

Establishment of a modest Tigray botanical garden in Belgium - An illustration of the Afromontane vegetation

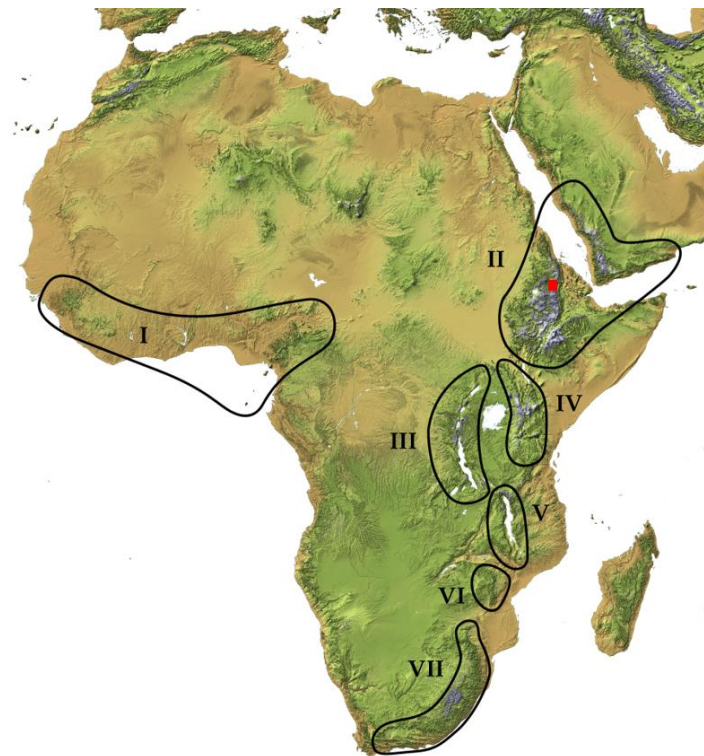
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Jan Nyssen

Ghent University, Department of Geography, Belgium

Abstract

The Afromontane biogeographic region includes plant species found in Africa's highlands. Temperatures in these regions are comparable to those encountered in temperate climates, with the major temperature contrast being between day and night. The Dogu'a Tembien massif in Tigray is a 'sky island', that served as model for the establishment of a modest Afromontane floral park. The garden, dedicated to the slain Tigray people, was established in 2023 and has ten woody, four herbaceous, one palm and one succulent species. The garden is managed organically, with compost and horse manure used as fertilizers, no herbicides, and only a metaldehyde-based molluscicide. Geomembrane sheets are used to limit the abundant local vegetation, and plant labels are prepared in French with scientific and Tigrinya names in small lettering.



Map of the Afromontane regions. The red dot indicates the Dogu'a Tembien sky island that is represented in the botanical garden (Map by Andrew Z. Colvin for Wikimedia Commons)

Afromontane vegetation

The vegetation of the Afromontane biogeographic region includes plant species found in Africa's highlands. The Afromontane regions are discontinuous, separated from one another by lower-lying areas, and are distributed as a series of "sky islands" (Grimshaw, 2001). Temperatures in these tropical mountain climates are comparable to those encountered in temperate climates, with the major temperature contrast being between day and night rather than seasonal (Dereje Ashebir et al., 2010).

Tigray context

One of these Afromontane regions are the Ethiopian highlands. Zone II looks to be cohesive on the map, but it is actually an 'archipelago' of Afromontane islands (Grimshaw, 2001). The Dogu'a Tembien massif in Tigray is such a sky island, where the author has spent several years living and working.

Tigray has suffered through a brutal war waged on it by the Ethiopian, Eritrean, and Amhara armies (2020-2022), and there is still starvation and extreme insecurity (Luber, 2021). We attempted to build a modest Tigray garden in Belgium as a token of friendship and empathy. Despite the occasional severe



Remnant forest at the Tinsehe waterfall in Dogu'a Tembien, Tigray (Nyssen et al., 2019a)

cold in Belgium (at approx. 50°N and 180 metres elevation), the overall temperature similarity with Dogu'a Tembien allowed for the establishment of a modest private botanical garden representing species frequently occurring in Dogu'a Tembien (Tigray).

The Tigray garden

The Tigray garden was established in 2023 near Liège (Belgium). Some species had been planted for many years, while others are recent additions, that have not yet completely grown. The garden holds six woody, four herbaceous, one palm and one succulent species and was inaugurated in 2023. Some of the species were brought from Tigray, others obtained in Europe, and for a few, we substituted the Tigray species by a species of the same genus and with the same morphology, that can grow in the Belgian climate.

