybrids derived from cultivated plants of taxa recognized under the ICBN may also, alternatively, be assigned to cultivars or Groups (ICNCP Art. 1.2; see below).

The various modes of hybridization may be categorized in various different ways; hybridization may occur (1) as a natural part of the evolution legacy of some taxa, (2) as an effect of anthropogenic activities (i.e., human induced but unintentionally), or (3) artificially and intentionally by crossing as a result of human interaction. A relevant aspect concerning this differentiation is whether the distribution areas of the two parental taxa do overlap or not. *Agave chrysantha* and *Agave thoumeyana* have overlapping distribution areas, and therefore, sporadic hybridization between these two taxa results in the formation of naturally occurring interspecific F1 hybrids (*Agave* × *arizonica*; see CITES proposal CoP14 Prop. 22). In contrast, the natural distribution areas of *Platanus orientalis* (Turkey to western Himalaya) and *Platanus occidentalis* (North America) do not overlap, and therefore, the hybrids recognized as *Platanus* × *acerifolia* (syn. *P.* × *hispanica*, *P.* × *hybrida* [hybrid nature of this case is not indisputable]) are a result of anthropogenic activities.

Artificial hybrids in cultivation may be given names either based on the Botanical Code (ICBN, Art. 28 and Appendix I) or based on the Cultivated Plant Code (ICNCP), leading to potential confusion and inconsistencies in providing names to these entities (Spooner et al., 2003). There have been recent initiatives to resolve this problem (Botanical Congress in St. Louis, 2000).

Cultivars

A 'cultivar' (term derived from "cultivated variety") is a group (i.e. entity, taxon, unit) of cultivated plants that has been selected and given a unique name for a particular attribute or combination of attributes (ICNCP, Art. 2.2). It is expected to be clearly distinct, uniform (homogenous) and stable in its characteristics. These characteristics are retained exclusively by "artificial propagation".

Plant cultivars differ greatly according to their origin, breeding system and mode of (sexual or asexual) propagation (Bisby, 1995). Cultivars may arise by (1) deliberate hybridization or by accidental hybridization in cultivation, (2) by selection from existing cultivated stock, or may represent (3) a selection (i.e. genetic line) from variants of a wild population and maintained as a recognizable and distinct entity solely by continued artificial propagation (ICNCP, Art. 2). Other common types of cultivars are clones which are the genetically identical descendants of one individual (i.e. by vegetative propagation). This propagation can also be achieved by *in vitro* tissue culture (e.g. orchids; Bisby et al., 1995).

Names of cultivars are regulated by the International Code of Nomenclature for Cultivated Plants (Brickell et al., 2004). In order to become "established", a cultivar name must be published effectively (ICNCP, Art. 22; i.e. published in hard copy, provided with a date and with a description) or become accepted in a register maintained by an statuory plant registration authority (ICNCP, Art. 24.4). It is recommended to provide with the publication of a cultivar name information on its parentage and origin, as well as its intended mode of propagation (ICNCP, Recommendations 24A.1 - 24C.1) and a living or dried specimen should be deposited with a registration authority or a public herbarium (ICNCP, Recommendation 24E.1). A cultivar name consists of a botanical name of a genus, species or infraspecific taxon, or of an intergeneric or interspecific hybrid followed by a cultivar epithet that is capitalized and put between demarkation marks (i.e. single quotes). Cultivar epithets published after 1 January 1 1959, must consist of a word or words in a modern language (ICNCP, Art. 19.9) in order to avoid confusion with epithets in botanical names following the

Botanical Code (ICBN). Examples for cultivar names are *Asparagus officinalis* 'Calet', or *Viola* 'Penny Black'. Assemblages of two or more cultivars derived from the same botanical taxon i.e. genus, species, nothogenus (hybrid genus), or nothospecies (hybrid species) may be designated as a 'Group' (ICNCP, Art. 3). The epithet of a Group is not enclosed in single quotation marks and consists of up to three words in a modern language, including the word Group at its end. Examples are *Allium cepa* Shallot Group, *Beta vulgaris* Detroit Globe Group. The Cultivated Plant Code (ICNCP) also accommodates the special provisions for orchid nomenclature by including the grex as a particular sort of Group for use in cultivated orchid nomenclature.

