3.27 Trees: A Remarkable Biochemical Bounty

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3.27.1 Trees: Human Reliance on Arborescent Life

The importance of trees and their varied wood/bark constituents cannot be overemphasized, given humanity's critical reliance upon them for almost every aspect of life. Not only do they represent the sources of all of our commercial wood products, but also that of innumerable and often truly remarkable secondary products. Interestingly, while wood and bark usage worldwide is generally regional and application-dependent, many of their so-called secondary products have been traded over huge distances throughout history, for example, spices, fragrances, and so on. In other words, over millennia and across the globe, humans have sought and utilized – for a host of different purposes – a tremendous array of basic raw materials and substances from our diverse tree species. It is thus worth reflecting on the fantastic bounty that trees provide humanity, particularly since it is seldom fully appreciated that tree uses and applications depend upon their chemistries – whether as their diverse phytochemical constituents or as their structural/polymeric (material) components.

Many of our most familiar items are derived from wood. These range from basic writing equipment, such as pencils and paper, to the bulk of our pulp, paper, and fiber-based products that are used in many different applications. They are also the major sources of lumber, wood, and associated wood composites for construction of buildings and their interiors, and being extensively utilized for boats, utility poles, cooking and eating utensils, and so on (**Figure 1**). As a raw material, wood is also often used for the sophisticated design and crafting of musical instruments; for creation of the striking works of art, such as carvings, sculptures, totem poles, jewelry and the like; and for furniture/furnishings, either of rudimentary design and/or of truly creative/artistic expression (**Figure 2**). Such applications largely reflect the physical/mechanical properties of the wood structural biopolymers in their roles as materials. Wood is also used for a plethora of other sundry items and applications.

Trees are sources of other valuable commodities and products, such as rubber (**Figure 3**), lacquers (**Figure 4**), gums (**Figure 5**), syrups (**Figure 6**), resins, oils, varnishes, fossils (amber, **Figure 7**), and miscellaneous intermediate chemicals used in various products. However, they can additionally serve as important providers of specialty chemicals, flavor, and fragrance chemicals, and highly valued medicinals. Examples include common spices, such as cinnamon, cloves, nutmeg, and bay leaves (**Figure 8**); various flavors/fragrances including those from sandalwood, incense (e.g., *Boswellia* spp., *Commiphora* spp.), pine (*Pinus* spp.), and citrus (*Citrus* spp.), and so on; medicinals, such as taxol (**1**), camptothecin (**2**), quinine (**3**), acetylsalicylic acid (**4**), and camphor (**5**) (**Figure 9**); insecticides, such as azadirachtin (**6**) or poisons, such as strychnine (**7**) and cyanogenic compounds (e.g., (*R*)-amygdalin (**8**), (*R*)-prunasin (**9**)) (**Figure 9**). They are also sources of a fantastic array of foodstuffs, including fruits and nuts (**Figure 10**), and various products derived from specific types of foliage. In addition, there are many diverse bark products, ranging from the familiar suberized cork

