The Commonly Cultivated Species of *Xanthosoma* Schott (Araceae), including Four New Species

Eduardo G. Gonçalves
Jardim Botânico Inhotim
Rua B, 20, Instituto Inhotim, CEP 35460-000
Brumadinho, MG, Brazil
eduardo.goncalves@inhotim.org.br

ABSTRACT

The genus *Xanthosoma* Schott is widely cultivated in the tropics, but very little is known about its taxonomy, especially concerning the cultivated species. This article presents a key for determination, as well as morphological descriptions and additional information about 14 forms/species of commonly cultivated *Xanthosoma*, including four new species. The species surveyed (and described) are: *X. appendiculatum* Schott, *X. atrovirens* C.Koch & Bouché, *X. aureum* E.G.Gonç., *X. blandum* Schott, *X. brasiliense* (Desf.) Engl., *X. mafaffa* Schott, *X. mafaffa* Schott "*lineolatum*", *X. monstruosum* E.G.Gonç., *X. panduriforme* E.G.Gonç., *X. riedelianum* (Schott) Schott, *X. robustum* Schott, *X. sagittifolium* (L.) Schott, *X. taioba* E.G.Gonç. and *X. violaceum* Schott, all of them illustrated with pictures.

KEY WORDS

Xanthosoma, tannia, yautia, cocoyam, taioba, mangarito, tiquisque, belembe, Araceae.

INTRODUCTION

The genus *Xanthosoma* Schott is exclusively Neotropical, but has been introduced in many tropical areas as cultivated plants (Okeke, 1992; Quynh & Uyen, 1987). Some species are cultivated as food crops or simply gathered in the wild for many uses (Plowman, 1969). It is known to be more protein-rich than the traditionally cultivated taro (*Colocasia esculenta* (L.) Schott) and probably easier to digest (Giacometti & León, 1994). The interest in cultivation of *Xanthosoma* has been growing recently (Morton, 1972), mainly in developing countries. A list of descriptors has been prepared recently (IBPGR, 1989) and a great number of institutions have a clear interest in studying this important genus. It is estimated that approximately 400 million people worldwide use *Xanthosoma* leaves and/or corms as staple food (Onokpise, 2000). However, much more information on its diversity is needed in order to help in germplasm selection and preservation. Despite its importance as a cultivated crop, the taxonomy of the genus has been neglected since the last revision, completed by Engler & Krause (1920).

Even less information has been published concerning the taxonomy of cultivated species of *Xanthosoma* (e.g. Okeke, 1992). It has been stressed that many forms may be considered cultivars of *Xanthosoma sagittifolium* (L.) Schott (Giacometti & Léon, 1994), but it seems that most authors are not completely sure about what constitutes *Xanthosoma sagittifolium* (see discussion in Okeke, 1992).

The taxonomy of *Xanthosoma* (mainly considering cultivated species) is rather chaotic and poorly known (Giacometti & León, 1994; Milián *et al.*, 2003). The reasons for this confusion are numerous and the most important are: 1. Plant material is poorly preserved in herbarium specimens or too big to fit an herbarium sheet; 2. Many species were described based on bad drawings, incomplete or heterogeneous collections or material of unknown origin; 3. Phenotypic plasticity is almost a rule in the group; 4. Many species were primitively

selected by native people before Europeans start to study them, so many cultivated races are already developed. Moreover, details usually poorly preserved (or rarely annotated) seem to be important for the taxonomy of the genus, like color of different parts and habit that are rarely recorded on exsicattae. All these aspects turn the taxonomy of *Xanthosoma* into a real nighmare!

The history of the genus is also complex. When Linnaeus applied the binomial *Arum sagittaefolium* to an edible aroid from Central and South America, he cited three different occurrences: Jamaica, Barbados and Brasil. However, he based his species concept on published accounts available at his time and a few of them (including Sloane's book from 1707) were not entirely firsthand information, mixing up direct observation with the fragmentary reports available. Thus, the concept of the first known edible and useful species of *Xanthosoma* already started poorly defined and has caused an immense confusion since then. When Schott erected the genus *Xanthosoma* (1832) he indirectly based his new genus in this Linnean chimeric species. Although it seems that Schott interpreted the Linnean species precisely, his taxonomy were mainly based in living plants and very few later specialists followed his concepts precisely. The final result was that virtually all later researchers interpreted that the cultivated species they could spot locally were in fact *Xanthosoma sagittifolium*.

Recently, an enormous dataset has been constructed to improve the taxonomy of this group, including data on chromosome counts, morphology and molecular biology. These data will be published elsewhere soon, but based on this we have been able to reconstruct the knowledge on this important group. Since the names of the cultivated species of *Xanthosoma* are usually grossly misapplied, the main purpose of this article is to help with the identification of common cultivated species. It is possible that a few names or concepts will change after a close scrutiny of all published names, but I think that this first modern account of cultivated species would be useful for those interested on this important group.

MATERIALS AND METHODS

Living plants of all species were observed and at least one specimen of each observed taxon was vouchered. Voucher material is mainly deposited at Herbarium of the University of Brasília (UB), except when noted. Most specimens observed were growing in Brazil, USA, West Africa, Costa Rica and Mexico, but I believe that this survey is comprehensive in a worldwide basis. It is important to stress that the main aim for this article is to describe the most commonly cultivated species. A full revision of the entire genus is forthcoming (Gonçalves, in prep.).

RESULTS

Thirteen species and one cultivar of commonly cultivated species of *Xanthosoma* were surveyed. Most of them are cultivated as ornamental plants, although *Xanthosoma mafaffa* and *X. robustum* are important food crops (bearing in mind that they are usually referred as *X. sagittifolium* in literature). A tentative key for the commonly cultivated species of *Xanthosoma* is here presented:

KEY TO COMMONLY SPECIES OF *XANTHOSOMA*

1. Leaves pandurate-sagittate to tripartite
   2. Leaf blade 5–8 times longer than wide. Posterior lobes absent to measuring less than 1/6 the total leaf length . . . . . *X. panduriforme*
   2. Leaf blade usually 1.5–3(–4) times longer than wide. Posterior lobes usually well developed, measuring at least ¼ of total leaf length

3. Leaves hastate-tripartite, usually taller than 80 cm in mature plants. Stem cylindrical . . . . . *X. brasiliense*
3. Leaves pandurate-sagittate, usually up to 50 cm tall. Stem a tuber-like subglobose corm . . . . . *X. riedelianum*