The garden is managed organically, with compost and horse dung as fertilizers, no herbicides, and only a metaldehyde-based molluscicide. During the summer, geomembranes are used to reduce the abundant local vegetation ("weeds"). The geomembrane sheets are fastened with flintstone mined from a local outcrop of 'flint eluvium' (Bourguignon, 1957; Dusar et al., 2011; Nyssen et al., 2014; Pel, 1960) because it was impossible to carry a sufficient volume of the vast range of Dogu'a Tembien lithology (Nyssen et al., 2019a).

All planted species are very common in Tigray, and one may occasionally find them in gardens in different countries; none of these species are on the IUCN Red List. It is their grouping in this garden that makes it unique, hence the name "Tigray Garden", "Jardin du Tigray" in French, ገደና ትግራይ [gedena tigray] in Tigrinya. "Gedena" points to a spot in the backyard of the farmer's homestead, meant for planting, multiplying and preserving the family's most valued and essential plants and vegetables. I received many other suggestions, including ደካሪ ቤት [dehri bèt] which points to the

broader backyard (Nyssen et al., 2016) and ማእከል እፅዋት [ma'ekel 'etswat] for botanical garden, which is a bit overdone for this small garden.



View on the Tigray Garden on 22 May 2023.

As the garden is visible to the general public, plant labels are produced in the local French language, with scientific and Tigrinya names written in tiny font.

<p>Bananier <i>Musa basjoo</i> ሙዝ ተምቤን [muz tembien]</p>	<p><i>Jardin du</i> <i>Tigray</i></p>	<p>Rue <i>Ruta graveolens</i> ጩና ኣዳም [ch'enna-addam]</p>	<p><i>Jardin du</i> <i>Tigray</i></p>
<p>Cédratier <i>Citrus medica</i> ትሩንጊ [trunghi]</p>	<p><i>Jardin du</i> <i>Tigray</i></p>	<p>Olivier brun <i>Olea europaea subsp. cuspidata</i> ኣውሊዕ [awli'i]</p>	<p><i>Jardin du</i> <i>Tigray</i></p>

Sample of species labels in the Tigray garden, represented at scale 1/3

The next pages give a description of the species planted, their context, and summary of their management in the Belgian climate.

Candela regia

Verbascum sinaiticum

The plant is common in Tigray and endemic to the Horn of Africa and SW Asia. The plant has multiple uses in traditional medicine (Teklay et al., 2013); its roots have antibacterial properties (Yeabyo et al., 2018). In traditional veterinary use, it is administered against anthrax, and the leaves may be tied around animal legs to cure dislocated bones (Teklay, 2015).

In Tigrinya : ትርናኻ, ጥርናቕ [tirnakha, t'irnaqa] (November et al., 2002), ሓንደጋ [handega] (Teklay et al., 2013).



Substituted by *Verbascum nigrum* in the Tigray garden (Belgium) (June 2023)



Verbascum sinaiticum on Mt. Hermon (Lebanon)

Plants purchased from Willemse nursery (France) through mail order in 2023. Perennial plant. Seeds are mainly dispersed by the fur of larger mammals. There is little chance for seed dispersion in Belgium, the only roaming larger mammals in this area are cats and foxes.

Meskel flower

Bidens macroptera

By the mid of September, near the end of the rainy season, Tigray's landscapes are green, with large spots of bright yellow Meskel flowers, named after the Meskel holiday that is celebrated at the end of September. The *Bidens* genus is widespread all over Africa, and beyond (Tadesse, 1993). In Tigrinya : ገልገለ ሞስቆል [gilgile meskel] (November et al., 2002).



In the Tigray garden (Belgium), *Bidens macroptera* is substituted by *B. ferulifolia* (June 2023)



Typical growth of *Bidens macroptera* under an *Acacia* cover in Tigray in September (Miheni enclosure) (Aerts, 2019)

Plants purchased in 2023 from Home Meets Nature (The Netherlands) through mail order. Annual plant, may disperse its seeds.

East African cedar

Juniperus procera

A coniferous tree native to mountainous areas in Africa and the Arabian Peninsula. It is a characteristic tree of the Afromontane flora. It often reaches a height of 25 metres (Adams, 2004). In Tigrinya : ፅሕዲ [tsihdi] (Reubens et al., 2011).



