Commiphora: An Introduction to the Genus

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Part 1: Distribution, Taxonomy, and Biology

The family Burseraceae is of modest size, with about 600 species in about 17 genera. Most species occur in the tropics, some in the subtropics, of both hemispheres. Many grow in drier climates and some of these are soft-wooded with a tendency toward succulence and pachycauly. Amongst those of interest to succulent growers are two of the larger genera, *Bursera*, primarily of the New World, and *Commiphora*, primarily of the Old World. The other two genera grown in the hobby are the Old World *Boswellia* and *Beiselia mexicana*, a monotypic Mexican species. Many members of the family produce aromatic oils and resins in their sap and these materials have been used throughout human history for various purposes. Famous amongst these are myrrh, from Arabian and east African commiphoras, frankincense, from Arabian and east African boswellias, and copal, from American burseras.

The genus *Bursera* is familiar to most experienced growers of succulents, especially to those who enjoy pachycaul or caudiciform plants. Many species are naturally suited for bonsai; young plants thicken quickly, they branch freely, are easy to prune and train, and often have naturally small, compound leaves. As trunk and branches swell, even with young plants, the bark often begins peeling giving the plants an appearance of greater age. *Bursera* is a New World genus, with distribution from the southern United States through Mexico and the islands of the Caribbean, and into South America.

In the Old World the genus *Commiphora* is the sister group of *Bursera*; several studies, both morphological and molecular, have demonstrated that the two genera are closely related[22]. As a whole, commiphoras share many of the same characteristics with burseras, including a marked tendency toward stem succulence and pachycauly, artistic branching patterns, peeling bark, soft wood, small leaves, and fragrant resins. They even share the same ecological traits, being frequent (sometimes dominant) components of the dry forests of deserts and semi-arid areas. Yet, until fairly recently, *Commiphora* has been overlooked as a group of horticulturally interesting plants. But in the past 10-15 years collected plants, primarily from tropical east Africa, the Horn of Africa, and Madagascar have become available. These have often been costly plants, and sometimes difficult to reestablish in cultivation, factors that have restricted a wider appeal to enthusiasts. With only occasional exceptions, seedlings have rarely been offered by nurseries, and seed availability is uncommon and seeds sometimes have frustratingly poor germination rates. But interest in the group continues to grow and the number of species available is gradually increasing.

I became interested in the aesthetic appearance of commiphoras, especially the more succulent species, on my first trip to Namibia and South Africa in 1998[11], and they have been of significant interest since. In addition to the species of southern Africa, I've had the pleasure of seeing them in habitat in Madagascar and tropical east Africa, both being centers of evolutionary diversity of the genus. I've also seen the only New World species in southern Brazil where it is quite common. Most of my field experience has been in Namibia and many of the photos used in this article are from there.

Regrettably, there is relatively little horticulturally satisfying literature on the Burseraceae. (A notable exception being the recent book on *Boswellia* by Jason Eslamieh[7].) Regarding *Commiphora*, there are some quite good taxonomic works, especially for Namibia[12,18], South Africa[17], Kenya[4], Ethiopia[21], Somalia[16], and tropical east Africa[9] but most

of these have relatively few illustrations (primarily line drawings detailing plant parts of interest to the taxonomist). Illustrated floras on Namibia[12], Saudi Arabia[5], India[14], and Soqotra[13], with good sections on *Commiphora*, have appeared in the last 10 years or so. Recently, Marthinus Steyn has produced an excellent and copiously-illustrated field guide to the species of southern Africa[15]. Besides this, there are numerous technical papers on the aromatic resins of many species, and the medicinal and other uses of these resins. There is very little printed horticultural information on the genus. The purpose of this article is to review the basic botany and biology of the genus; future articles will discuss the uses and cultivation of these plants.

1 *Commiphora leptophloeos* near Morro do Chapéu, Bahia, Brazil, deciduous in the dry season. This is the only species of *Commiphora* native to the New World.