1. Leaves cordate to sagittate
4. Leaves usually with a small leafy appendage at the abaxial (lower) surface, usually making the main leaf turn upwards . . . . . *X. appendiculatum*
4. Leaves without any leafy appendage at the abaxial surface. Some may have filiform appendages on the apex of leaves.
5. Petioles dark colored, blackish green to purplish, at least at base.
6. Leaves usually yellow-edged, somewhat deformed, sometimes bearing 'pockets' at the apex of leaves of young leaves, with a terminal filiform appendix . . . . . *X. monstruosum*
6. Leaves never yellow-edged or deformed.
7. Petioles, as well as the midrib adaxially, violet (after having removed the wax), posterior lobes with acute to obtuse apex . . . *X. violaceum*
7. Petioles dark green (after having removed the wax), midrib green adaxially; posterior lobes with rounded apex . . . . . *X. atrovirens*
5. Petioles plain green, sometimes bluish because of the wax
8. Basal ribs denuded for at least 1 cm, usually more than this.
9. Younger plants golden green. . . . . *X. aureum*
9. Younger plants medium to dark green.
10. Midrib and primary lateral veins more or less concolorous with the blade. . . . . *X. blandum*
10. Midrib and primary lateral veins discolorous i.e. paler than the blade
11. Stems epigeous, in adult plants up to 1.5 m above ground, staminodes white . . . . . *X. robustum*
11. Stems usually hypogeous in adult plants (or epigeal only for less than 15 cm), staminodes pinkish to purplish . .*X. mafaffa*
8. Basal ribs never denuded or only slightly so.
12. Midrib and primary lateral nerves concolorous with the leaf blade.
13. Leaf blade dark green. . . . . *X. sagittifolium*
13. Leaf blade golden to yellowish green. . . . . *X. aureum*
12. Midrib and primary lateral nerves discolorous, paler than the leaf blade.
14. Posterior lobes comprising at least 1/3 of the leaf length. . . . . *X. taioba*
14. Posterior lobes comprising usually 1/5 or less of the leaf length . . . . . *X. mafaffa* "lineatum"

Annotated Checklist of Cultivated Species

1. *Xanthosoma appendiculatum* Schott Oesterr. Bot. Wochenbl. 4: 417. 1854.

Xanthosoma atrovirens var. *appendiculatum* Engler in Martius, C. Flora Brasiliensis 3(2): 194, 1878.

Vernacular name: Tambatajá (Brazil).

Plant up to 1 m tall. Stems always hypogeous, rhizomatous, cylindrical, up to 4 cm in diameter, moderately covered by brown fibers, producing sparse cormels. Leaves 3–4 per plant; petioles 64–90 cm long, blackish–green, conspicuously waxy, sheathed up to 1/3 of its length, sheath revolute; leaf blade 14–33 × 25–30 cm, subcordate to sagittate in young plants, sagittate or occasionally hastate in mature plants, usually with the apical half turned upwards, glossy blackish green adaxially, medium glossy green abaxially, producing an extopic inverted leaflet-like appendage

at some medial point of the midrib, appendage varying from hook-shaped or cup-shaped to broadly leafy and undulated or even duplicate, rarely lacking in young plants, primary lateral veins 6–7 per side, arising at an angle of 55–60°, slightly discolorous adaxially, concolorous abaxially, apex acuminate; basal ribs denuded for 0–1.5 cm, basal lobes turned backward or slightly extroses, round at apex. Inflorescences unknown. Figs. 1–2.

Specimen seen: BRAZIL. Pará: Belém, Cultivated, 20 Feb 2011, *Gonçalves 2018* (UB, UFMG, MO, K)

Original distribution: Most ancient publications cited Pará state (Northern Brazil) as the origin of this plant.

This species has never been seen by me in the wild, but it was described based on material from the Brazilian state of Pará. It is mainly characterized by the dark green leaves usually with a small leafy appendage below (Fig. 1). In specimens or leaves with well-developed leafy appendages, there is a tendency for the leaf apex to turn upwards in order to also expose the 'adaxial' surface of the appendage (Fig. 2).

Xanthosoma appendiculatum was treated by Engler & Krause (1920) as a variety of *X. atrovirens*, mainly because of the blackish green leaves. However, the known origin of the material and the distinct aspect of the plant turn it into a recognizable species. Moreover, phylogenetically, both species are distinct (Batista *et al.*, in prep.).

The vernacular name of this species in Brazil is 'tambatajá', originated by the Tupi general language, spoken by the native Brazilians before the European colonization. It seems to be derived of 'tamba' (shell) or 'tembe' (lips), alluding to the appendages at the abaxial surface of the leaves that are said by natives to resemble the female external genitalia. The all-purpose name 'taja' or 'taya' or even 'taia' is used to designate any large aroid with terrestrial habit, cordate-sagittate leaves and reticulate venation (i.e. it includes all *Xanthosoma*, as well as the recently introduced *Colocasia* and *Alocasia*). *Xanthosoma appendiculatum* usually produces a small leafy appendage at the adaxial surface of the leaf that is an inverted leaflet. In Pará state, the existence of this small leaf under the main leaf has a magical meaning and there are some myths in the local folklore that "explain" the possible origins of this aberration.

2. *Xanthosoma atrovirens* C.Koch & Bouché Index Sem. App. 3, 1854.

Vernacular names: Malanga amarilla (West Indies); taioba-preta (Brazil)

Herb up to 1.8 m tall, robust. Stems hypogeous or occasionally epigeous, rhizomatous, cylindrical, up to 26 cm in diameter and sometimes up to 30 cm tall, densely covered by brown fibers, producing sparse turbinate cormels. Leaves 3–5 per plant; petioles 70–103 cm long, blackish-green, conspicuously waxy, slightly reddish at base, sheathed up to 1/3 of its length, sheath revolute; leaf blade 49–90 × 34–53 cm, cordate in young individuals, cordate to subhastate in mature plants, semi-matte blackish green abaxially, medium glossy green abaxially, primary lateral veins 8–10 per side, arising at an angle of 75–85°, slighly discolorous adaxially, concolorous abaxially, apex acuminate; basal ribs denuded for 0–1.5 cm, basal lobes turned backward or slightly extrose, round at apex. Inflorescences 1–3 per axil, peduncle 50–80 × .5–0,8 cm; spathe 30–36 cm long, tube 7–9 × 4–6 cm, blackish-green outside, white inside, lamina 15–18 × 6–9 cm long, yellowish-white on both sides; spadix 20–28 cm long, fertile male portion yellowish-white 10–12 × 1–2 cm, sterile male portion 5.5–6 × 1.5–2.5 cm, white, moderately dimorphic, female portion conoid, 5–6 × 1–1.5 cm, bright yellow. Fig. 3.

Specimen seen: BRAZIL. Rio de Janeiro: Sítio Roberto Burle Marx, s.d., *Gonçalves 842* (UB, UFMG, MO, K)

Original distribution: Venezuela.

Xanthosoma atrovirens can be recognized by the blackish green parts (espe-

Fig. 1. *Xanthosoma appendiculatum*. Note the leafy appendage below each leaf blade (*Gonçalves 2018*, photo E.G.Gonçalves).
Fig. 2. *Xanthosoma appendiculatum*. Note the leaf apical half turned upwards because of the influence of the small leafy appendage (*Gonçalves 2018*, photo E.G.Gonçalves).
Fig. 3. *Xanthosoma atrovirens* growing in Roberto Burle Marx collections. Note the blackish green foliage (*Gonçalves 842*, photo E.G.Gonçalves).
Fig. 4. *Xanthosoma aureum*, flowering individual. Note that adult plants are not so golden (*Gonçalves 843*, photo E.G.Gonçalves).

cially the upper leaf surface) and for the basal lobes that are almost invariably round (only rarely obtuse) at apex. Another noteworthy aspect is the lower surface of leaves that are strongly whitish, mainly in younger leaves.

