Populus tremula in Europe: distribution, habitat, usage and threats

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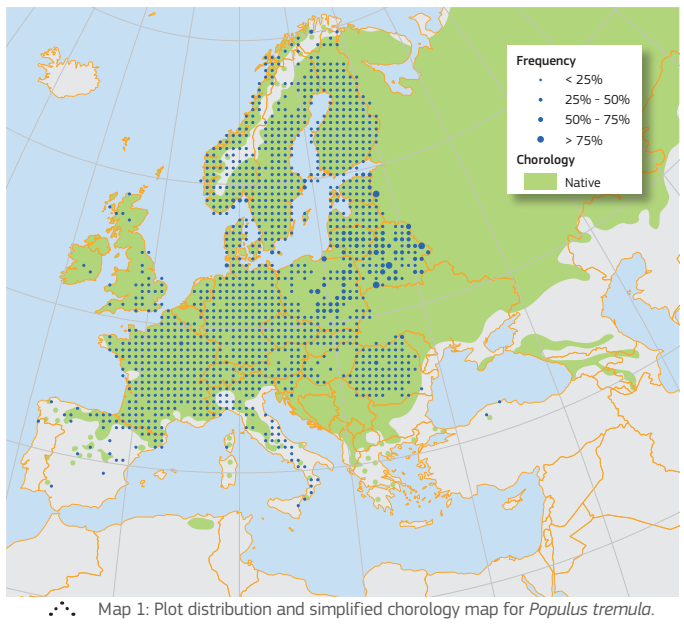
The Eurasian aspen (*Populus tremula* L.) is a fast-growing broadleaf tree that is native to the cooler temperate and boreal regions of Europe and Asia. It has an extremely wide range, as a result of which there are numerous forms and subspecies. It can tolerate a wide range of habitat conditions and typically colonises disturbed areas (for example after fire, wind-throw, etc.). It is considered to be a keystone species because of its ecological importance for other species: it has more host-specific species than any other boreal tree. The wood is mainly used for veneer and pulp for paper production as it is light and not particularly strong, although it also has use as a biomass crop because of its fast growth. A number of hybrids have been developed to maximise its vigour and growth rate.

Eurasian aspen (*Populus tremula* L.) is a medium-size, fast-growing tree, exceptionally reaching a height of 30 m[1]. The trunk is long and slender, rarely up to 1 m in diameter. The light branches are rather perpendicular, giving to the crown a conic-pyramidal shape. The leaves are 5-7 cm long, simple, round-ovate, with big wave-shaped teeth[2, 3]. They flutter in the slightest breeze, constantly moving and rustling, so that trees can often be heard but not seen. In spring the young leaves are coppery-brown and turn to golden yellow in autumn, making it attractive in all vegetative seasons[1, 2]. The aspen is a **dioecious** tree. Flowers are produced in February-March before the leaves appear[2, 3]. Male catkins are 5-10 cm long, grey-brown, yellowish in mid-March when shedding pollen. Female catkins are green, 5-6 cm at pollination, extending 10-12 cm long at maturity in early summer to bear 50-80 capsules each containing numerous tiny seeds embedded in downy fluff and dispersed by wind[4]. The bark is greenish-grey, smooth, wrinkled with diamond lenticels[1, 2].