Etymology

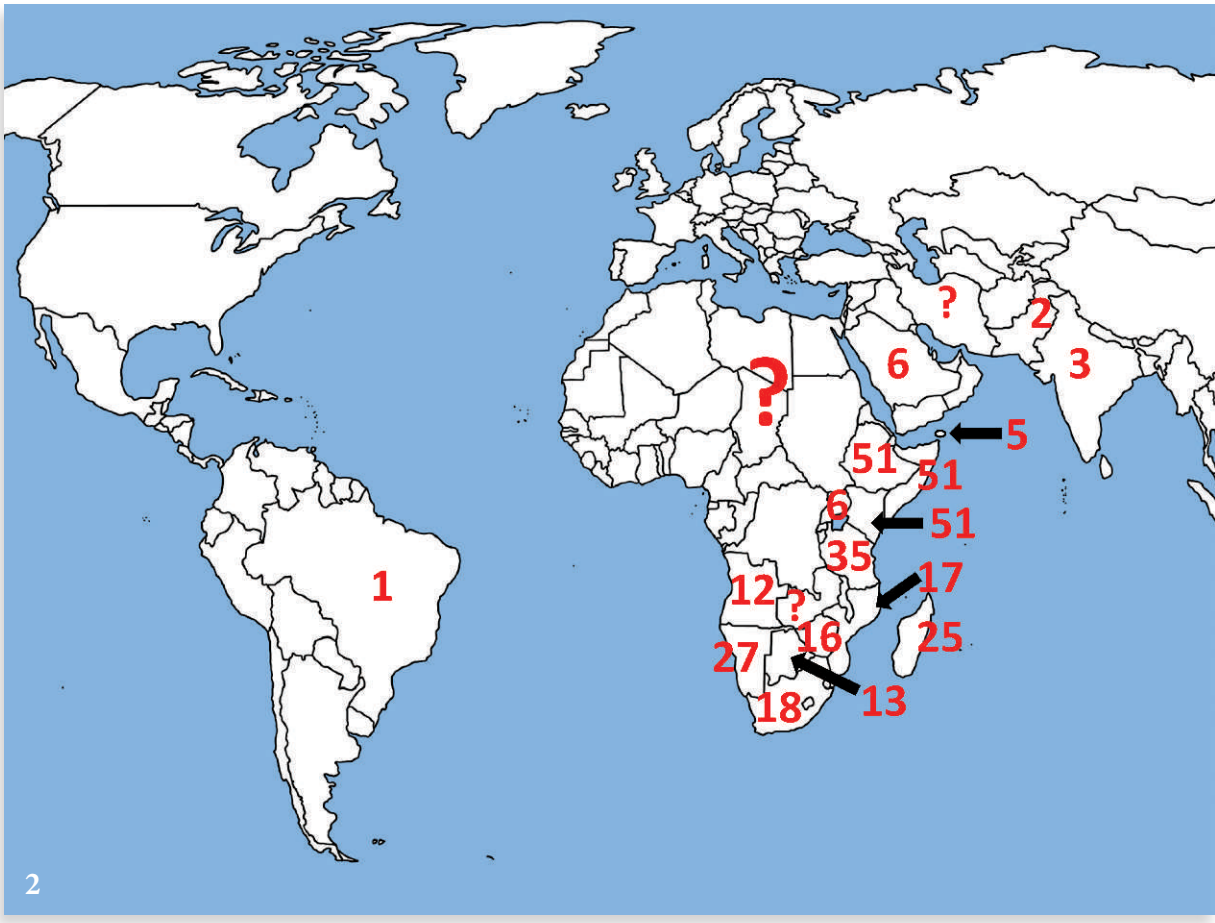
The genus name is derived from two Greek words, *kommi*, meaning gum, and *phoreus*, meaning carrying, referring to the gummy resins produced by most species. As such, the correct pronunciation is not *cum-**mif**-or-uh*, but instead *com-me-**for**-uh*.

Geographic Distribution

The genus *Commiphora* includes about 150-200 taxa (species, subspecies and varieties) that primarily occupy the warm, dry areas of the Old World, especially within the tropics. It occurs from southern Africa, eastward through tropical east Africa and the Horn of Africa, into the Arabian Peninsula, and with the northern limits of its distribution in the dry areas of Iran, Pakistan, and India (Fig. 2). One species, C. *leptophloeos* (Fig. 1) occurs in the Americas, specifically in southeastern Brazil. This was originally described as a *Bursera* but morphological and molecular studies have confirmed it to be a *Commiphora*[2,8]. (Note that two Mexican species of *Bursera*, *B. sarcopoda* and *B. tecomaca*, at one time proposed to be commiphoras have been shown by molecular techniques to properly belong to *Bursera*[2,3].) Examples of species richness, from southwest to northeast, include Namibia and South Africa, with about 35 spp.[15], including some of the most markedly succulent species, Madagascar 25 spp.[1], Kenya 50 spp.[9], Somalia 50 spp.[16], Ethiopia 50 spp.[21], Soqotra 5 spp.[13], Saudi Arabia 10 spp.[5], India 3 spp.[14]. (Numbers are approximate; adjacent countries share several species.)