Substituted by the winterhard *Juniperus communis* in the Tigray garden (Belgium) (May 2023)



Juniperus procera (Awulo, Tigray, 2023)

Juniperus communis obtained from a nursery in Belgium, and planted around the year 2000.

Tembien banana

Musa acuminata × *M. balbisiana* (Bluggoe subgroup)

Banana plants grown traditionally in Tigray and the wider Ethiopia are of local cultivars (Asmare Dagnev et al., 2021), which produce short and very tasty bananas, internationally called “apple banana” (Onyango et al., 2008).

In Tigrinya : ሙዝ ጻዲ [muz ‘addi] (local banana) or ሙዝ ተምቤን [muz tembien] (Tembien banana), in contrast to the commercial banana ሙዝ ፈረንጂ, “banana from abroad”. The “local” banana species reached Tigray between 700 and 1100 CE, originating from Taiwan and the Philippines (Watson, 1983), the “foreigners’ bananas” (mainly Cavendish) came in a recent wave after a detour through Latin America (Wakuma Biratu et al., 2022).

The Tembien banana cultivar was identified as “Bluggoe” (genome ABB) (Lim, 2012) by banana researcher Roni Swennen (IITA). It is one of the best drought tolerant starchy bananas. The cultivar has been studied in detail in deep valleys in Oman (Behrendt et al., 2015), where it similarly has a very good taste, presumably due to the specific environmental conditions. Note that Oman is along the and trade route from SE Asia to the Horn of Africa.



The Tigrayan “local banana” plants were substituted by the winterhard *M. basjoo* in the Tigray Garden (Belgium) (June 2023)



Tembien banana tree (Abiy Addi, Tigray) and a bunch of Tembien bananas with pen for scale (Photos Seifu Gebreselassie and Sarah Tewoldeberhan, May 2023)

The shoots of *M. basjoo* planted in the Tigray garden were obtained in 1992 from a hobby gardener in Liège (Belgium). The plant was grown in pot until 1995. Planted in full ground in 1996. Every winter the foot is covered with decayed leaves and straw. Re-emerges in spring and produces small fruits by August-September. Vegetative multiplication.

Rue, herb-of-grace

Ruta graveolens

Rue is grown as culinary herb and medicinal plant in Tigray (Teklay et al., 2013; Teklit Gebregiorgis, 2015). It is also cultivated as an ornamental plant, and as an insect repellent and incense. The plant is native to the Balkans, and may be found in traditionally managed gardens in Belgium.

In Tigrinya : ጩና ኣዳም [ch'enna-addam] (November et al., 2002).



Herb-of-grace in the Tigray garden (Belgium)
(May 2023)



Herb of grace in Mekelle (Tigray)
(Teklit Gebregiorgis, 2015)

Plant obtained from a hobby gardener in Liège (Belgium) in 2023. Grows in full ground; winterhard.

CARE: urticant

Tree heath

Erica arborea

In Tigray, heath trees can be up to 10 m high. They form the upper tree belt on Tigray's highest mountains. For instance, the upper tree line is at 3700 m on Ferrah Imba, the peak of Tigray (Jacob, 2015). *Erica arborea* has a large distribution from the Mediterranean maquis to Afromontane ecosystems. The *E. arborea* populations in these areas have been separated for a long time, hence there may be genetic variants with possible different ecological behaviour (pers. comm., B. Muys, 2023).

In Tigrinya : ሻቅቶ [shaqto], ሓስቲ [hasti] (November et al., 2002).



Tree heath in the Tigray garden (Belgium) (May 2023)



Tree heath on Dabba Selama mountain at 2646 m, Dogu'a Tembien, Tigray

Plants purchased from Esveld nursery (The Netherlands) through mail order in 2023. Reputedly grows in full ground without reproduction. Said to reach up to 2 m high in the Belgian climate. The planted variety is expected to be of Mediterranean origin and may have characteristics that are slightly different from the Tigrayan variety (McGuire and Kron, 2005). It resists frost up to minus 10°C (successful stress test at -6°C in 2023).

Citron or cedrate

Citrus medica

A variety of lemon that is widespread in the Middle East and also in Tigray (Alemtsehay Tsegay et al., 2019). It is a large fragrant citrus fruit, a huge, rough lemon with a thick rind, which is consumed. It is one of the original citrus fruits from which all other citrus types developed through natural hybrid speciation or artificial hybridization (Klein, 2014).

In Tigrinya : ትሩንጎ [trunghi].



