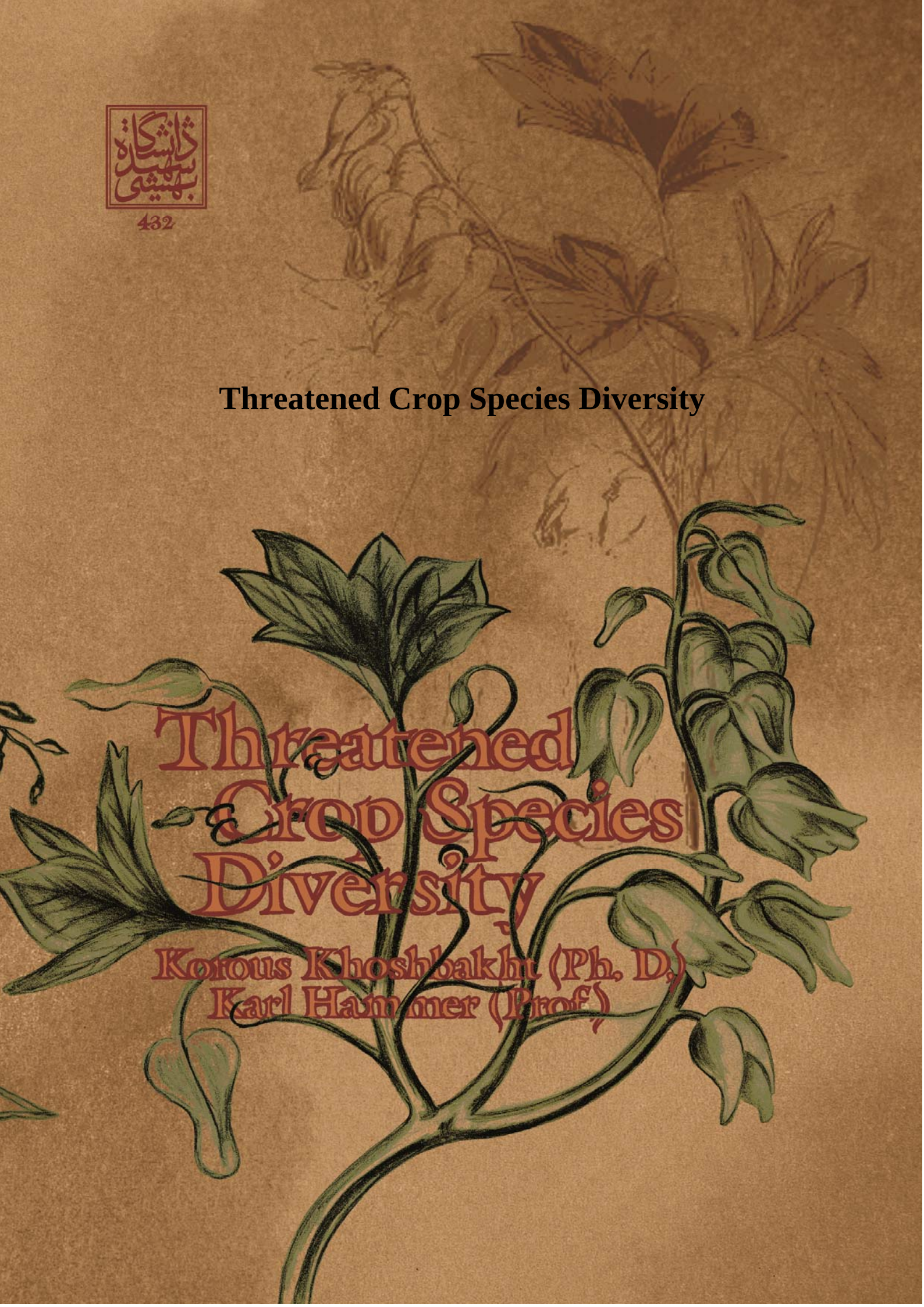
Threatened Crop Species Diversity



Threatened Crop Species Diversity

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2010

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Preface

With the emerging discussions on biodiversity during the 1980s species extinction became a focus of scientific investigations and interests. The book entitled "The Sixth Extinction" (Leakey and Lewin 1995) clearly demonstrated the role of man in the present global extinction event. However, the following aspect of this “sixth” extinction remained greatly neglected during the general discussions and political considerations: what has happened and will happen to the living by-products of human evolution, the domesticated plants and animals?

Roughly 10.000 years of domestication have created a tremendous amount of domesticates, especially in plants. In the last few centuries and especially since the beginning of the industrial revolution globalization and specialization have diminished the diversity of these domesticates.

For the cultivated plants the beginning of this process has been early documented by A. De Candolle (1883) in his book “L’origine des plantes cultivées”. He entitled article 4 of his book "Cultivated Plants which are extinct or becoming extinct in a wild state" (cited after the English edition of his book from 1967). He listed seven species (given here in modern nomenclature): *Vicia faba*, *Cicer arietinum*, *Vicia ervilia*, *Lens culinaris*, *Nicotiana tabacum*, *Triticum*

aestivum and *Zea mays*. Additionally he named two candidates: *Ipomoea batatas* and *Carthamus tinctorius*. None of these species shows any indication for extinction today except the bitter vetch, *Vicia ervilia*, which has become rare and can be found only occasionally as a crop in traditional growing areas such as Italy (Hammer *et al*. 1992). De Candolle's main reason for proposing those cultivated plants to become extinct is concerning the fact that they are highly domesticated and do not have the ability of propagating outside cultivated fields. As he stated (1967, p. 459), "All these species, and probably others of little known countries or genera, appear to be extinct or on their way to become so. Supposing they ceased to be cultivated, they would disappear, whereas the majority of cultivated plants have become somewhere naturalized, and would persist in a wild state."