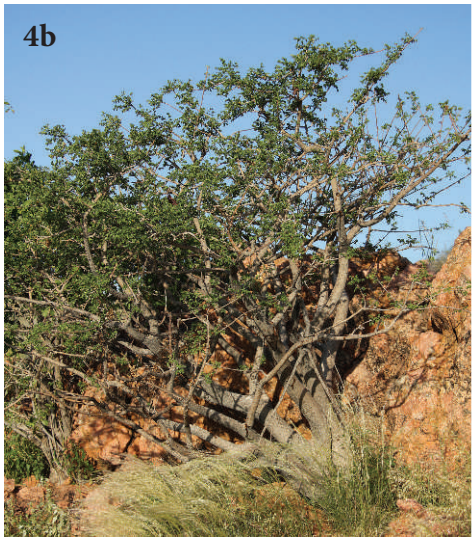
Taxonomy and Characters Used in Identification

The family Burseraceae is a member of the order Sapindales, which includes other familiar families such as Sapindaceae (litchi and rambutan as examples), Hippocastanaceae (horse chestnut and buckeye), Aceraceae (maple), Meliaceae (mahogany), Rutaceae (citrus), and Anacardiaceae (cashew, pistachio, mango, sumac, and poison ivy). Burseraceae is closely related to the latter family, with which



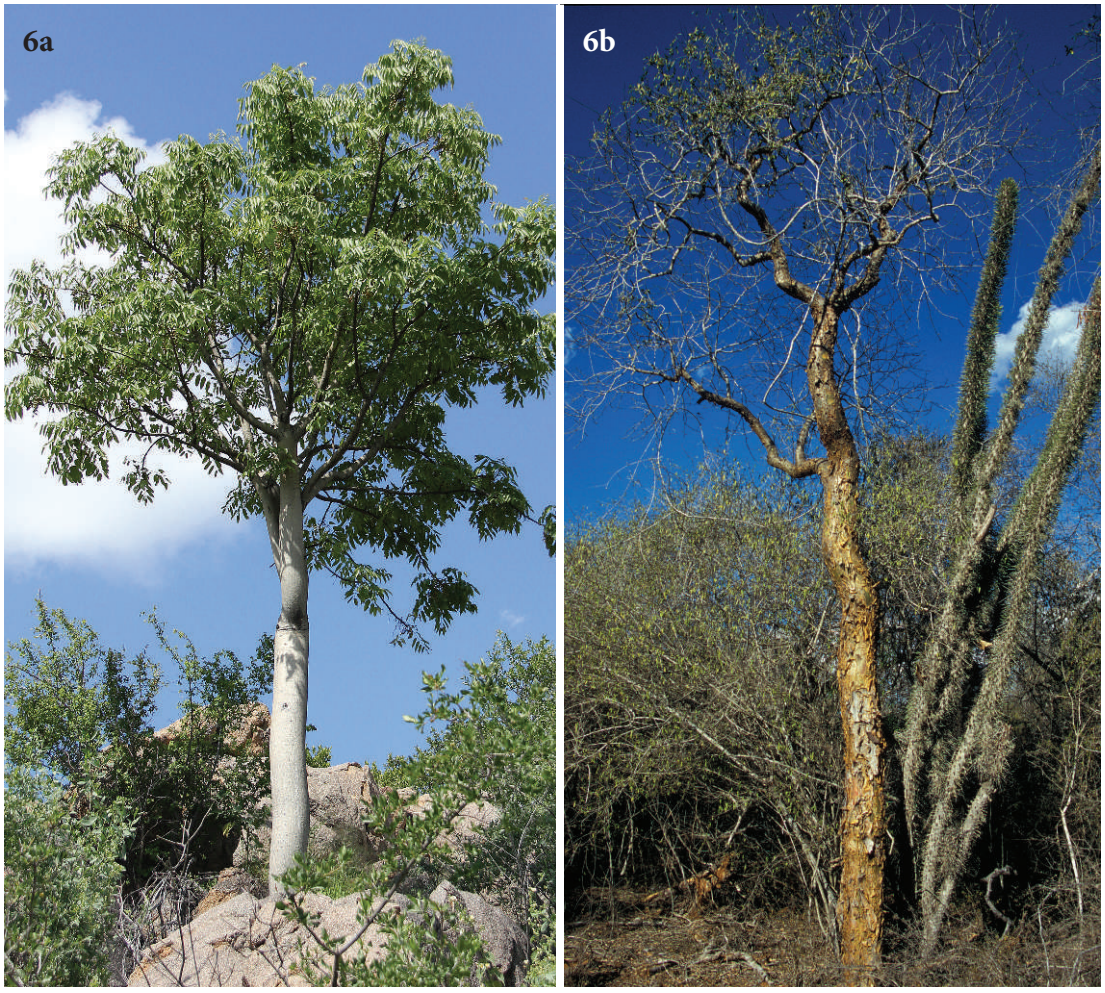
2 Map of the distribution of the genus *Commiphora*. Numbers indicate the number of species per country.