Xanthosoma atrovirens is usually labeled as *X. violaceum*, mainly because of the waxy petioles that gives the impression of being purplish. In fact, this aspect is caused by the effect of the bluish wax over the dark green petioles. If the wax is scratched, it is possible to observe that the petioles are not at all violet. True *X. violaceum* are always violet, even below the wax covering.

This species seems to get dormant irregularly even without external factors like a dry or cold period. I have seen plants entering into dormancy in Burle Marx's collection at Rio de Janeiro, where the conditions usually do not vary through the year.

Since its original description, many varieties has been referred to this species, possibly only based on the blackish green parts. None of those varieties and forms are here recognized, since molecular studies has shown that these varieties are not any closer to *Xanthosoma atrovirens* than to any other sagittate-leaved *Xanthosoma*.

3. *Xanthosoma aureum* E.G.Gonç. sp. nov.

Ab aliis speciebus foliis petioloque flavo-viridibus differt praecipue in stirpibus juvenculis.

Typus: BRAZIL. Rio de Janeiro: Pedra de Guaratiba. Cultivated at Sítio Roberto Burle-Marx, s.d., *Gonçalves 843* (holotype UB; isotype UFMG, MO, K).

Vernacular names: taioba-dourada (Brazil); golden Yautia, lime-zinger (USA).

Herb up to 1.15 m tall. Stems hypogeous or occasionally epigeous, rhizomatous, cylindrical, up to 7 cm in diameter and sometimes up to 5 cm tall, densely covered by brown fibers, producing sparse cormels. Leaves 2–5 per plant; petioles 60–100 cm long, golden green, poorly waxy, sheathed up to 1/2 of its length, sheath erect or slightly convolute; leaf blade 41–48 × 44–46 cm, sagittate in young individuals, sagittate to subhastate in mature plants, golden green to clear green abaxially, matte pale green abaxially, primary lateral veins 6–7 per side, arising at an angle of 80–85°, slightly discolorous to concolorous adaxially, concolorous abaxially, apex acuminate; basal ribs denuded for .3–1.5 cm, basal lobes slightly extrose, obtuse to round at apex. Inflorescences 1–3 per axil, peduncle 15–17 × .4–.5 cm; spathe 11–15 cm long, tube ovoid 6–7 × 4–6 cm, yellowish green outside, white inside, lamina 13–14.5 × 2.5–5 cm, ivory green in both sufaces; spadix 9.5–11.5 cm long, fertile male portion yellowish-white 6–7 × .7 cm, sterile male portion 1.5–2 × .8–1 cm, white, weakly dimorphic, female portion conoid, 2–3 × .8–1 cm, dark ferrugineous. Figs. 4–6.

Original distribution: Unknown.

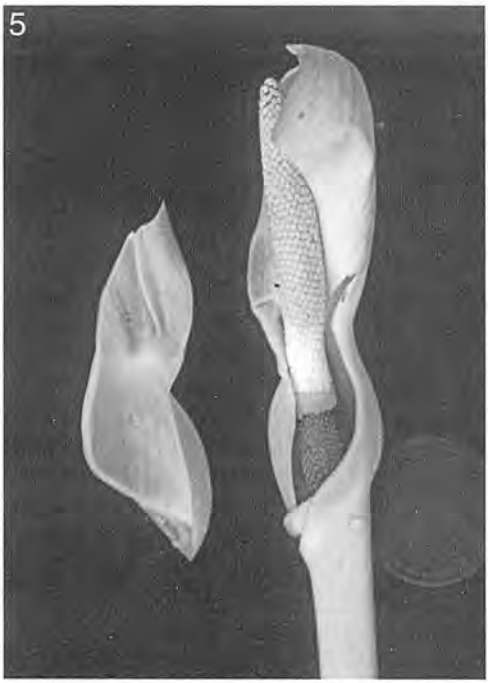
This species is readily recognized because of the coloration of young plants that are golden green color (although it is usually less pronounced in mature individuals), as well as for the strongly ferrugineous coloration of the female portion, mainly after the anthesis (Fig. 5). They are usually eye-catching plants, so they are used for landscaping and are present in collections worldwide. They will turn less golden with age (Fig. 4), but even this way they are still striking. They are easy to cultivate, but flowering events are rare.

4. *Xanthosoma blandum* Schott Bonplandia 10: 346. 1862.

Xanthosoma mafaffa var. *blandum* (Schott) Engl. Fl. Bras. 3(2): 193, 1878.

Vernacular names: Taiobinha (Brazil).

Plant up to 1.6 m tall, but rarely reaching half of this size. Stems always hypogeous, rhizomatous, cylindrical, up to 7 cm in diameter, moderately covered by brown fibers, branching profusely in well stablished plants, producing sparse globose-turbinate cormels. Leaves 3–4 per plant; petioles 30–98 cm long, green, never conspicuously waxy, usually brownish at base, sheathed up to 1/3 of its length,



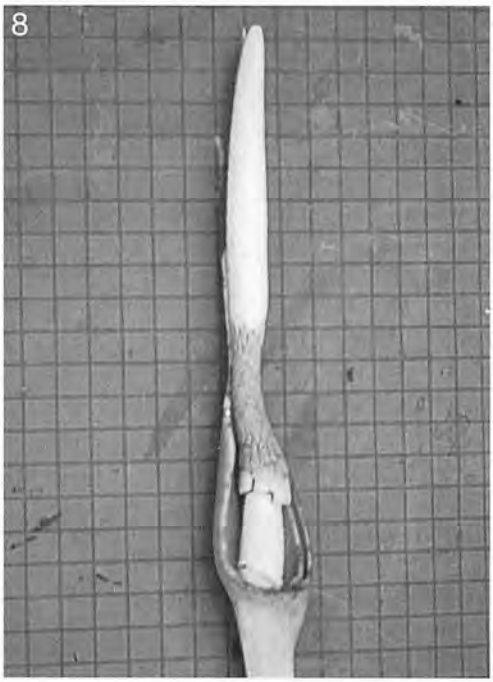


Fig. 5. *Xanthosoma aureum*, inflorescence with spathe cut to show the blackish female spadix (*Gonçalves 843*, photo E.G.Gonçalves).
Fig. 6. Young individuals of *Xanthosoma aureum*, showing the striking yellowish color (*Gonçalves 843*, photo E.G.Gonçalves).
Fig. 7. *Xanthosoma blandum*. Cultivated group (*Gonçalves 891*, photo E.G.Gonçalves).
Fig. 8. *Xanthosoma blandum*. Detail of inflorescence (*Gonçalves s.n.*, photo: E.G.Gonçalves).

Fig. 9. *Xanthosoma brasiliense* cultivated in group. Note the strongly tripartite-hastate leaf blade (*Gonçalves 2019*, photo E.G.Gonçalves).
Fig. 10. *Xanthosoma mafaffa* growing spontaneously around Capellades, Costa Rica (*Gonçalves 2018*, photo E.G.Gonçalves).

sheath convolute; leaf blade 32–67 × 19–40 cm, ovate in outline in both young and adult plants, semi-glossy green adaxially, clearer and matte abaxially, primary lateral veins 5–6 per side, arising at an angle of 50–60°, concolorous with blade at both sides, apex acuminate; basal ribs denuded for 2–4 cm, basal lobes slightly extrose, conspicuously acute at apex. Inflorescences 1–3 per axil, peduncle 30–110 × 0.3–0.5 cm; spathe 17.5 cm long, tube 4 × 2 cm, green outside, white inside, lamina 14.5 × 3 cm long, white in both sides; spadix 15 cm long, fertile male portion white 9 × 1 cm, sterile male portion 3.5 × 1.1 cm, pinkish, moderately dimorphic, female portion 2–3 × 1 cm, pale yellow. Figs. 7–8.