A series of institutions (in total 71 as of 28 January, 2008; www.ishs.org/sci/icra.htm) are appointed by the International Society for Horticultural Science (www.ishs.org) to register names of cultivars and Groups, as well as to compile and publish lists thereof. Each International Cultivar Registration Authority (ICRA) is responsible for some taxonomic groups (i.e. denomination class), such as conifers or the genus *Rosa*. For Cactaceae, only cultivars derived from genera classified in the tribe Hylocereeae of subfamily Cactoideae are managed by a specified ICRA. In contrast, for Orchidaceae, newly registered orchid cultivars are published regularly, including parentage and registrating person or institution.

Cultivar and Group names must be universally available in all countries for general use. In contrast, trademark names (or "selling names") are assigned to some person or corporation for marketing (ICNCP, Principle 6).

b) **CITES in particular**

CITES defines and uses the term species more broadly than generally known in biology. Specifically, the Convention subsumes infraspecific taxa as recognized by the Botanical Code (i.e. subspecies, variety, subvariety, forma, subforma; only by inference) and the Zoological Code (i.e. subspecies only) under the term 'species', It also uses the term 'species' for geographically distinct populations of more widely distributed species. Furthermore, in Resolution Conf. 9.24 (Rev. CoP14) on *Criteria for amendment of Appendices I and II*, Annex 5, it is specified that 'varieties' (presumably on the basis of a form as recognized by the Botancial Code; see discussion below) are covered by the term 'species'. In any case, CITES stakeholders need to be aware of the multitude of connotations that go with the term 'species'.

Hybrids are not explicitly defined for CITES purposes and regulations. Resolution Conf. 11.11 (Rev. CoP14) on *Regulation of trade in plants* determines that:

> *hybrids shall be subject to the provisions of the Convention even though not specifically included in the Appendices if one or both of their parents are of taxa included in the Appendices, unless the hybrids are excluded from CITES controls by a specific annotation in Appendix II or III.*

This inclusive regulation does not differentiate between the potentially widely deviating nature and origin of hybrids (see above). In consequence, it does not accommodate with the widely diverging expectations and requirements of all stakeholders involved, and a solution more in line with actual practice should be sought. It will be difficult to aim at such a solution by additional specification, such as "hybrid taxa not known to occur in the wild", but on the basis of a clear distinction between taxa (following the rules of the Botanical Code) versus culta (following the rules of the Cultivated Plant Code).

Cultivars, as recognized by the Cultivated Plant Code (ICNCP), are exclusively products of artificial origin. They may not be treated, implicitly or explicitly, as synonym to hybrids for issues concerning CITES, though, artificial hybrids may (and should!) be recognized as cultivars.

Cultivars combine germplasm of different taxa or involve processes of selection that make determining origins very difficult (Spooner et al., 2003). It is expected by the Cultivated Plant Code (ICNCP) that only entities distinct from their parentage, and as such they represent a 'culton' (term parallel to 'taxon' for a group of cultivated plants with distinct user criteria; ICNCP, Appendix XII – in this document cultivar is used in synonymy with culton). As such, a cultivar would not be covered by CITES - if not a generic, specific, or infraspecific taxon name would be part of the cultivar or Group name (Spooner et al., 2003). Extending the regulations of CITES to cultivars because taxon

names are part of the cultivar names is not in the interest of CITES, in view of the artificial nature of these entities.