3 *Commiphora tenuipetiolata* (left) and the smaller, shrubbier *C. angolensis* (right) are closely related, have overlapping distributions, and have similar appearing bark, leaves, and stones, making identification difficult. There are many such groups of similar species within the genus.



4 *Commiphora saxicola*, growing at three locations in northern Namibia, demonstrates the extreme variability that can be seen within a species, from dwarf *(4a)*, shrubby *(4b)* to arborescent, with a single trunk *(4c)*. Similar variability can be seen in other species. Certainly local soil and climate play roles in shaping these plants, but the contributions of local population genetics is unknown.

5 Some commiphoras are immediately distinctive and cannot be confused with other species. An example is *C. kraeuseliana*, with a spreading, flat-topped habit, vertically striated lower stems, feather-like leaves, and large, whitish fruits.



6 *Commiphora* species range in form from fairly typical, single-trunked "normally" proportioned trees to more stout, pachycaul forms, sometimes with multiple trunks, to upright or prostrate shrubs, to low-growing caudiciform plants. These two appear as fairly conventional trees. *C. crenatoserrata* from Namibia *(6a)* and an unidentified species from Madagascar *(6b)*, with beautiful, peeling golden bark.

7 Representative bark characteristics of commiphoras. Bark somewhat varies with species, individual, population, and environment. *(7a)* Smooth bark of *C. kuneneana*, northern Namibia. *(7b* & *c)* Flaking bark of *C. glaucescens* and *C. mollis*, respectively, Namibia. *(7d)* Flaking-peeling bark of *C. anacardifolia*, Namibia. *(7e)* Bark peeling in thin horizontal strips, *C. discolor*, Namibia. *(7f–h)* Bark peeling, revealing lower green or blue photosynthetic bark, *C. leptophloeos*, Brazil; *C. glandulosa*, Namibia; *C. holtziana*, Kenya. *(7i)* Bark peeling without photosynthetic under-layer, *C. orbicularis*, Madagascar.

8 There are spinescent species of *Commiphora* virtually throughout the range of the genus. The spines are short vegetative shoots. This is *C. pyracanthoides,* which has a transcontinental distribution in southern Africa. Shown is recent growth; at the end of the season the leaves will be shed and the spines will harden sufficiently to penetrate the sole of a hiking shoe.

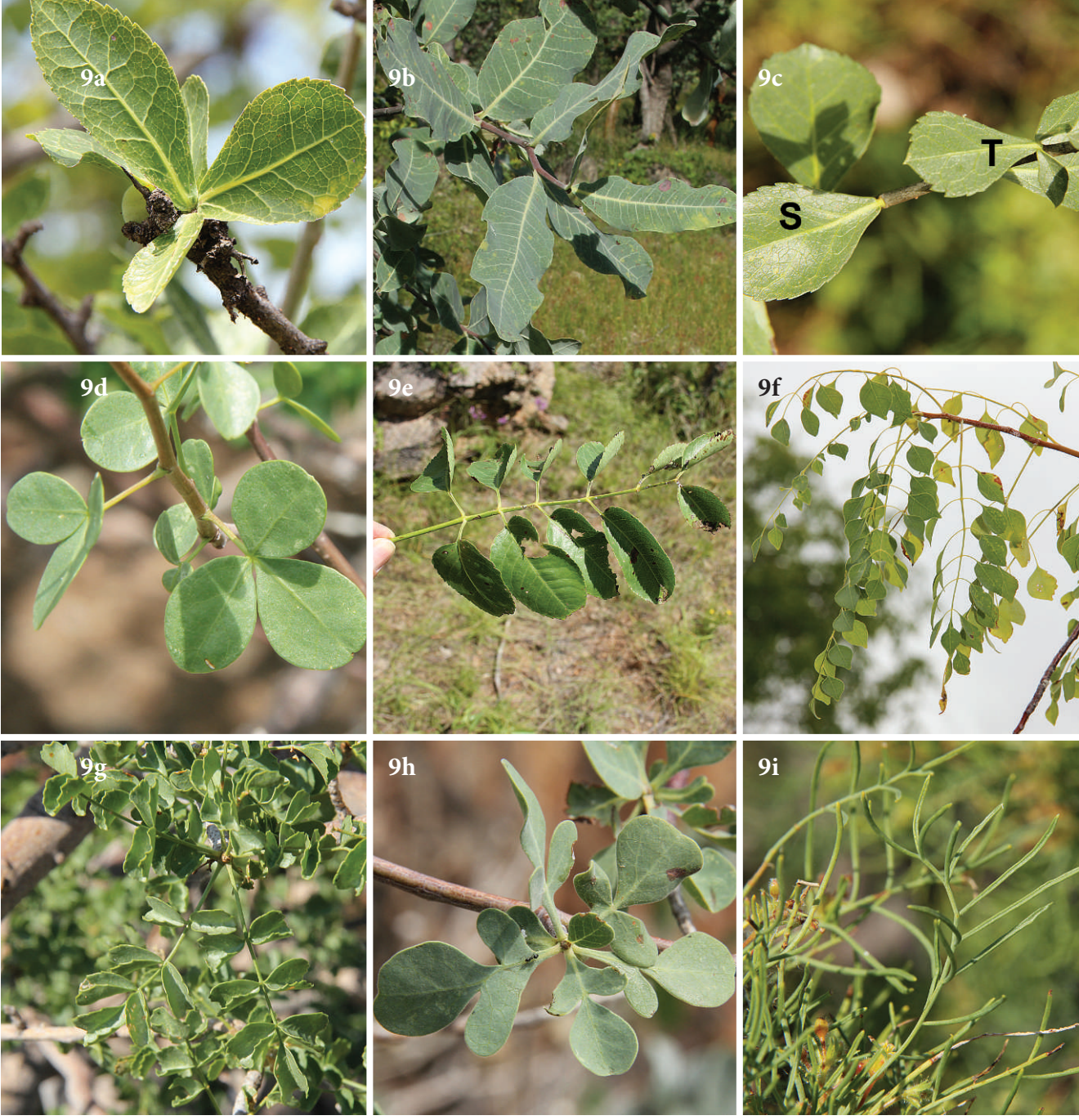
it shares certain characteristics such as pinnately compound leaves, peeling bark, and resinous sap. The Anacardiaceae also includes succulent and semi-succulent species, such as in the genera *Operculicarya*, *Pachycormus*, and *Cyrtocarpa*, and others not yet commonly in cultivation. Burseraceae has been divided into three tribes, with *Commiphora*, *Bursera*, and *Boswellia* (frankincense) belonging to the tribe Bursereae.