Distribution

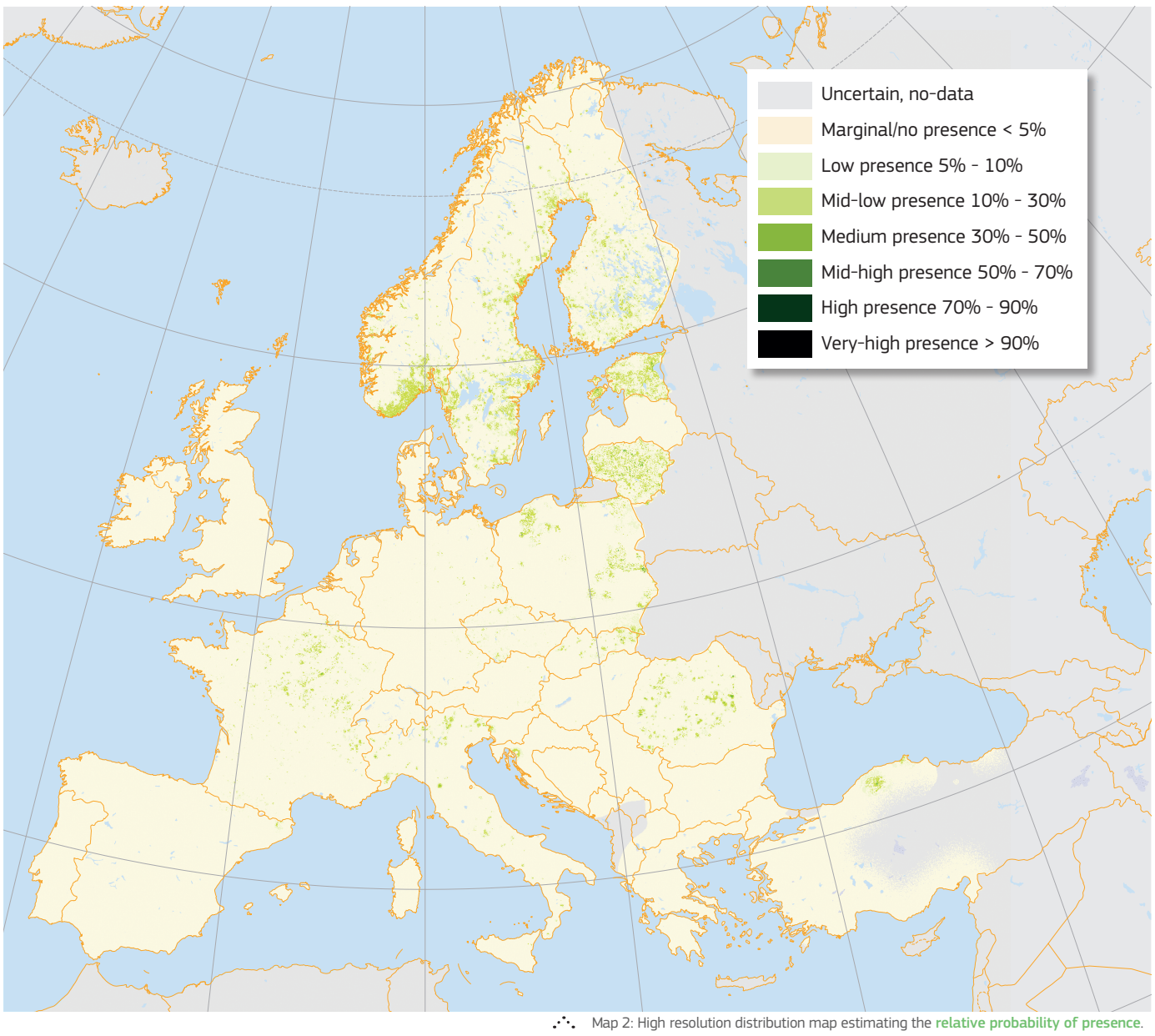
This species is native to cool temperate and boreal regions of Europe and Asia. It is the second most widely distributed tree in the world, after Scots pine (*Pinus sylvestris*). Aspen's range extends from Iceland and Ireland to Kamchatka, and from north of the Arctic Circle in Fennoscandia and Russia (growing at sea level), to Spain, Turkey, North Korea and northern Japan (growing up to 1900 m in the Pyrenees)[5-9]. There are also isolated glacial-relict populations on the highest elevations of the Atlas Mountains in Algeria[10]. Due to its wide distribution, many geographical races have been differentiated morphologically, and some of these forms are considered as sub-species[8].



Map 1: Plot distribution and simplified chorology map for *Populus tremula*.
Frequency of *Populus tremula* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *P. tremula* is derived after several sources[5, 30, 31].

Habitat and Ecology

Eurasian aspen is a light-demanding, rapidly growing broad-leaved tree. Its fast-growing habit continues until the age of about 20 years when crown competition increases. After that, its growth increment is slower and culminates at about 30 years of age, and the average lifespan is 50-100 years[8, 9, 11]. The enormous wide natural range demonstrates its tolerance of a high variety of climatic and habitat conditions, such as frost, shade, waterlogging, wind and weed competition. It also grows on a wide range of soils, from slightly dry to wet soils of poor to rich nutrient status, although it favours moist soils with a high organic matter content and wet conditions[8, 11, 12]. Light is more important than soil conditions, even if, unlike many other poplars, it is sufficiently shade-tolerant to be a stable part of a mixed stand



Map 2: High resolution distribution map estimating the **relative probability of presence**.