Citrus medica in the Tigray garden (Belgium) (June 2023)



Citrus medica tree in Israel, where it is called “etrog” (<https://gardening.stackexchange.com>)

Tree purchased from Plantencentrum Exotica (Belgium) through mail order. Grown in pot, and transferred to frost-free environment from 1 November till the end of April.

African wild olive

Olea europaea subsp. *cuspidata*

The wild olive tree is very useful for dryland restoration, as it is drought and frost resistant (Aerts et al., 2008). The tree is also harvested (and over-exploited) for its durable timber. The leaves make good livestock fodder during the dry season and when burnt, the smoke from its leaves and stem is being used to fumigate food and liquid containers. Root and bark are used to treat malaria (Teklay et al., 2013). Because of the many uses of this tree, it has been over-harvested dramatically in Tigray (www.weforest.org).

In Tigrinya : አውሊሳ [awli'i] (Reubens et al., 2011).



African wild olive in the Tigray garden (Belgium) (June 2023)



African wild olive tree near the edge of Des'a forest in Tigray

Tree obtained from the May Zahla nursery in Dingilet (Tigray). Grown in pot, and transferred to frost-free environment from 1 November till the end of April. The tree sheds nearly all its leaves in winter, presumably due to poor light conditions.

Red hot poker

Kniphofia foliosa

Five endemic *Kniphofia* species are known in Ethiopia; they most often grow in wet and stony habitats (Tilahun Teklehaymanot et al., 2008). Annually the Ashenda festival (named after this plant) is organised in almost all villages and towns of Tigray, which empowers, inspires and provides freedom to women and girls (who wear a skirt prepared from *Kniphofia* leaves over their clothes) in a society that traditionally subordinates them (Selam Balehey and Mulubrhan Balehegn, 2019).

In Tigrinya : አሽንዳ [ashenda] (November et al., 2002).



Substituted by *Kniphofia* 'Papaya Popsicle' in the Tigray garden (Belgium) (June 2023)



Ashenda along the Rift Valley escarpment (photo Tesfa Tours)

Plants purchased from Esveld nursery (The Netherlands) through mail order. Reputedly grows in full ground in the Belgian climate with vegetative reproduction.

Candelabra tree

Euphorbia candelabrum

Euphorbia candelabrum is one of the species that dominates a major vegetation type occurring in Tigray, i.e., montane evergreen thicket and scrub with on shallow soils (Aerts et al., 2004). Though of a totally different family, this tree shows isomorphism with cacti as in Arizona – the two species, on different continents, evolved into similar morphology with succulent stems and spines, given similar environmental conditions (Meyen, 1973). Cacti are from the Americas and have single spines, or grouped in cluster, while euphorbias (from Afro-Eurasia) have twin spines. The latex is used as medicine for various diseases, and also as a base for ointments (mixed with other herbs) (Teklay et al., 2013).

In Tigrinya : ቁልቁል [qwolqwal] ; as the plant produces latex when damaged, it is also called “qwolqwal demay”, where "demay" means 'bleeding' (Reubens et al., 2011).



Euphorbia candelabrum in the Tigray garden (Belgium) (May 2023)



Euphorbia candelabra near Abune Ayezgi church in Haddinet (Dogu'a Tembien, Tigray, 2017).

A branch was taken from a tree in Addi Qoylo (Tigray) and potted around 2014. Vegetative multiplication. Grown in pot, and transferred to a frost-free environment from 1 November till the beginning of May.

CARE: urticant

Jacaranda

Jacaranda mimosifolia

Though jacaranda originates from Brazil, it is a popular ornamental tree in Tigray. It grows in most soils, prefers highland areas but can also grow in drier places (Bekele-Tesemma and Tengnäs, 2007). Jacaranda may not be deemed naturalised or invasive in Tigray since it requires human assistance for reproduction (unlike in Tanzania or South Africa), yet it uses a lot of ground water (phreatophyte) (Versfeld et al., 1998).

In Tigrinya : ጃካራንዳ [djakaranda].



Jacaranda in the Tigray garden (Belgium) (June 2023)



Jacaranda trees in a street of Mekelle (photo Olav Greve)

Tree purchased from a nursery in Mekelle (Tigray) around 2015. Permanently grown in pot, and transferred to a frost-free environment from 1 November till the beginning of May. We managed to obtain lush vegetative growth but no flowers, so far.