The genus *Commiphora* has been divided into several sections (species groups) that are fairly well delimited. These will not be presented here; if interested, see Vollesen[20] and Gillett[9] in the references provided.

A combination of vegetative and reproductive characteristics is used for species identification. These include leaf, stem, and bark characteristics, flowers, fruits, and the stone, and the overall architecture of the plant (e.g. tree or shrub, single or multiple trunks, stiff or lax stems, sparsely or profusely branched, straight or crooked branches, spiny or not). Identification can be very difficult, both in the field and in the greenhouse. As a group, the genus tends to have short vegetative and reproductive periods in the field, coinciding with the often-brief rainy season. Flowering often occurs at the end of the dry season before the plants are in leaf. Leaves are produced at the onset of the rainy season, but usually by the beginning of the dry season most plants have defoliated, nothing remains of the flowers, and fruits and stones are few and far between. All of these factors make field identifications problematic for many months of the year. The flowers are tiny (usually 2-3 mm) but carry information useful (sometimes essential) in identification. Plants are usually dioecious and sometimes both male and female plants are needed for certain identification. Further, the species tend to be gregarious, that is, often where you find one species you find several growing together, further complicating identification. In some of the taxonomic papers it has been noted that herbarium sheets, even of type specimens, may be confused, having parts of more than one species. And, even more frustrating for the plant identifier, within certain sections there are species that are very closely related, with very similar vegetative characteristics, and these may be found growing literally side by side, as in Fig. 3. Finally, some species have rather large distributions, and occur in a variety of microclimates. Under such conditions, there can be gross variability in vegetative characteristics from location to location. For example, *C. saxicola* is a common Namibian endemic, but the overall plant form can vary with environment, from a low-growing, sparsely branched prostrate shrub, to a more upright, highly branched shrub, to a small single-trunked tree (Fig. 4).

Although in some species identifications can be tricky, sometimes a combination of characteristics coupled with known geographic distributions makes for relatively easy field identification. For example, in the Kaokoveld of Namibia, *C. kraeuseliana* (Fig. 5) is a spreading, flat-topped shrub with feathery leaves. Straddling the Orange River between Namibia and South Africa, *C. cervifolia* has tiny, deeply-dissected leaves. In southwestern Madagascar, *C. simplicifolia* is the only spiny species.

Because of the difficulty in identifying many species without the entire suite of important characteristics, the buyer of imported plant material should be cautious at accepting the provided species name. As an aid, if possible, secure the source locations when making purchases as this can be an aid. Further, keep in mind that the relatively lush conditions of horticulture may result in more luxuriant growth – longer, thinner stems, larger leaves, more leaflets – than found in habitat, and which may result in deviation from species descriptions which are based on habitat material.