Specimen seen: BRAZIL.Amazonas: Manaus, depois do Aeroporto, em direção à BR-174. Floresta secundária em frente a sede da União do Vegetal, 8 May 2001, *Gonçalves et al. 891* (UB, UFMG, MO, K)

Distribution: Northern Brazil and French Guiana.

Xanthosoma blandum is not common in cultivation worldwide, but it is common as a local weed, notably around the city of Manaus, Brazil. It was also seen in French Guiana (Boos, pers.obser). It is characterized by its branched cylindrical rhizomes, adult leaves with acute and somewhat extrorse posterior lobes and by the conspicuous naked portion at the basal rib. Also distinctive is the staminoidal pink portion in the inflorescences (Fig. 8). Most plants usually reach less than 1 m tall, but some plants will get taller than 1.6 m. It seems to be cultivated only as pig food.

5. *Xanthosoma brasiliense* (Desf.) Engl. Das Pflanzenreich IV, 23E: 58. 1920.

Caladium brasiliense Desf. Tableau de l'École de Botanique 7: 386. 1829.

Vernacular names: majaja (Trinidad); calaloo, kalalu (Venezuela); belembe (Cuba)

Plant up to 2 m tall in ancient individuals, but rarely reaching 1 m. Stems always hypogeous, rhizomatous, cylindrical, up to 6 cm in diameter, moderately covered by brown fibers, producing occasional globose-turbinate cormels. Leaves 3–4 per plant; petioles 45–95 cm long, green, sometimes tinged with purplish at base, never conspicuously waxy, sheathed up to 1/3 of its length, sheath convolute with purplish margins; leaf blade 19–33.5 × 21–39 cm, sub-hastate to hastate in young leaves, hastate to subpedate in adult plants, glossy green adaxially, clearer and matte abaxially, primary lateral veins 4–7 per side, arising at an angle of 40–45°, concolorous with blade at both sides, apex acuminate; basal ribs denuded for 2.5–6 cm, basal lobes strongly extrorse, obtuse to round at apex. Inflorescences 1–2 per axil, peduncle 20–25 × .5 cm; spathe 18–19 cm long, tube 5 × 2.5 cm, green outside, white inside, lamina 13–14 × 3 cm long, white in both sides; spadix 14–16 cm long, fertile male portion white 10 × 1–1.5 cm, acute at apex, sterile male portion 3.5 × 1.1 cm, white, weakly dimorphic, female portion 2–3 × 1 cm, pale yellow. Fig. 9.

Material seen: BRAZIL. Federal District: Taguatinga, cultivated at Universidade Católica but originally from Trinidad, s.d., *Gonçalves 2019* (UB, UFMG, K, MO).

Distribution: It is always associated with human settlements, mostly in West Indies. The epithet seems to be an

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Fig. 11. *Xanthosoma mafaffa*, inflorescence detail (*Gonçalves 2021*, photo E.G.Gonçalves).
Fig. 12. Adult plant of *Xanthosoma mafaffa* "Lineatum" (*Gonçalves 1018*, photo E.G. Gonçalves).

error, since it has been never found or popularly cultivated in Brazil and the only specimens seen here were brought by me a few years ago.

Easily identified because it is the only cultivated species with strongly hastate to subpedate leaf blade that are quite distinctive (Fig. 9). It could only be confused with other wild species with hastate or pedately lobed leaf blade, but most of them have round corms and are much smaller.

Although its leaves are usually reputed to be edible (Plowman, 1969), they were not found to be eaten in Trinidad (Boos & Boos, 1993). This species is also broadly cultivated in the Miami area, essentially as an ornamental crop, sometimes reaching an impressive size.

6. *Xanthosoma mafaffa* Schott Arac. Betref. 2: 5. 1855.

Xanthosoma roseum Schott, Oesterr. Bot. Wochenbl. 3: 370. 1858

Vernacular name: Tiquisque, tiquisque morado (Costa Rica), Quequesque (Nicaragua), malanga morada (Cuba), malanga lila (Cuba), red coco, red cocoyam (Jamaica), macabo (Nigeria).

Herb up to 1.7 m tall, robust. Stems hypogeous or occasionally epigeous and decumbent, rhizomatous, cylindrical, up to 15 cm in diameter and sometimes up to 10 cm tall, densely covered by brown fibers, producing sparse turbinate cormels. Leaves 5–6 per plant; petioles 104–130 cm long, green, sometimes red at base conspicuously waxy, sheathed up to 1/4 of its length, sheath margins erect to revolute; leaf blade 44–85 × 31–50 cm, triangular-subcordate in young individuals, cordate to sagittate or subhastate in mature plants, patent, semi-matte dark green abaxially, medium matte green abaxially, margins reddish or purplish, primary lateral veins 7–9 per side, arising at an angle of 50–70°, discolorous adaxially, concolorous abaxially, apex acuminate; basal ribs denuded for 1–3 cm, basal lobes acute to acuminate at apex. Inflorescences 1–5 per axil, peduncle 30–85 × 1–1,8 cm; spathe 27–38 cm long, tube 8–9.5 × 4–6 cm, reddish or pinkish green outside, white inside, lamina, 17–22 cm long, greenish-yellow at both sides, margins occasionally reddish; spadix 22–30 cm long, fertile male portion white 13–16 × 1.2–2.5 cm, obtuse to truncate at apex, sterile male portion 6–7 × 1.0–2.3 cm, pink, moderately dimorphic, female portion conoid, 6–8 × 1.5–1.8 cm, bright yellow. Figs. 10–11

COSTA RICA. San Jose: Around San Jose en Estación Experimental, 20 Feb. 2011, *Gonçalves 2018* (UB, UFMG, MO, K).

Original distribution: Costa Rica to Guatemala, but possibly also ranging both southwards and northwards. Artificially spread in Caribbean Islands and also Florida.

The name *X. mafaffa* is one of the most frequently misapplied in the genus. Although one of the most commonly cultivated species in Central America (and possibly now also in Caribbean areas) and Africa, it is always treated as *X. violaceum*, *X. atrovirens* or *X. sagittifolium*. The combination of pink staminodes (Fig. 11), patent (and huge) leaf blades and waxy and usually pinkish-edged petioles make this species easy to recognize.

The name *X. roseum* has usually been used as a synonym of *X. robustum*, but the presence of pink staminodes and the leaf aspect, together with the occurrence in Costa Rica make it clear that *X. roseum* and *X. mafaffa* are inseparable.

There are at least two forms: One of them has the parenchyma of the stem or cormels strongly red and it is called "tiquisque morado" in Costa Rica. The other form has the parenchyma white and it is called "tiquisque blanco". Both are quite similar in other aspects and the only variation is the overall pigmentation, because the red form is tinged with pale red in many parts (petioles, sheaths, spathes).