Young trees in Lapland, Finland..
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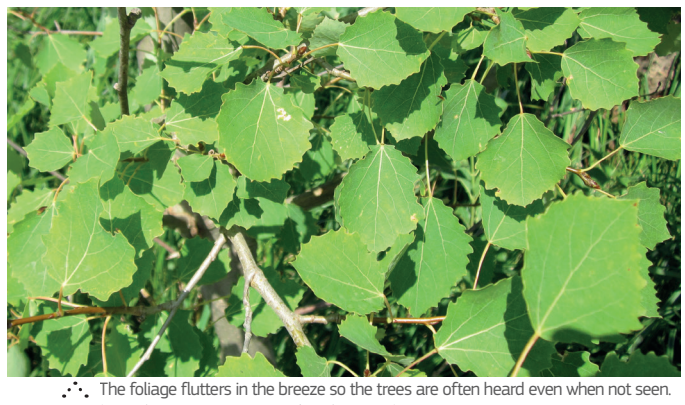
woodland, especially with species casting a relatively light shade, such as Scots pine (*Pinus sylvestris*) and birches (*Betula* spp.)[11]. Eurasian aspen trees typically occur as scattered patches in the midst of the conifer-dominated landscape. It is a disturbance-adapted species and is a coloniser of clear disturbed areas such as after fire, clear-cutting, wind-throw or defoliation. In such cases it may form large and more continuous stands[9, 13]. Though Eurasian aspen may produce enormous numbers of viable seeds, seedlings find it difficult to establish apart from under suitable environmental conditions or after a forest fire[14]. Aspen maintains its existing populations mainly through vegetative replacement and expansion. The vegetative reproduction is guaranteed by root suckers, which are abundantly produced on the shallow lateral roots after an individual has been damaged or destroyed, e.g. by cutting, fire or diseases, leaving an open space exposed to sunlight. The trees growing from the suckers form clones and mature stands reproduce vigorously by this vegetative means. Clones may live thousands of years if new suckers continuously arise from the original rootstock[4, 9]. Eurasian aspen hybridises naturally with white poplar (*Populus alba*) forming the grey poplar (*Populus* x *canescens*), which is intermediate morphologically, but more vigorous than its parents[8]. Artificial hybrids have been produced with a number of other poplars. In particular *Populus tremula* x *tremuloides*, the hybrid with the North American quaking aspen (*Populus tremuloides*), is widely used for large-scale plantations thanks to its stronger vigour and higher growth rates[4, 15].

Importance and Usage

Although its commercial importance is limited compared with other tree species, aspen is often found to be a keystone species due to its fundamental ecological importance for other species; e.g. herbivorous, **saprophytic** invertebrates, fungi and lichens, birds, etc. It has more host-specific species than any other boreal tree and is one of the most significant contributors to total **epiphyte** diversity in the boreal forest[9, 11, 16]. It is an attractive species for ornamental purposes thanks to the colouration of foliage[8, 11]. The wood is not dense, like other poplars, and it is mainly used for veneer and pulp for paper production, also for good quality charcoal and chip-wood[8, 11]. It is used as a biomass crop for energy production because of its rapid growth. As a pioneer species Eurasian aspen is often used for afforestation of barren or degraded lands, and it is also planted as a shelterbelt species thanks to its wind resistance[8]. As other fast growing



The foliage flutters in the breeze so the trees are often heard even when not seen.
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Salicaceae, this aspen is multi-functionally suited for pollution mitigation , microclimate regulation and to enhance the structural and biological diversity in open agricultural landscapes[17]. Its very broad spatial distribution overlaps with many areas in Europe affected by high erosion rates, including European boreal areas and moist slopes with high drainage-area within the European mountain systems[18]. In many erosion-prone areas, Eurasian aspen contributes to provide important ecosystem services such as watershed protection and soil stabilisation[19]. It is also exploited for phytoremediation with the hybrid aspens *Populus tremula* x *alba* and *Populus alba* x *tremula*[20]. In the Nordic and Baltic countries the hybrid *Populus tremula* x *tremuloides* is planted for pulp fibre production. On the best sites it can produce almost twice as much wood as native aspen[9]. Eurasian aspen is among the group of plants that significantly emit **isoprene**, which is one of the **biogenic volatile organic compounds** affecting a complex chain of feedbacks between the terrestrial biosphere and climate, with relevant although not yet completely understood implications under the ongoing climate warming[21-23].