9. The Namibian *Commiphora* species graphically demonstrate the incredible leaf diversity within the genus. Here are just a few examples. *(9a)* Leaves can be simple, relatively small, without a petiole, and with toothed or notched edges as in *C. viminea*. *(9b) C. glaucescens* has small to large glaucous (bluish) leaves with smooth, undulate edges. *(9c)* Many *Commiphora* species are trifoliolate (with a terminal and two lateral leaflets), usually with the apical leaflet larger than the laterals. *C. glandulosa* can have both simple (S) and trifoliolate (T) leaves on the same stem! *(9d) C. virgata* has trifoliolate leaves with a petiole, but the leaflets are sessile (without petiolules). (9e) *C. crenatoserrata* has a large (to 9") pinnate leaf. *(9f)* The pinnate leaf of *C. multijuga* has a slender elongate petiole and rachis and slender petiolules, giving the tree an attractive, weeping appearance. *(9g)* The leaflets of *C. saxicola* are reflexed and folded upward along the mid-vein, and the edges are toothed. *(9h) C. wildii* has the leaves deeply lobed, somewhat asymmetrically, appearing somewhat like a small oak leaf. *(9i) C. kraeuseliana* has deeply dissected leaves with just a tiny amount of tissue remaining around the main veins, giving the foliage a feathery appearance.

Morphological Trends

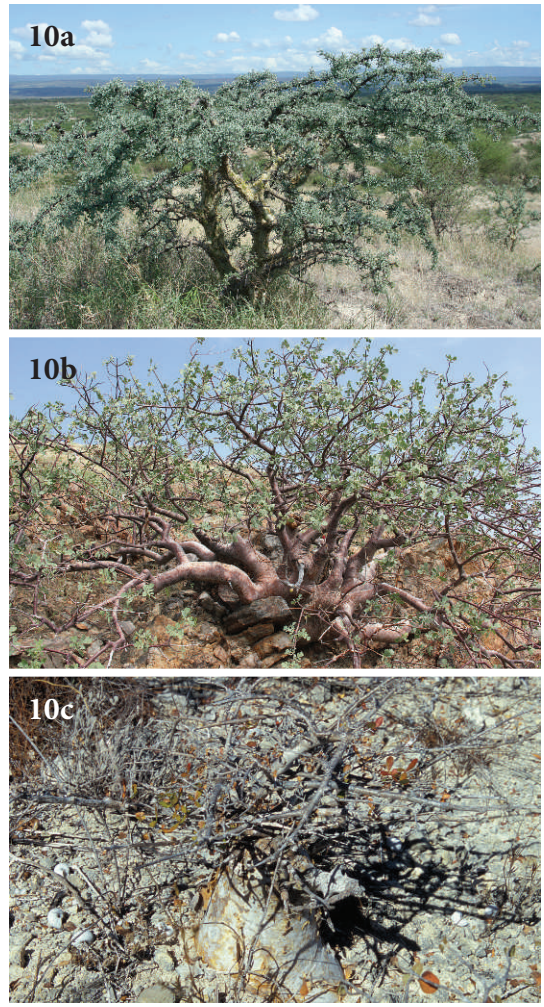
The genus covers a broad geographical area, within which it populates a multitude of habitats; this has resulted in a fair diversity of morphological forms. This diversity adds to the horticultural interest of the group.

Many species are perfectly good trees, with a single trunk and a branched canopy (Fig. 6). No species get exceedingly large, and most arborescent species are considered small trees. The tallest in tropical east Africa (Kenya and Tanzania) is apparently *C. baluensis* at about 20 m[9]. At the opposite end of the scale are the relatively small shrubby types; for example, the shortest from Somalia are *C. murraywatsonii* and *C. spinulosa* at 0.2 and 0.3 m respectively[16]. Taller, more arborescent species are generally found in wetter climates and shorter, shrubbier, and often more succulent species are found in drier climates. For example, in tropical east Africa with higher rainfall (Kenya, Tanzania, and Uganda) about 46% of the species can be over 6 m tall, while in drier Namibia and Somalia the values are substantially reduced to 33% and 19% respectively. (The value for Namibia is even lower if the species found only in the relatively moister Caprivi Strip are discounted). The descriptions of many species state something like "shrubs or small trees". In part this relates to those species with a distribution that covers a range of rainfall amounts or habitat types; individuals will usually be taller and more tree-like in wetter areas and shorter and stouter in drier areas or when growing in areas of poor soil or extreme drainage, such as rocky slopes.

The bark of many species is attractive. Some have a relatively smooth bark whereas others flake or peel. In the case of the latter, the underlying bark is often photosynthetic and attractively colored in shades of green and even blue (Fig. 7).

Many species develop short stems that are sharp at the end, forming spines (Fig. 8). In some, the spination is rather fierce. As the spines are growing they have clusters of leaves and additional stems can sprout from the axils, resulting in spines developing from spines.