7. *Xanthosoma mafaffa* Schott "Lineatum",

"Xanthosoma jacquini lineatum", Graf in Tropica 2nd Ed, Roehrs Company Publishers, East Rutherford, 1981 (pg. 127).

Herb up to 1.7 m tall, robust. Stems hypogeous or occasionally epigeous and decumbent, rhizomatous, cylindrical, 3–8 cm in diameter and erect tip sometimes up to 14 cm tall, densely covered by brown fibers, producing sparse turbinate cormels. Leaves 5–6 per plant; petioles 95–120 cm long, green, conspicuously waxy, sheathed up to 1/4 of its length, sheath margins involute, usually pinkish or purplish; leaf blade 41–50 × 27–32 cm, subcordate to subhastate in young plants, cordate to sagittate or subhastate in mature plants, patent, semi-matte dark green with conspicuous white stripes adaxially (composed not only of areas with different pigmentation but also structural differences), medium matte green abaxially, primary lateral veins 5–7 per side, arising at an angle of 45–80°, discolorous adaxially, concolorous abaxially, apex acuminate; basal ribs denuded for .3–.5 cm, basal lobes cuneate to round at apex. Inflorescence 1–3, peduncle 10–20 × 2.5–3 cm, spathe 15–27 cm long, tube ovoid, 5–7.5 × 3.5–4.5 cm, clear green and waxy outside, whitish green with pale pink stripes inside, blade, 9.5–19.5 × 4–6 cm, whitish to yellowish green with pale pink stripes outside, white inside, margins pink, spadix 11–21.5 cm long, fertile male portion white, 4.5–13 × 1.2–2.5 cm, obtuse to truncate adaxially, sterile male portion pink, 4–6 × 1.4–2.4 cm, slightly dimorphic, female portion, conoid, 1.5–4 × 1.2–2.5 cm, pale yellow. Fig. 12–13.

Specimen seen: BRAZIL. São Paulo: Nova Odessa, Jardim Botânico Plantarum, s.d., *Gonçalves 1019* (UB, UFMG, MO, K)

Original distribution: Unknown

Early descriptions of *X. mafaffa* do not mention this whitish striped variety. However, this form shares with the typical *X. mafaffa* the pink sterile male portion (Fig. 13), together with pale yellow stigmas and obtuse spadix. Moreover, it also shares the patent leaves with reddish margins. The presence of a convulute leaf sheath, together with the obvious stripes (Fig. 12), are distinctive of this variety but until more studies (specially molecular studies) are completed in the complex *X. mafaffa-X.robustum-X.violaceum*, I decided not to distinguish this taxonomically from the typical *X. mafaffa*.

It is attractive as an ornamental plant, and can reach up to 1.6 m tall. Despite it not being commonly cultivated, it is one of the few commercially available forms of *Xanthosoma* in Brazil. The use of this species as food is not documented.

8. *Xanthosoma monstruosum* E.G. Gonç. sp. nov.

Ab aliis speciebus foliis deformantibus et flavomarginatibus apicali pusillo marsupio formanti differt

Typus: BRAZIL. Distrito Federal: Brasilia, Campus da University of Brasília, s.d. *Goncalves 2017* (Holotype UB; Isotype UFMG, MO, K).

Vernacular names: Cara-de-gato, taiá-variegado (Brazil), mickey-mouse plant, pocket plant (USA).

Herb up to 1 m tall. Stems hypogeous and decumbent, rhizomatous, cylindrical, up to 5 cm in diameter, densely covered by brown fibers, producing sparse turbinate cormels and numerous stolons. Leaves 5–6 per plant; petioles 21–90 cm long, blackish green, conspicuously waxy at apex, sheathed up to 1/2 of its length, sheath margins involute and sometimes yellowish; leaf blade 12–25 × 8–30 cm, sagittate to subhastate in both young and adult leaves, semi-matte blackish green adaxially, medium matte green abaxially, usually with large spots of yellowish tissues. Primary lateral veins 2–5 per side, arising at an angle of 45–80°, essentially concolorous in both sufaces, apex usually forming a small pocket that accumulates water and also