A cultivar, for instance derived from hybridization between some parental species with disjunct distribution areas, should be recognized as a distinct entity for CITES regulations. This would offer the possibility to allow cultivars to be excluded from the Appendices. For instance, if the hybrid between *Taxus baccata and T. cuspidata* (*Taxus* × *media*) were registered and recognized as a distinct and identifiable cultivar (e.g. *Taxus* 'Media') it could form as such the provision for excluding it from the Appendix. It is admitted here that numerous cultivars of *Taxus* are available, issues concerning CITES implementation need to carefully be considered. The argument of false declaration, in particular in view of a cultivar name based on a species or infraspecific taxon listed in the Appendix (e.g. *Taxus cuspidata* versus *Taxus cuspidata* 'Stricta'), is serious. This is unfortunate, since a recognized cultivar derived from the wild stock of a taxon listed in the CITES Appendix through selection may quite often be much easier to identify than wild individuals of closely related species (e.g. *Taxus cuspidata* versus *Taxus baccata*).

2. Other entities recognized in horticulture

a) **Overview**

Forms and varieties: The terms 'form' and 'variety' are both widely used in different modern languages, referring to variants of living or non-living objects. Therefore, both terms have different meanings and connotations, with the potential for confusion (Spooner et al., 2003).

For the Botanical Code (ICBN), 'variety' is an infraspecific category in the taxonomic hierarchy between subspecies and forma (e.g. *Echinocactus polycephalus* var. *xeranthemoides*). For the Cultivated Plant Code (ICNCP), 'cultivated variety' (generally known as 'cultivar') is the main recognized and named entity (e.g. *Taxus cuspidata* 'Stricta'). In some countries, the term 'variety' is used by the International Union for the Protection of New Varieties of Plants (UPOV Convention) as a grouping of individuals, which can be distinguished from any other plant groups for legal and marketing purposes.

For the Botanical Code (ICBN), 'forma' is an infraspecific category below the category 'variety'. In zoology, the term 'form' is used as an informal category, but is not regulated by the Zoological Code (ICZN).

In addition to forms and varieties, various terms exist that refer to groups of organisms as recognized in some formal classification system. A detailed list of infraspecific ranks used in biology can be found on Wikipedia (http://en.wikipedia.org/wiki/Taxonomic_rank).

Chimera (or chimæera): a single plant organism with genetically distinct types of tissue in intimate association. Chimeras are also known for animals. Graft-chimeras are chimeras derived from grafting (based on ICNCP, names for graft-chimeras are marked with and additional sign [+]).

Convariety (convarietas, convar): originally a category between subspecies and varieties mainly for the classification of cultivated plants. It roughly corresponds to Groups (i.e. cultivar groups; ICNCP), and it should not be used in modern cultivated plant taxonomy (Brandenburg and Schneider, 1988; Spooner et al., 2003).

Grex (pl. greges): a type of Group (i.e. category denoting an assemblage of cultivars; ICNCP) used in orchid nomenclature applied to individuals derived from artificial crosses of specified parents.

Unlike most other groups of plants, orchids hybridize widely in nature. For the last 150 years they have been widely crossed in cultivation to produce over 110,000 hybrids, which are classified as greges. Orchid hybrids can involve up to 20 distinct species from up to nine distinct natural genera.

Landrace: cultivar that originated as a product of mass selection, and not as a product of modern plant breeding, generally confined to a certain region.

Lusus: group of organisms with a genetically-based morphological anomaly.

Natio: in zoology, a group of similar specimens recognized at the infraspecific rank - ICZN Art. 45.

Race: any group of distinct organisms (recognized on the basis of biological, ecological, geographical, or physiological properties) that might be recognized at any infraspecific (i.e. intraspecific) rank, but not specifically assigned to any infraspecific (intraspecific) rank.

Strain: a low-level taxonomic group used for animals (e.g. strains of mices) and plants without any official status.

b) **CITES in particular**

CITES litterature does not use the terms 'form' and 'variety' as the botanical classification system (Botanical Code, ICBN) does. In cases when they are used, they connote interpretations as generally used in zoology.