Some species have simple leaves but most have compound leaves, as shown in Fig. 9. Many are trifoliolate (with 3 leaflets; the two basal leaflets are often noticeably smaller than the apical leaflet); most are pinnate with upwards of 15 pairs of leaflets. In some cases the leaves or leaflets are quite small, no more that 10-15 mm long. At the other extreme the largest simple leaves can be over 125 mm long,



10 Within the genus *Commiphora* there is a strong tendency toward pachycauly and caudiciformity, as demonstrated by *(10a)* *C. campestris* (Kenya), *(10b)* *C. wildii* (Namibia), and *(10c)* *C.* cf. *humbertii* (Madagascar).

and the largest compound leaves even longer. Most species are soft-wooded and many have thickened trunks and stems; some are noticeably pachycaul or even caudiciform (Fig. 10). The soft-woodedness allows for the young stems to be easily blown to and fro; as the branches age they stiffen in random directions resulting in a rather haphazard appearance (Fig. 11). Some species are rather sparsely branched and the leaves may be small, resulting in a canopy with an open appearance (Fig. 12).

The flowers are tiny – just a few mm in length – and easily overlooked (Fig. 13). The flower arrangement varies considerably with species; at one extreme single sessile (stemless) flowers are formed at the

11 Their soft-wooded nature, possibly in conjunction with winds, give many *Commiphora* species a rather disheveled canopy architecture, with contorted branches going to and fro, as demonstrated by these three species from the dry spiny forest of southwestern Madagascar. ***(11a)*** is of *C. monstruosa*; identity of the two species in ***(11b*** & ***c)*** is unknown. Photo (c) courtesy of Tim Harvey.

leaf axils; at the other extreme pedicellate (stemmed) flowers are borne in clusters in elongate panicles; various intermediate arrangements occur. In many species flowering occurs before the onset of the rainy season while the plants are leafless. The plants are usually dioecious and the flowers are usually unisexual, but on many plants these characteristics are imperfect and self-pollination is known to occur[9]. Therefore, it is possible in greenhouse collections to produce a few viable seeds from a single plant. I have a small bonsaied *C. glandulosa* that produces upwards of a dozen fruits each year and *C. wightii* plants routinely produce asexually derived (by apomixis[10]) viable fruit on quite young plants. The small fruit, usually about ½-3/4" (10-20 mm) in diameter, has been categorized as a drupaceous capsule[6,19] (Fig. 14). Externally it has a fleshy pericarp, usually starting green and ripening to red or purple, then splitting and falling away revealing the hard stone within (Fig. 15). The stone is usually black and partially covered with a brightly colored (usually red, but sometimes orange, yellow, or white) fleshy aril-like structure called a pseudaril (Fig. 16), which is thought to be nutritious and therefore attractive to birds that harvest and disperse the seeds. What appears to us to be a seed is actually a compound structure. The ovary of the flower has 2-3 locules, each with one ovule; usually all but one are sterile. However occasionally two or all three locules can be fertile and pollinated, resulting in as many as 2-3 seedlings ("twins" or "triplets", each resulting from a separate pollen grain). Therefore, what we think of as the seed is, from a botanical perspective, more correctly called a stone or putamen[9] or pyrene[19].


12

12 Some commiphoras are naturally sparsely branched, such as *C. coleopsis* in southern Madagascar. This is a large plant at about 9 ft tall. Reproduction can occur when plants are only 18" tall (inset: fruit and 3 ripe stones).

Ecology

Most commiphoras are found in dry or seasonally dry habitats. In many locations they are a dominant component of the plant community, and it is quite common to find four or five or more species growing together. Because of their abundance they form an important component of the natural community and provide food, water, and shelter for numerous other organisms. The leaves and young stems are browsed by large mammals and the ripe stones are eaten by birds which play an important role in dispersal. During times of drought the stems, trunks and roots are used as a source of moisture by large animals, and severe damage can be done to the plant populations over large areas.