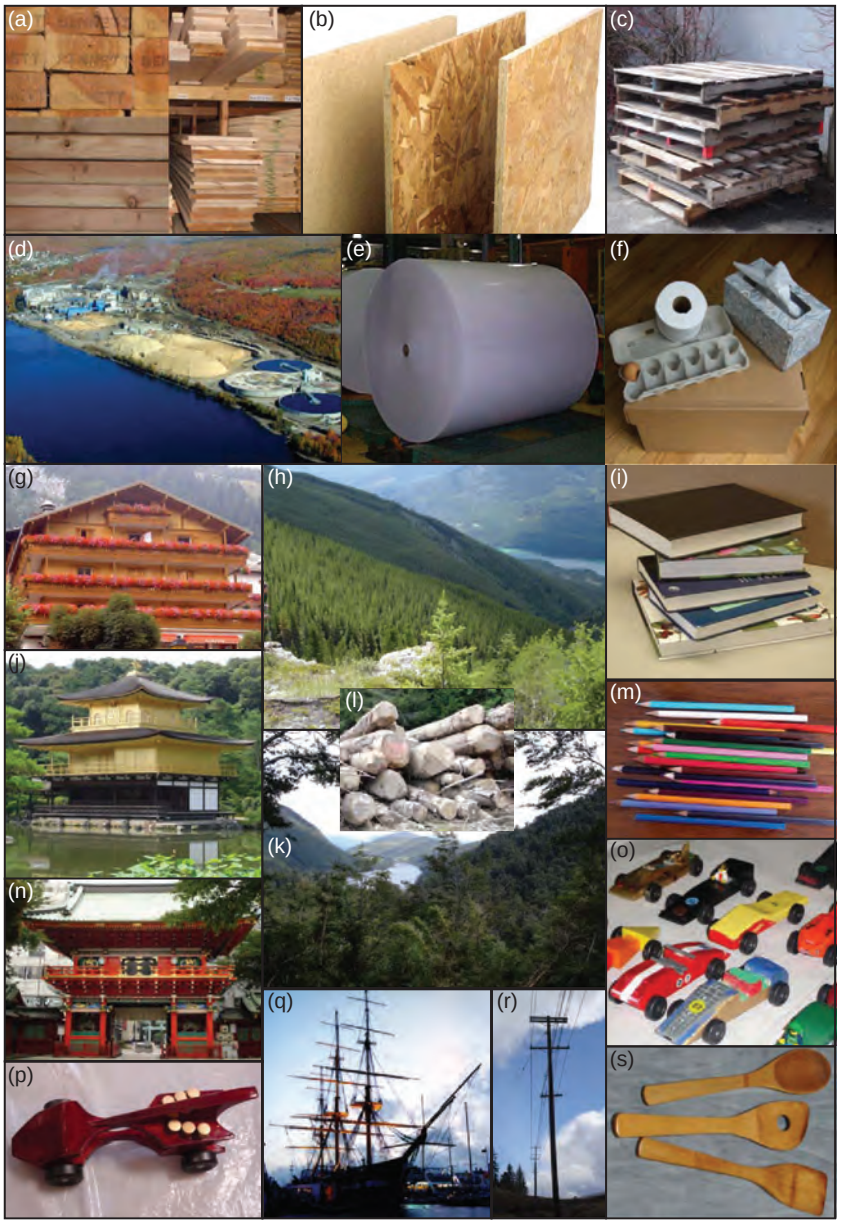

Figure 1 Some familiar uses of wood as a material and as a source of other cellulose-derived products: Wood for lumber (a); Wood composites such as waferboard (b); Wood pallets (c); Aerial photograph of pulp and paper mill (Tembec, Temiscaming, Québec, Canada), with the light-colored wood chip piles in the center of the image used as raw material (d); Paper is wound into large rolls (which can weigh up to ~25 tons), with this resulting from processing wood chips to make pulp, compressing the same to remove water and drying pulp (e); Selected pulp and paper products (toiletries/paper towels, paper tissues, packaging (e.g., egg and cardboard boxes, paper tissues) (f); books (i); newsprint (not shown), and so on. Selected examples of wood products in building construction, such as a typical 'chalet' in the Alps, France (g); the Golden Temple in Kyoto, Japan (j); and the main gate of the Kanda Shrine in Tokyo, Japan (n); Pencils (m); toys (o, p); boats (q); utility poles (r); and cooking/eating utensils (s); A forested hillside in British Columbia, Canada (h); and in the Lake District of Chile (k); with harvested timber temporarily piled (l); Images from L. B. Davin, Washington State University (a, c, f–s); http://www.plywoodnews.com (b); M. G. Paice, Pulp and Paper Institute of Canada, Pointe Claire, Québec, Canada (d); and ForestWorks, North Melbourne, Victoria, Australia (http://www.forestworks.com.au), with permission (e).