3. Conclusions and recommendations

The issue of 'wild' versus 'cultivated' is at the heart of the current discussion on "hybrids and cultivars" (see Summary Record CoP14 Com. I Rep. 13). CITES is concerned with wild animals and plants, and parts and derivatives thereof. Plants in cultivation may:

a) represent individuals (or their descendants through artificial propagation) taken from wild populations;

b) represent a selection of wild variants that are maintained as a recognizable entity solely by deliberate and continuous propagation (potentially a cultivar if proposed as such);

c) represent a selection from existing cultivated stock (potentially a cultivar); or

d) arise either by deliberate or accidental hybridization (hybrid taxon or cultivar) (Spooner et al., 2003).

As such, they either have relevance for CITES (cases 1 and 2) or not (3 and 4). Of concern is, however, the origin of the parental material that was used to 'create' these cultivars or cultivated hybrids (cases 3 and 4).

Practicability of identification is a pressing issue in all these discussions on "hybrids and cultivars". Hybrid taxa are proposed and described following the rules of the Botanical Code (ICBN), and as such are expected to represent distinct entities as easy or difficult to identify as any other taxon (i.e. species, subspecies, variety or forma). Numerous cases are known where the hybrid nature of a proposed taxon was only recognized later on. Modern, molecular-based methods (e.g. sequencing, AFLP, ISSR) now widely established in biology and applied sciences may help to resolve these challenges in animal and plant identification in the near future (i.e. DNA bar-coding and DNA taxonomy). Furthermore, cultivars, as recognized by the Cultivated Plant Code (ICNCP), are expected to be "clearly distinct, uniform and stable", providing the basis for successful identification and verification. Cultivars of hybrid origin (i.e. orchids) may represent the admixture of genomes of various parental taxa. In such cases, the contributing parentage can no longer be identified, hence the issue of the legal origin of that parental material is obsolete. Furthermore, hybrids between parental taxa with non-overlapping distribution areas are exclusively the product of human interaction (e.g. *Taxus* × *media* = *Taxus baccata* × *T. cuspidata*).

4. Recommendations

a) The text of the Convention, as well as other official CITES documents, use the terms 'species', 'subspecies', 'subcategories of species', 'taxa', as well as 'higher taxa' inconsistently and in some cases contradictorily (i.e. sometimes subspecies are intentionally included in species, sometimes subspecies are mentioned in addition to species). Furthermore, infraspecific ranks other than subspecies (as recognized by the Botanical Code) are only mentioned in Resolution Conf. 9.24 (Rev. CoP14) for the case of 'varieties'. A definition for 'variety' is not given, and its connotation is probably related to zoological nomenclature, as an infraspecific category not currently recognized by the Zoological Code (ICZN). This issue could be resolved by introducing the term 'infraspecific taxa',

either restricting it to categories only officially recognized by the Botanical and Zoological Codes or expanding it to any 'distinct' subspecific entity (see incomplete list above).

Along this line, it is also important to point out the inconsistent use of the term 'population' in CITES documents, which is defined in Resolution Conf. 9.24 (Rev. CoP14) to "include the total number of individuals of the species". This definition is in line with accepted terminology in statistics (Sokal and Rohlf, 1998), but contrary to general use in biology.

b) In order to preserve the evolutionary dynamics in nature, it is recommended that the regulation on hybrids as specified in Resolution Conf. 11.11 (Rev. CoP14) maintained, namely:

> *hybrids shall be subject to the provisions of the Convention even though not specifically included in the Appendices if one or both of their parents are of taxa included in the Appendices ...*

c) Provisions should be provided for annotating CITES Appendices to the effect of excluding "established" (ICNCP, Art. 24), registered and specifically named cultivars. These recognized cultivars (potentially after registration and the provision of additional information) can then be exempted from CITES regulations. In consequence, only cultivars (including artificial hybrids) as recognized by the Cultivated Plant Code (ICNCP) may become exempted, but not hybrids described (and characterized by their nature) as nothotaxa based on the Botanical Code (ICBN).

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