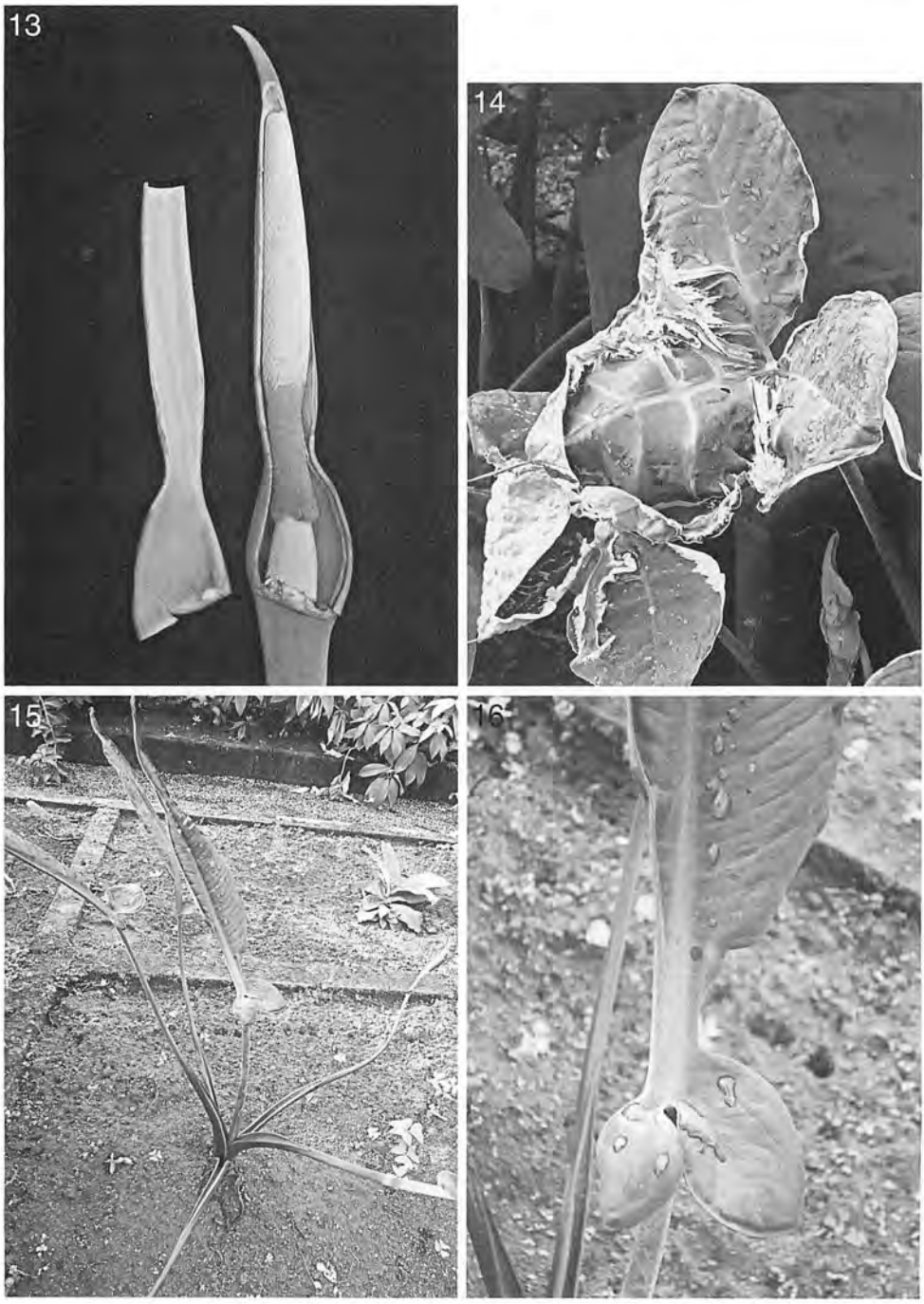

Fig. 13. Detail of inflorescence of *Xanthosoma mafaffa* "Lineatum" (*Gonçalves 1018*, photo E.G.Gonçalves).
Fig. 14. *Xanthosoma monstruosum*, habit (*Gonçalves 2017*, photo E.G.Gonçalves).
Fig. 15. *Xanthosoma panduriforme*, habit (*Gonçalves 2017*, photo E.G.Gonçalves).
Fig. 16. Detail of leaf blade of *Xanthosoma panduriforme* (*Gonçalves 2016*, photo E.G.Gonçalves).

with an apical filament, up to 8 cm long; basal ribs denuded for 0–1 cm, basal lobes extrose, apex obtuse at apex. Inflorescence unknown. Fig. 14.

The species is characterized by its deformed leaves, usually producing a pouch at the anterior division of the blade and usually with yellow margins. Bown (2000) speculated that this species could be a proto-carnivorous aroid, because of the pouches formed in the apex of usually deformed leaves. Those pouches usually accumulate water and organic debris but this hypothesis has not been tested. However, it seems that younger plants have a stronger tendency to develop the pouch. I also observed that well fertilized plants usually have leaves that are almost "normal", i.e. they have only irregularly yellow margins, but do not develop pouches.

The origin of this cultivar is not known, despite having been widely cultivated.

9. *Xanthosoma panduriforme* E.G. Gonç. sp. nov.

Ab aliis speciebus foliis panduriformis et vittiformis differt

BRAZIL. São Paulo: São Paulo, próximo ao campus da USP, s.d. *Goncalves 2016* (Holotype UB; Isotypes UFMG, MO, K).

Xanthosoma atrovirens var. *panduriforme* Engl. Das Pflanzenreich, IV.23E (Heft 41): 51 (1920).

Vernacular name: unknown.

Small to medium sized herb, up to 90 cm tall, stem hypogeous erect, up to 6 cm diam., sparsely covered by fibers, very few cormels or stolons; Leaves 3–5 per plant, petioles 22–64cm, blackish green, strongly waxy to the apex, sheath rarely reaching the basal 1/2, sheath margins involute, free portion cylindrical to slightly flattened adaxially; leaf blade pandurate and strap-line, 35–44 × 1.5–8 cm, irregular, sometimes strongly oblique, sometimes erect, blackish green, semi glossy adaxially, whitish and matte abaxially, primary lateral veins 3–5 per side, almost invisible, arising at an angle of 45–70°, apex long acuminate; basal lobes asymmetric, basal rib lacking or purely vestigial, sometimes subhastate, apex rounded. Inflorescences not seen. Figs. 15–16.

Original distribution: Unknown

This attractive form is recognized by its blackish green leaves and petioles, posterior lobes poorly developed and obovate to oblanceolate anterior divisions. The cultivated specimen I have were obtained in a cluster of "regular" *X. monstruosum*. It would be interesting to investigate if this variation arises from another form and if is caused by a chromosomal loss or a chromatid break, or even a one step mutation.

10. *Xanthosoma riedelianum* (Schott) Schott Oest. Bot. Zeitschr. 15: 33. 1865.

Vernacular name: Mangarito, Mangará (Brazil).

Small sized geophytic herbs, usually less than 80 cm tall. Corm hypogeous, subglobbose, 2–4 × 2–3.5 cm, laxly covered by sparse fibers, with occasional globose cormels. Leaves 2–4 per plant, petioles 20–60, green, not obviously waxy, sheathed to ½ of its length, sheath involute; leaf blade pandurate, to subhastate usually held 45° erect, 16–23 × 9–13 cm, somewhat oblique, matte medium green adaxially, paler and matte green adaxially, primary lateral nerves 3–5 per side, arising at an angle of 50–60°, leaf rounded, denuded portion of basal rib 1.5–3 cm, posterior lobes obliquely elliptic, apex obtuse to rounded. Inflorescences usually solitary, petioles 10–15 cm long. Spathe 12–15 cm long, tube 3–4 cm, greenish outside, white inside, lamina 9–11 cm, clear green in both surfaces. Details of spadix not available for study. Figs. 17–18.

Original distribution: Southeastern Brasil (States of Rio de Janeiro, São Paulo and Minas Gerais)

Specimen seen: BRAZIL. Minas Gerais: Cultivated at Belo Horizonte Botanical

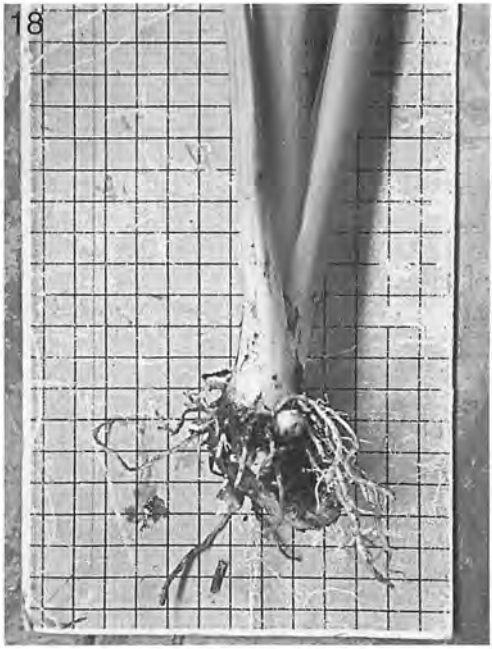

Fig. 17. Leaves of *Xanthosoma riedelianum*. Note that the clearer markings on leaf blade are caused by a virus (Dasheen Mosaic Virus), not a regular pattern on this species (*Gonçalves 763*, photo E.G.Gonçalves).

Fig. 18. *Xanthosoma riedelianum*, stem (*Gonçalves 763*, photo E.G.Gonçalves).

Garden. s.d. *Gonçalves 763* (UB, UFMG, MO, K)

Possibly, *X. riedelianum* has not been collected in the wild since Riedel's type material. Most collections I could observe were made from cultivated material. Like most cultivated species of the genus *Xanthosoma*, the precise natural ocurrence of this species is not clear. It seems to have been cultivated for a long time in southeastern Brazil and it is possible that it was already in cultivation when Riedel collected the type material in Rio de Janeiro state ("Serra da Estrela"). It is also possible that *X. riedelianum* is a domestiscated form of another species that already has been in cultivation by indians since ancient times. *Xanthosoma riedelianum* can be recognized by its panduriform to hastate leaves and considerably small size, as well as by the subglobose corms.

Xanthosoma riedelianum differs from *X. brasiliense* in being much smaller, in having subglobose corms (not a cylindric rhizome) and for having a obtuse to round apex of leaf (not acuminate).