Buckthorn

Rhamnus prinoides

Gesho (*Rhamnus prinoides*) is a perennial shrub or bushy tree with red berries, that naturally grows near streams or along forest margins (Pankhurst, 2005). It is commonly cultivated in backyards and is one of the basic ingredients of *siwa*, the Tigrayan local beer, in addition to water, a home-baked and toasted flat bread and some yeast (*Saccharomyces cerevisiae*). The dried leaves of *gesho* serve as a catalyser (Lee et al., 2015). Gesho leaves are harvested by hand-picking or by cutting together with adjacent shoots. After the leaves are collected, they are dried in the sun; after sun-drying, the quality of the leaves is judged from its colour, which should be green-yellowish (Abadi Girmay, 2015).

In Tigrinya : ጌሽ [gesho] (November et al., 2002; Reubens et al., 2011).



Rhamnus alaternus as a substitute for *gesho* in the Tigray garden (Belgium) (June 2023)



Rhamnus prinoides leaves and drupes (stone fruits) (Abadi Girmay, 2015)

Growing *gesho* in Belgium would be impossible in full ground. In our garden, we substituted it with Mediterranean buckthorn (*Rhamnus alaternus*), another species of the same genus, which is said to support frost up to -3°C . It will be covered by an amovable greenhouse in winter. As a back-up some additional plants will be kept in pot in a warmer place during winter. The *Rhamnus alaternus* was obtained from TheOriginalGarden in Miramar (Valencia, Spain).

Winter thorn

Faidherbia albida

Faidherbia albida (“momona”) is a typical scattered tree on farmlands in Tigray. It is highly valued in traditional agroforestry systems, because on the one hand (as all leguminous trees) it is a nitrogen fixer, enhancing soil fertility in its surroundings. And on the other hand, it sheds its leaves during the crop growing season (rainy season) so that it does not compete with the crops (Yikunoamlak Gebrewahid et al., 2018). Note that the rainy season in Tigray is in the summer (we are in the northern hemisphere), but a popular mistake is to associate it to winter because clouds and rain make it the coldest season in daytime.

In Tigrinya : ጡጡና [momona] (November et al., 2002; Reubens et al., 2011).



Robinia pseudoacacia as a substitute for *momona* in the Tigray garden (Belgium) (May 2023)



Momona at May Shewate, Hech'i, Tigray (2005).

Growing *Faidherbia albida* in Belgium would be impossible in full ground; it would require a large greenhouse. In our garden, we substituted it with another leguminous tree, *Robinia pseudoacacia*, popularly called “acacia”, which sheds its leaves in winter and which allows pruning to obtain a typical acacia savannah tree shape. Both species are thorny. The robinia was obtained from the Amazonia plant shop in Rocourt (Belgium) around 2010.

Apple

Malus domestica

Apple trees have been introduced into the tropical mountains of Tigray, in Adigrat first, by Italian missionaries around 1980, in Wukro around 2000, and in Mekelle and Hagere Selam in 2002 at our initiative (Dereje Ashebir et al., 2010). Building on this expertise, the Relief Society of Tigray further introduced the Ana cultivar to many highland areas in Tigray. Although seasonal temperature amplitudes are still too low to obtain effective winter chilling (Tromp et al., 2005) at these high elevations in the tropics, average temperatures are lower, making it simpler to approach chilling conditions (Osborne, 2000). Warm winters cause apple trees to hibernate for an extended period, which causes poor blossoming, extremely vigorous upward growth, unsynchronized phenology, and low yields (Cook and Jacobs, 2000). The strategy used is to discontinue watering the trees, which is followed by hand defoliation (Diaz et al., 1987; Jones, 1987). After harvest, defoliation—the removal of mature foliage—prevents the buds from going into endo-dormancy and instead encourages them to develop again (Tromp et al., 2005). Most apple trees around Hagere Selam are taken care of in this manner (Dereje Ashebir et al., 2010). In Tigrinya : አጥል [appel] or ሞላ [mèla].



Medium stem apple tree (Belle-Fleur cultivar) in the Tigray garden (Belgium) (June 2023)



Apple trees at May Zahla Experimental Orchard near Hagere Selam in 2007. Cultivars introduced and tested are Golden Delicious, Granny Smith, Jonagold and Gala Must. Given the need for hand defoliation, only short stem trees were introduced to Tigray.

Apple trees in Belgium are typically grown in full ground without irrigation. Traditionally in the surrounding vegetable and fruit growing area, they had been planted as tall stem. Here we have opted for medium stem, for easier management and access, while keeping the ground free for other activities. A traditional *Belle-Fleur* cultivar (Lateur et al., 2000) was planted around 2010, obtained from Frijns Nursery in Groot-Welsden (The Netherlands), which supplied also the first batches of apple trees planted in Dogu'a Tembien and in Mekelle University's orchard.