Wooly male catkins with purplish anthers.
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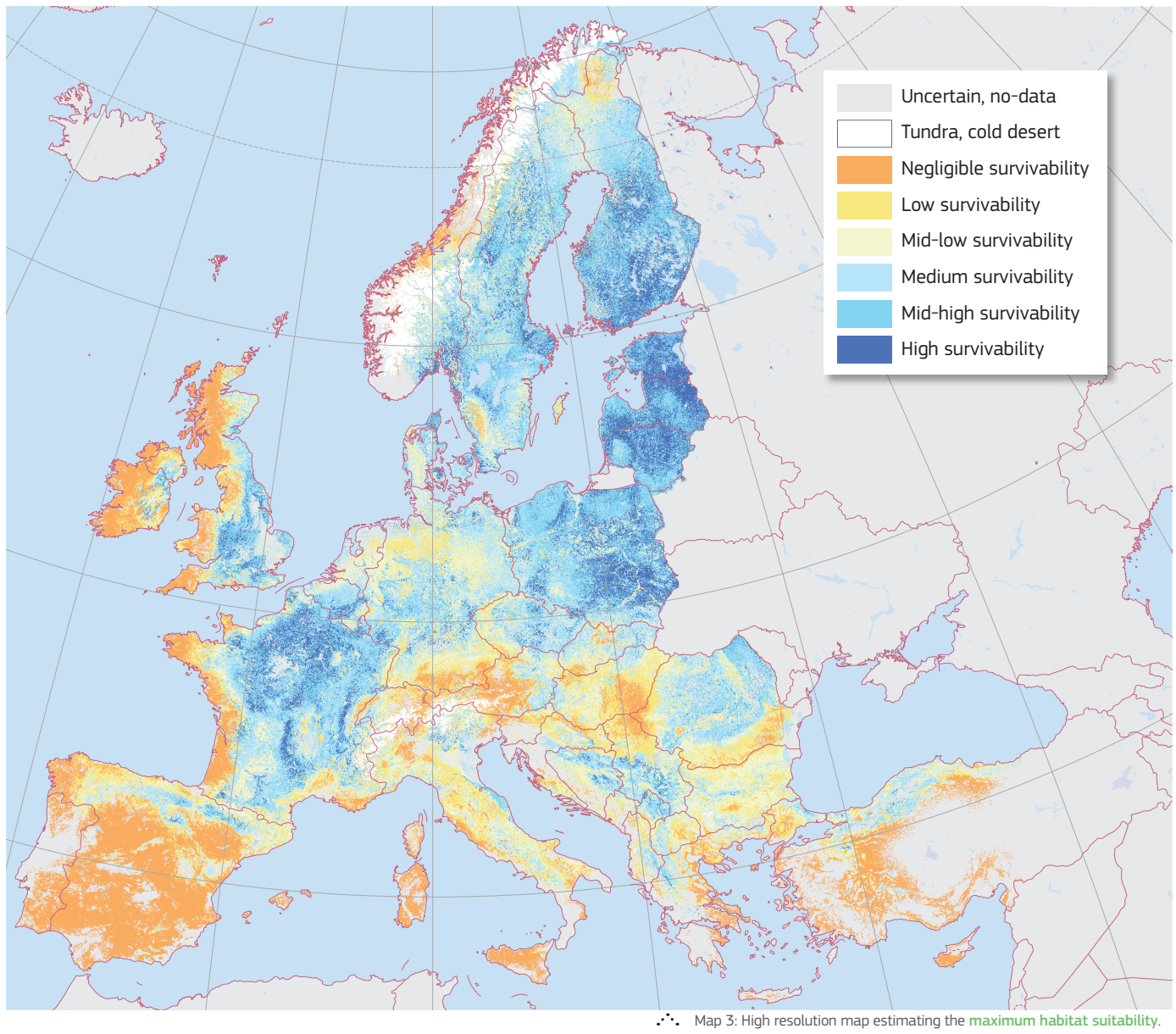


Map 3: High resolution map estimating the **maximum habitat suitability**.