Smyrnium olusatrum (alexanders) is the only plant species De Candolle explicitly mentioned in connection with extinction (1967, p. 91): " ... this was the commonest in gardens for nearly fifteen centuries, and it is now abandoned. We can trace its beginning and end." The decline of alexanders in several countries was also observed by Alefeld (1866) and other botanists. However, the example of alexanders demonstrates the difficulties of proving extinction. Apart from surviving in the wild, alexanders was found as recent as last year as a garden plant in the Salento of Apulia (South Italy) (Laghetti and Hammer, in prep.).

De Candolle's "opus magnum" about cultivated plants from 1883 was antedated by his "Géographie botanique raisonée" (1855) which

included a special chapter on cultivated plants developing similar ideas and serving as an important source of information on cultivated plants for Darwin (1859, 1868).

The already mentioned Alefeld wrote a local flora on cultivated plants in Germany (Landsrath and Hammer 2007). But De Candolle had only few successors investigating cultivated plants and comprehensive treatments of their diversity are a rarity to the present day. An exceptional scientist was the Russian N.I. Vavilov (1887-1943), who established the theory of the centers of origin for most crop species (Vavilov 1926). He was a very prolific worker and writer. A selected translation of his treatments concerning "origin and geography of cultivated plants" (Dorofeev 1992) provided the opportunity for an intensive search for remarks about extinctions in cultivated plants. The South American cereal mango grass, *Bromus mango*, was the only successful hit in this respect. Vavilov characterized this species as "almost-extinct" or "no longer cultivated" in several sections of the book. Other comprehensive treatments, e.g. Zhukovsky (1962), did not provide any information about extinction of cultivated plant species. An exception is the encyclopedia by Hanelt and IPK (2001), treating more than 6.000 crop plants and providing the most comprehensive information presently available on the cultivated plants in the sense of De Candolle. China, the "mother of gardens", has to be mentioned as a neglected area of research because of its still insufficiently known wealth of cultivated plants and a long horticultural and agricultural history. It is difficult to overview

and was not properly addressed by De Candolle but highly respected by Vavilov.

Li (1982) was one of the most fascinating authors of this country with experiences in wild and cultivated plants. He reported the following vegetables from ancient China which were "lost because of their gradual replacement by other crops" (in modern nomenclature, indications by Li in brackets): *Malva verticillata*, *Angelica japonica* (*A. kiusiana*), *Crepidiastrum denticulatum* (*Lactuca denticulata*), *Rorippa indica* (*Nasturtium indicum*), *Polygonum hydropiper*, *Viola verecunda* and *Xanthium strumarium*. These old Chinese vegetables are in fact not extinct on the species level. They exist as weeds, or are cultivated today in other countries, e.g. *Polygonum hydropiper* in Japan (Hanelt and IPK 2001). *Xanthium strumarium* even changed the mode of use and was cultivated after World War II in the CIS republics and Germany as an oil and fibre plant (Hanelt and IPK 2001), whereas *Malva verticillata* is grown in northern Italy as a minor medicinal plant (Hammer *et al*. 1999).

Besides comprehensive treatments and area-specific accounts there is a third source for studying the decline of cultivated plants: crop-specific reports. Wheat can serve as an example for which the classical book of Percival (1921) and the excellent monograph by Dorofeev *et al*. (1979) provide useful information. More recent monographs and treatments concentrate mostly on different aspects of plant evolution.

There exist major problems in studying cultivated plants and their decline, which have partly been mentioned in the preceding examples:

- Cultivated plants are neglected by the majority of botanists.
- Comprehensive treatments on cultivated plants or floras of them are rare.
- The mode of use of cultivated plants can change.
- Cultivated plants are on different evolutionary levels with respect to domestication.
- Only highly domesticated cultivars cannot survive without human care.
- Cultivated plants have a history of only about 10.000 years but a high variation which often excels that of wild plants.

The last point requires some explanation. Most of the examples found in literature about declining cultivated plants are on the level of cultivars and landraces. Plant breeding activities in the 19th century, often already performed by specialized plant breeders, lead to a number of new and high-yielding cultivars, selected mostly from traditional landraces, and started to replace the locally adapted material at an accelerated rate. Von Proskowetz (1890) and Schindler (1890) belong to the first scientists having stressed the importance of landraces for the genetic improvement of breeding new cultivars. And shortly after that the decrease of landraces in their areas of distribution was noticed by other scientists (e.g., Stapf 1909, Baur 1914, Tschermak 1915). This process of loss of diversity on the infraspecific level, also observed by Harlan and Martini (1936), was much later called genetic erosion (Bennett 1968), a term specifically coined for cultivated plants.

There is still a third level of loss of diversity, the one of loss of agro-ecosystems. Although very important, this is not the focus of the present discussion.

From theoretical considerations and practical experiences it is clear that a continuing loss on the genetic level will finally culminate in a loss on the species level, i.e. in extinction. Thus, the reduction in growing area of many species to a few species and the decreasing number of cultivars and their infraspecific diversity have lead to the situation that today less than 30 crop species have to secure the nutrition of the human world population.

Extinction and genetic erosion in cultivated plants have, therefore, to be addressed with highest priority. It is not the task of this book to present apocalyptic scenarios but to develop the basis for understanding the amount of genetic erosion in the hope of finding ways for slowing down or even reverting this trend.

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