This species has an specially tasty tuber when cooked, reputed as the most delicious tuber-like plant ever (Pio Correa, 1926). In fact, the baked tubers have the taste of a mixture of the regular baked potato (*Solanum tuberosum*) with butter.

11. *Xanthosoma robustum* Schott Oesterr. Bot. Wochenb. 3: 370. 1853.

Vernacular Names: capote, pixi (Mexico); quequesque, marac (Guatemala); quiscamote and quiscamo (Honduras); Tannia, tannier (USA).

Herb up to 4 m tall, robust. Stems hypogeous in young plants but epigeous and robust in adult specimens, usually reaching 20–25 cm in diameter, densely covered by brown fibers, producing numerous stolons and sparse fusiform cormels. Leaves 5–6 per plant; petioles 105–150 cm long, green, conspicuously waxy, sheathed up to 1/2 of its length, sheath margins revolute to erect, usually with wavy edges; leaf blade 52–160 × 32–100 cm, sagittate in young plants, cordate to subhastate in mature plants, reflexed to patent, semi-matte dark green adaxially, medium matte green abaxially, primary lateral veins 7–10 per side, arising at an angle of 50–70°, discolorous adaxially, concolorous abaxially, apex acuminate; basal ribs denuded for .3–2.5 cm, basal lobes cuneate to round at apex. Inflorescence 1–7 per axil, peduncle 20–25 × 3–3.5 cm, spathe 30–43 cm long, tube ovoid, 12–16 × 9–11 cm, clear green and strongly waxy outside, whitish green inside, blade 28–31 × 10–15 cm, whitish to yellowish green with pale pink margins outside, white inside, spadix 28–40 cm long, fertile male portion white, 25–30 × 2–2.5 cm, cuneate to obtuse apically, sterile male portion white, 8–12 × 1.4–3 cm, weakly dimorphic, female portion, conoid, 5–6 × 2–3.5 cm, pale yellow to ochre. Figs. 19–21.

Original distribution: Mexico to Costa Rica.

Specimen seen: MEXICO, Chiapas: Palenque, ruins nearby ancient city. s.d. *Gonçalves 2022* (UB, BHCB).

This plant seems to be the largest species of *Xanthosoma*, sometimes reaching 4 m tall, as I could see in Palenque Maya ruins, Chiapas, Mexico. It is possible that this species has been used by the Aztecs (Plowman, 1969). Large populations can be seen growing as weeds along road margins in southern Mexico. It is the most widely cultivated species in USA, where it is usually identified as *X. sagittifolium*.

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Fig. 19. *Xanthosoma robustum*, adult plant growing in Palenque ruins, Chiapas, Mexico (*Gonçalves 2022*, photo E.G.Gonçalves).

Fig. 20. *Xanthosoma robustum*, detail of the huge epigeous stem (*Gonçalves 2022*, photo E.G.Gonçalves).

Fig. 21. *Xanthosoma robustum*, detail of inflorescence (*Gonçalves 2022*, photo E.G. Gonçalves).
Fig. 22. *Xanthosoma sagittifolium*, adult plant from Haiti (*Gonçalves 2023*, photo E.G. Gonçalves).

It is one of the most difficult *Xanthosoma* to identify at species level, because adult plants are very variable depending upon the conditions they are growing. No other *Xanthosoma* can grow so massively, but medium-sized individuals are easy to confuse with *X. mafaffa* (mainly) and with *X. sagittifolium*. From *X. sagittifolium* it differs in having usually an epigeous stem (always hypogeous in *X. sagittifolium*) (Fig. 20), in having usually more lateral veins (7–12 instead of 5–7), and in having usually a denuded portion of basal rib (never denuded in *X. sagittifolium*). From *X. mafaffa* it differs by the lack of pinkish staminodes and in having usually ochre to ferrugineous stigmas (not bright yellow).

12. *Xanthosoma sagittifolium* (L.) Schott Melet. Bot. 19. 1832.

Caladium sagittifolium (L.) Vent. Arch. Bot. Roemer 2(3): 351. 1801.

Caladium xanthorrhizon (Jacq.) Willd. Sp. Pl. 4: 490. 1800.

Arum sagittifolium L. Spec. Pl. 2. 966.1753.

Arum xanthorrhizon Jacq. Hort. Schoenbr. 2: 32. t188. 1797.

Xanthosoma xanthorrhizon (Jacq.) Koch Bonplandia 4: 4.1856.

Vernacular names: malanga, malanga amarilla (West Indies); matabala (St. Tomé and Principe).

Herb up to 2 m tall, robust. Stems hypogeous in young plants, erect, cylindric, 7–9 cm in diameter, densely covered by brown fibers, producing cormels that are cylindric at base and globose at apex, adult plant producing a stout columnar stem, up to 15 cm diam. Leaves 4–7 per plant; petioles 80–160 cm long, green, poorly waxy, sheathed up to 1/2 of its length, sheath margins erect to slightly convolute; leaf blade 60–97 × 30–44 cm, subhastate in young plants, sagittate and ovate in mature plants, reflexed to subpatent, semi-matte dark green adaxially, paler matte green abaxially, primary lateral veins 5–8 per side, arising at an angle of 45–80°, poorly discolorous to concolorous adaxially, concolorous abaxially, apex acuminate; basal ribs not denuded at all, basal lobes acute to cuneate at apex. Inflorescence 1–3 per axil, peduncle 16–17 × 1.5–2 cm, spathe 23–32 cm long, tube ovoid, 7–10 × 4–5 cm, clear green and moderately waxy outside, whitish green inside, lamina 15–16 × 5.0–6.5 cm, ivory white in both surfaces, spadix 17–25 cm long, fertile male portion 9.5–13 × 1.3–2.2 cm, tapering to the apex to obtuse, sterile male portion 3–5 × 1.7–2.5 cm, white, only weakly dimorphic, female portion conoid, 4–6 × 1.5–2 cm, pale yellow. Figs. 22–24.

Original Distribution: Antilles, mainly Jamaica and Hispaniola.

Specimen seen: HAITI: Exact origin unknown. s.d., *Gonçalves 2023* (UB, BHCB, MO, K).

Xanthosoma sagittifolium can be recognized by the invariable lack of denuded portion of the basal rib, for its essentially concolorous primary lateral veins (at least adaxially) and for the dark green leaf blade (mainly when grown in half-shade). It differs from *Xanthosoma taioba* in having an epigeous stem in mature individuals (not invariably hypogeous) and also for having the concolorous primary lateral ribs on leaves (whereas they are strongly discolorous in *X. taioba*). Also distinctive is the color of the staminodes, which are white in *X. sagittifolium* (Fig. 25) and pink in *X. taioba*.

It has been regarded as one of the most famous cultivated species of the genus, but, in fact, its name has been grossly misused. There is a strong misbelief that many species described in *Xanthosoma* belong here as synonyms (Bunting, 1979) which does not

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Fig. 23. *Xanthosoma sagittifolium*, leaf blade (*Gonçalves 2023*, photo E.G.Gonçalves).
Fig. 24. *Xanthosoma sagittifolium*, detail of inflorescence (*Gonçalves 2023*, photo E.G.Gonçalves).