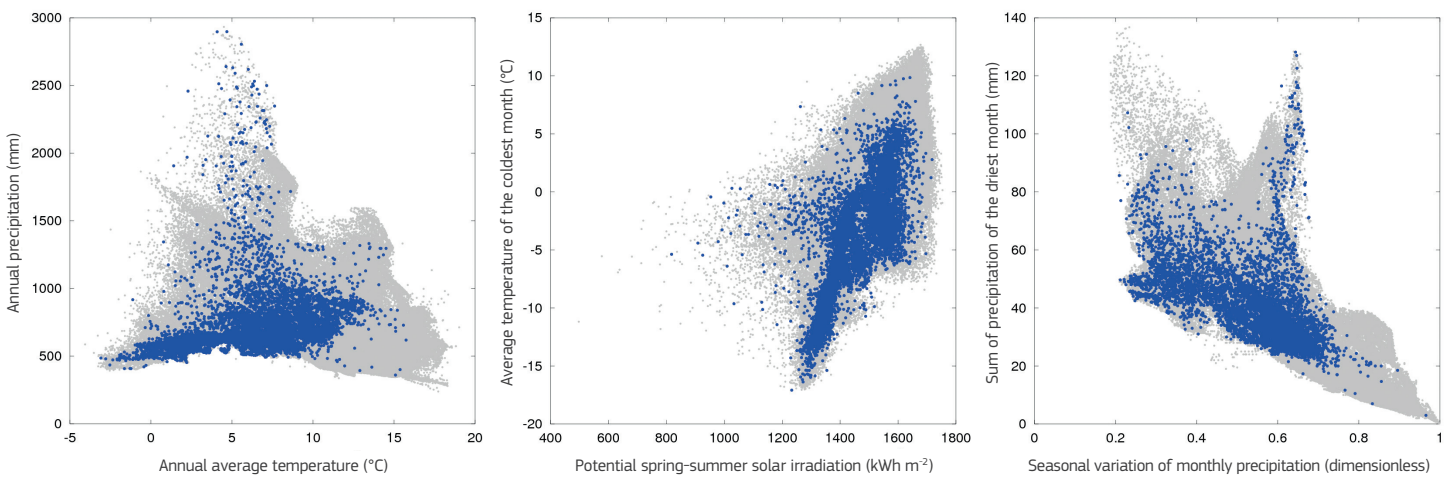
Threats and Diseases

A large number of herbivores graze aspen leaves for foraging. Despite its fast growth, repeated browsing activity can limit the successful establishment, especially of young trees. In boreal, temperate, and mountain forests, aspen can be heavily defoliated by moose and deer (Cervidae), livestock, rabbits (Leporidae), or killed by bark stripping or fraying activities[9, 14, 24]. In regions of intensive agricultural and silvicultural land-use aspen has been removed over centuries and restricted to marginal or abandoned sites. In such regions it is now considered to be a threatened species and the genetic variation is also reduced by the improving use of hybrids, which pose a potential threat to the genetic integrity of the native populations[4]. Aspen is also affected by numerous fungi and diseases, most of them part of the forest ecosystem and not threating the host[9]. Economic damage is caused principally on stands for wood production. The fungi *Neofabraea populi* and *Entoleuca mammata*, which have been imported into Europe and Scandinavia from North America, can potentially cause severe infections[25, 26]. Like other poplars aspen can be attacked by several species of leaf rusts of genus *Melampsora*. This fungus causes decay spots on the leaves and kills the growing tips of new shoots. Heavy infestation can result in defoliation[11, 27]. The species *Melampsora pinitorqua*, which causes serious diseases on young Scots pine stands, has the aspen trees as an intermediate host, so that aspen has been eliminated from most managed forests containing pine in Finland. The main agent responsible for the death of old and large tree is the stem white rot fungus *Phellinus tremulae*. On plantations this disease can reduce considerably the economic value of the wood[14, 16]. The Eurasian aspen is a susceptible host for the Asian longhorned beetle (*Anoplophora glabripennis*), despite showing noticeable resistance and thus potentially acting as overwintering reservoir of the beetle[28, 29]. The larvae of *Trichiocampus viminalis* may defoliate the Eurasian aspen[29]. The lepidopteran *Clostera anastomosis* especially feeds of this tree[29]. The leaf-feeding beetles of *Chrysomela tremulae* can damage young plantations of the hybrids *Populus tremula* x *tremuloides* and *P. tremula* x *alba*[29].

Bark detail showing diamond pattern.
(Forestry Commission, www.forestry.gov.uk: © Crown Copyright)

Field data in Europe (including absences) ● Observed presences in Europe ●

Autoecology diagrams based on harmonised **field observations** from **forest plots**.



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