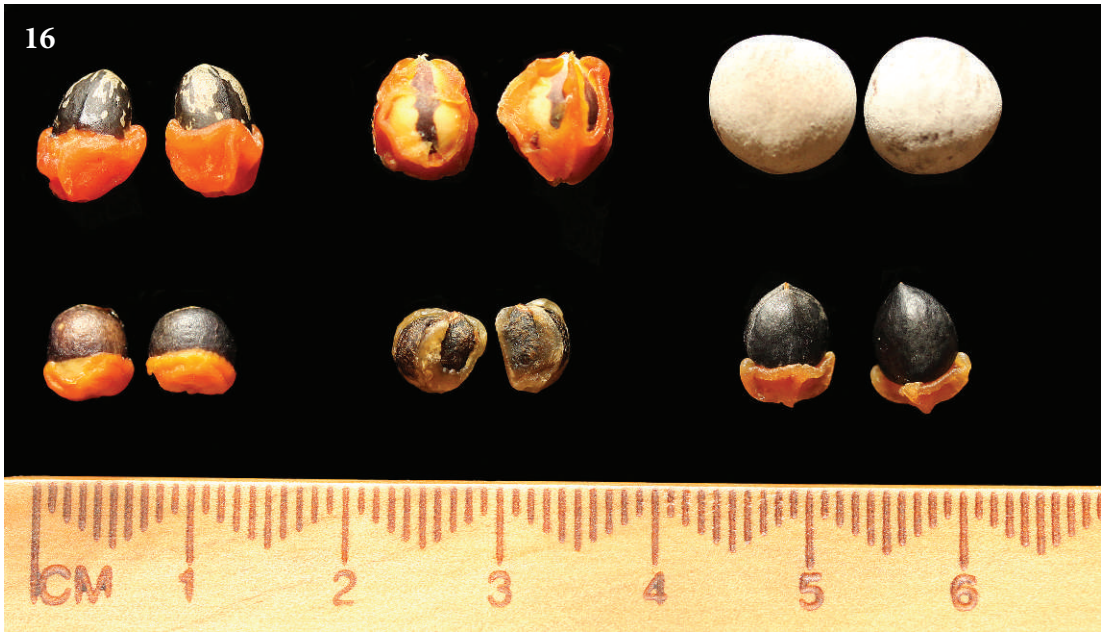
Commiphoras have developed several adaptations to help them overcome drought, most noticeably

13 Commiphoras have tiny flowers, only 2-3 mm in size. (a) buds and fully open flowers of *C. kraeuseliana* in northern Namibia. (b) *C. kua*, female flower. (c) *C. monstruosa*, male flower. Photos (b) and (c) are of plants in cultivation, courtesy of Dan Houston.

water storage resulting in thickened trunks, stems, and roots. Another adaptation is small leaves to reduce the surface area and thereby reduce the loss of water through transpiration. In addition, commiphoras notoriously drop their leaves rapidly in response to declining moisture. At the onset of the dry season they are amongst the first trees and shrubs to go deciduous (Fig. 17) (making it frustrating to do field identifications!). They also will refoliate if moisture once again becomes available during the normal growth period. Potted plants in cultivation readily demonstrate this phenomenon. However, many are obligately dormant during their normal dry period and will not refoliate regardless

14 Flowers and fruit can be borne singly or in small to large clusters; they can be with or without stems and stalks. These are all Namibian species:
(14a) *C. kuneneana*,
(14b) *C. crenatoserrata*,
(14c) *C. glaucescens*,
(14d) *C. virgata*,
(14e) *C. saxicola*.

15 Close-ups of fruit *(15a)* and stones of *Commiphora glandulosa*. In *(15b)* the pericarp (fleshy "fruit") has dried, split, and fallen away to reveal the stones. The red structure on the stone is called a pseudaril. Its shape can be diagnostic for species identifications. These two photos were taken about two weeks apart.



16 Stones of Namibian commiphoras. Top, left to right: *C. glaucescens*, pseudaril without arms and covering about half the stone; *C. multijuga*, pseudaril with long arms extending to the apex of the stone; *C. kraeuseliana*, large brownish stone without pseudaril and covered in fine whitish powder. Bottom, left to right: *C. saxicola*; rounded stone with short cupular pseudaril; *C. virgata*, pseudaril often whitish with long arms; *C. wildii*, pointed stone with short, cupular pseudaril.

of available moisture, until after the winter solstice, when the photoperiod begins to lengthen. To compensate for small leaves and a short leafy period, many species have photosynthetic bark. In such species there is a dead flaky or papery outer layer of bark and a living green or even bluish inner layer. During dry periods the trunk and branches lose moisture reducing their circumference and the dead outer layer provides further protection from desiccation. During the wet season the trunk and branches swell, resulting in the splitting or flaking of the outer layer and exposing the photosynthetic layer to more light.

Most commiphoras are from summer rainfall areas, but there are exceptions. For example, the region along the Orange River forming the border

17 The forest has numerous commiphoras of at least three species; these are amongst the first trees to turn color and then drop their leaves. Other trees on the hillside include *Terminalia*, *Combretum*, and acacias which hold their foliage longer.

between South Africa and Namibia has a Mediterranean climate with winter rainfall. Most of the species found in this region do not grow in the summer rainfall area not far to the north, and the summer rainfall species do not occur in the winter rainfall area.

Because commiphoras are a dominant component of the environment in many areas, indigenous peoples have developed many uses for them, which will be summarized in a subsequent article, along with the modern research on the medicinal value of the resins. The final part of this introduction to *Commiphora* will discuss horticultural cultivation.

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