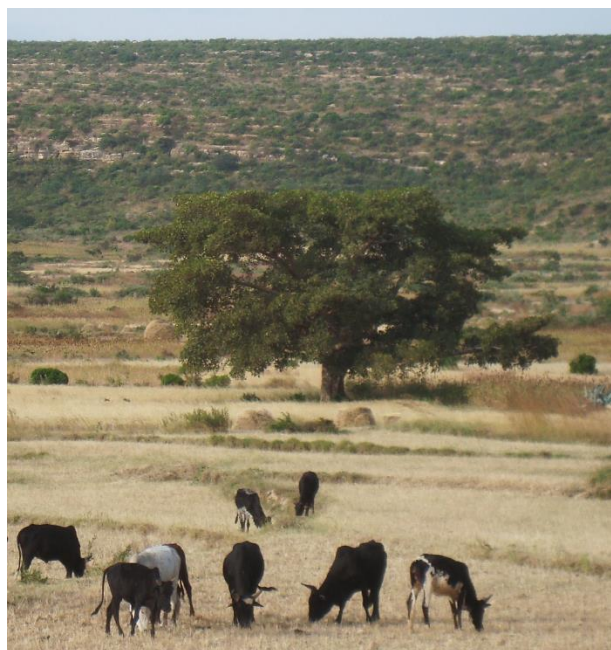
Fig tree

Ficus vasta and *F. sur*

Ficus vasta (fig tree), *F. sycomorus* (sycamore) and *F. sur* (Cape fig) are common large wild fig trees from Tigray. They often stand isolated in farmlands, and nearby springs (Etefa Guyassa and Raj, 2013). *F. vasta* grows in or near the Horn of Africa while *F. sur* is widespread across Africa (Berg, 1990). The trees produce small figs which invite the children to climb the trees. These wild edible fruits are however not marketed (Negash Aregay et al., 2017). In Tigray, the tree's latex may be smeared on warts for curing them (Fitsumbirhan Tewelde and Mebrahtom Mesfin, 2020). In Tigrinya : *Ficus vasta* ዳዕሮ [da'iro]; *F. sycomorus* ሳግላ [sagla]; *F. sur* ሻፋ [shafa], ኮዶ [kodo] (November et al., 2002; Reubens et al., 2011)



A common fig cultivar (*F. carica*) was planted as a substitute for the large sycamores in the Tigray garden (Belgium) (June 2023)



Ficus vasta at Addi Keshofo, Dogu'a Tembien, Tigray. Cattle in the foreground are grazing the stubble after harvest (Nyssen et al., 2019b).

Growing sycamores or Cape figs in Belgium would require an extremely large greenhouse. In our garden, we substituted it with a Mediterranean species of the same genus, *Ficus carica*, which is winterhard. The common fig plant was obtained from a hobby gardener in our neighbourhood.

Sand olive

Dodonaea viscosa subsp. *angustifolia*

Dodonaea viscosa subsp. *angustifolia* is one of the world's most greatly disseminated transoceanic plants in places with tropical and mediterranean climates (Harrington and Gadek, 2009). In Tigray it is part of the undergrowth of natural forests, but also frequently used for reforestation as the small tree disperses a large number of seeds. It has a strong resistance to drought and poor soil (Aerts et al., 2006). It forms a bush or small tree up to 10 m high.

In Tigrinya : ታህሰስ [tahses] (November et al., 2002; Reubens et al., 2011).



Dodonaea viscosa "purpurea" as a substitute for *D. viscosa* subsp. *angustifolia* in the Tigray garden (Belgium) (June 2023)



Tahses at Addi Qwalqwal, Tigray (Etefa Guyassa et al., 2023).

We could not yet obtain a plant of *Dodonaea viscosa* subsp. *angustifolia* from Tigray. In our garden, we substituted it with a cultivar of the same species, *D. viscosa* "purpurea", which supports frost up to -3°C. Leaves turn purple in winter, but otherwise its morphology is very similar to *D. viscosa* subsp. *angustifolia*. It will be covered by an amovable greenhouse in winter. As a back-up some additional plants will be kept in pot in a tepid place during winter. The *Dodonaea viscosa* "purpurea" was obtained from TheOriginalGarden in Miramar (Valencia, Spain).

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