Fig. 25. *Xanthosoma taioba*, growing along the road in Areias, Paraiba State, Brazil (*Gonçalves 911*, photo E.G.Gonçalves).
Fig. 26. *Xanthosoma taioba*, details of inflorescence (*Gonçalves 911*, photo E.G. Gonçalves).
Fig. 27. *Xanthosoma violaceum*, growing at University of Brasilia, Brazil (*Gonçalves 184*, photo E.G.Gonçalves).

seem to be true. In fact, *Xanthosoma sagittifolium* is rarely cultivated outside the Caribbean Islands, since this germplasm has been replaced by more productive lineages like *X. mafaffa* and *X. robustum*. It is important to state that this species should be conserved and better studied. I only could confirm the identity of this species after finding it growing in a germplasm collection in Costa Rica University.

13. *Xanthosoma taioba* E.G.Gonç. sp. nov.

A Xanthosoma sagittifolio similis sed nervis lateralibus discoloribus, staminodiis roseis et caudice hypogeo differt.

Typus: BRAZIL. Paraíba: Areias, Alto da Serra. 6°59'S–35°41'W, 28 Aug. 2011, E.G. *Gonçalves, L. Lohmann & H. Lorenzi 911*. (holotype UB; isotypes UFMG, MO, K).

Vernacular names: taioba, taiá, tajá, efó (Brazil).

Herb up to 1 m tall, delicate. Stems always hypogeous, erect, cylindric, 3–7 cm in diameter, densely covered by brown fibers, producing sparse stolons and almost lacking cormels. Leaves 2–4 per plant; petioles 25–65 cm long, green, conspicuously waxy, sheathed up to 1/2 of its length, sheath margins convolute to erect; leaf blade 25–50 × 18–55 cm, cordate in young plants, sagittate in mature plants, always reflexed, semi-matte medium green adaxially, paler matte green abaxially, primary lateral veins 5–7 per side, arising at an angle of 45–60°, strongly discolorous adaxially, concolorous abaxially, apex acuminate; basal ribs not denuded at all, basal lobes acute to cuneate (rarely obtuse). Inflorescence 1–3 per axil, peduncle 16–17 × 1.5–2 cm, spathe 20–24 cm long, tube ovoid, 6–7 × 4–5.5 cm, clear green and strongly waxy outside, whitish green inside, lamina 15–16 × 5.0–6.5 cm, yellowish green at both surfaces, spadix 16.5–17 cm long, fertile male portion 9.5–10 × 1.5–1.6 cm, tapering to the apex, sterile male portion 2.5–3 × 1.7–2.5 cm, pinkish, female portion conoid, 3.5–4.5 × 2.3–3 cm, bright yellow. Figs. 25–26.

Original Distribution: Eastern Brazil.

Xanthosoma taioba can be easily recognized by its basal ribs that are never denuded at all, for the discolorous veins (that are always paler than the leaf blade), for the pale pink staminodes (Fig. 26) and for the soft membranaceous leaf blades. It could be mainly confused with two species: *X. sagittifolium* and *X. robustum*. From both species it differs by the stem always hypogeous in mature individuals and for the pale pink (not purely white) staminodes. It can be separated from *X. sagittifolium* by the clearly discolorous primary lateral veins and by the essentially cordate (not sagittate) leaves in very young individuals. From *X. robustum* it differs in having cordate (not sagittate) leaves in very young individuals and for the constant absence of denuded portion of basal ribs. It could be also confused with *Xanthosoma mafaffa* from which it differs in having a smaller size and for the invariably denuded basal rib in *X. mafaffa*.

The first accounts about a spinach-like big leafed aroid eaten in Brazil came from Sousa (1587, but published in 1971), whose description could be freely translated from Portuguese as "... thus soft as spinach leaves, called taiobas, that are eaten in stews...". A few decades after, MarcGraf wrote his chapter in Piso's masterpiece "Historia Naturalis Brasiliae" (1649) a clear description of the native edible species in Northeastern Brazil, that he spelled as "tajaoba". He also published a drawing that could fit precisely the Brazilian plant.

14. *Xanthosoma violaceum* Schott Oesterr. Bot. Wochenbl. 3: 370. 1853.

Vernacular names: inhame roxo, taioba roxa (Brazil); malanga lila (West Indies).

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Fig. 28. *Xanthosoma violaceum*, details of inflorescence (*Gonçalves 184*, photo E.G. Gonçalves).

Plant up to 1.6 m tall. Stems hypogeous in young plants, epigeous and decumbent in old plants, up to 16 cm in diameter, covered by brown fibers from old leaf sheaths, cormels occasional, stolons usually long and abundant. Leaves 4–6 per plant; petioles 80–134 cm long, violet, conspicuously waxy, sheathed up to 1/2 of its length, sheath margins convolute, reddish; leaf blade 69–113 × 45–67 cm, sagittate to subhastate, ovate to triangular in outline in both young and adult plants, usually reflexed, occasionally patent in plant in full sun, semi-matte medium green adaxially, paler matte green abaxially, margins violet, primary lateral veins 7–8 per side, arising at an angle of 70–85°, strongly discolorous adaxially, discolorous violet abaxially, apex acuminate; basal ribs denuded for 2–3.0cm, basal lobes acute to cuneate. Inflorescence 1–3 per axil, peduncle 35–50 × 3–4 cm, spathe 39–42 cm long, tube ovoid, 12–14 × 5.5–7 cm, clear green tinged with purple and strongly waxy outside, whitish green inside, lamina 27–28 × 12–14 cm, yellowish green at both surfaces, margins tinged with purplish, spadix 35–39 cm long, fertile male portion 14–16 × 1.5–2 cm, tapering to the apex, sterile male portion 11–13 × 1.8–2.8 cm, white, female portion conoid, 10–12 × 1.8–2 cm, pale yellow. Figs. 27–28.

Original distribution: This species has been considered from an unknown origin until a recent collection in the wild by me in Costa Rica.

Specimens seen: BRAZIL. Distrito Federal: Brasília, cultivada na Universidade de Brasília. s.d., *Gonçalves 184* (UB).

This species is one of the easiest to identify. It is the only broadly cultivated species that has pure violet parts (petioles, major nerves, peduncles, etc) that stay violet even after the wax is scratched from its surface. Schott (1853) already noted this aspect in his original description. It is also one of the four cultivated species with pink staminodes (together with *X. blandum*, *X. taioba* and the forms of *X. mafaffa*). Wild material from the plant recollected recently in Costa Rica is more variable in color distribution and saturation, but it is also always violet.

It is known in Brazil as 'taioba roxa' and it is widely used, mainly as an ornamental plant. It is also common in European conservatiores, probably all from the original introduction. In USA it seems to be much rarer and most material I have seen identified as *X. violaceum* is, in fact, *Xanthosoma mafaffa* or *Xanthosoma atrovirens*.

It has been broadly cited that *X. nigrum* (Vell.) Stellf. belongs here as a synonym (e.g. Croat & Mount, 1988), but in its original description (see Vellozo, 1829), *X. nigrum* is cited it as a wild species occurring around Rio de Janeiro. In this context, probably *X. nigrum* is a synonym of *X. maximilianii* that is native in eastern Brazil and has nothing to do with *X. violaceum*.

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