
Elevation of Three Varieties of the Malagasy Endemic *Casearia nigrescens* (Salicaceae) to the Species Level

Angelina X. Wang,¹ Laurel Philpott,² and Wendy L. Applequist^{3*}

¹Environmental Science Department, Willamette University,
900 State St., Salem, Oregon 97301, U.S.A.

²Ecology and Evolutionary Biology Department, University of Tennessee,
569 Dabney Hall, 1416 Circle Dr., Knoxville, Tennessee 37996, U.S.A.

³Missouri Botanical Garden, 4344 Shaw Blvd., St. Louis, Missouri 63110, U.S.A.

* Author for correspondence: wendy.applequist@mobot.org

ABSTRACT. The Malagasy species of *Casearia* Jacq. (Salicaceae) have no modern taxonomic treatment and present particular difficulties due to their similar flowers. Twentieth-century authors have adopted overly lumping classifications featuring broad circumscriptions of *C. nigrescens* Tul. Perrier de la Bâthie published three varieties within *C. nigrescens* sensu Tulasne: varieties *onivensis* H. Perrier, *ovata* H. Perrier, and *subtrinervia* H. Perrier. All of these are from eastern humid forests, farther inland and at higher elevations than is typical of variety *nigrescens* s. str. Study of the available specimens indicates that all are sufficiently distinct from variety *nigrescens* that they should be elevated to the rank of species. They are herein recognized as *C. onivensis* (H. Perrier) Ang. X. Wang & Philpott, *C. angustifructa* Ang. X. Wang & Appleq., and *C. subtrinervia* (H. Perrier) Ang. X. Wang & Appleq., respectively. All are rarely collected, and preliminary assessment of their conservation status suggests that all three are Endangered.

Key words: *Casearia*, IUCN conservation status, Madagascar, new combination, replacement name, Salicaceae, Samydaceae.

Casearia Jacq. is a pantropical woody genus of ca. 200 species that is most diverse in the Neotropics. It is usually placed within Salicaceae (e.g., Chase et al., 2002; Angiosperm Phylogeny Group IV, 2016), though the alternative classification proposed by Alford (2005) would segregate *Casearia* and 13 other genera of Salicaceae into Samydaceae, thus creating two smaller families that are both monophyletic and morphologically distinguished.

All the Malagasy and African species of *Casearia* belong to section *Casearia* as defined by Sleumer (1980). Their flowers are usually tiny and have few distinguishing characters. The first treatment of *Casearia* in Madagascar was by Tulasne (1868), who described five

species, ranging from the very large-leaved *C. amplissima* Tul. to the very small-leaved *C. parvifolia* Tul. (nom. illeg., non Willd.). Perrier de la Bâthie (1940) recognized the same species and published three varieties of *C. nigrescens* Tul. (varieties *onivensis* H. Perrier, *ovata* H. Perrier, and *subtrinervia* H. Perrier) as well as a form and a variety within *C. elliptica* Tul. (variety *macrocarpa* H. Perrier and form *elongata* H. Perrier). The same species were recognized in the subsequent *Flore de Madagascar* treatment of Perrier de la Bâthie (1946), except that the name *C. tulasneana* (Baill.) Warb. was substituted for the illegitimate *C. parvifolia*.

Sleumer (1971) revised *Casearia* for Africa, Madagascar, and the Mascarenes. In his treatment, all Malagasy taxa of *Casearia* were lumped into *C. nigrescens*, apparently because of their similar flowers. Within that species two varieties were recognized: variety *nigrescens* and variety *lucida* (Tul.) Sleumer, which were distinguished primarily by minute pubescence on the pedicels and parts of the tepals in the latter. Sleumer's variety *nigrescens* included not only the previously recognized varieties of *C. nigrescens* s. str. but also *C. elliptica* and *C. amplissima*, of which the latter is notable for its leaves often well over 20 cm long. Both "varieties" had very large latitudinal ranges, but variety *nigrescens* usually occurred in humid, or sometimes littoral, forests relatively close to the east coast, while variety *lucida* usually occurred farther west, farther inland, and at sometimes higher elevations. This treatment was plainly unusable, so most herbarium workers have relied upon that of Perrier de la Bâthie (1946).

However, Perrier de la Bâthie's classification is now obsolete, because very little herbarium material was available at the time of the *Flore de Madagascar* treatment compared to what exists today. Multiple taxa have been collected but never named or have been treated at an inappropriately low rank. An ongoing effort to resolve the taxonomic difficulties in Malagasy *Casearia*

has already resulted in the identification of three new species: *C. anosyensis* Appleg. & M. T. Gates, *C. montigena* Appleg. & M. T. Gates, and *C. razakamalalae* Philpott & Appleg. (Applequist & Gates, 2020; Philpott & Applequist, 2023).

In the present study, the status of the varieties of *Casearia nigrescens* published by Perrier de la Bâthie (1940) was reexamined. The circumscription of *C. nigrescens* var. *nigrescens* (sensu Perrier), relative to *C. elliptica* and probably additional yet-unnamed taxa, has not yet been clarified. Both of those taxa are found primarily in coastal or low-elevation humid forests, but extend into mid-elevation humid forests. Perrier's varieties *onivensis*, *ovata*, and *subtrinervia*, all of which seem to be rare, are endemic to mid-elevation humid eastern forests. As formally defined, mid-elevation forests range from 800 to 1800 m elevation (Du Puy & Moat, 1996; Gautier et al., 2018). Reported elevations for these taxa are limited to the lower part of that range, from 800 to 1140 m; occurrence at slightly lower elevations would not be unexpected.

Two of Perrier de la Bâthie's varieties (mentioned above) are at least sometimes arborescent, as is variety *nigrescens* sensu Perrier, but one, variety *onivensis*, is reported only as a shrub. All have leaves that are on average somewhat smaller than those of variety *nigrescens*, but leaf shape conspicuously differs among them. Though all three co-occur in close proximity in the Alaotra-Mangoro region, they appear distinct both from one another and from variety *nigrescens*, including both coastal populations at similar latitudes (comparable to the type) and inland, higher-altitude specimens identified as variety *nigrescens*. This raised our suspicion that these taxa were genetically separated and would be more appropriately recognized at the species level. More detailed examination revealed sufficient morphological differences among them to justify elevating all three to the rank of species, which is done here.

MATERIALS AND METHODS

Standard herbarium methods were used to examine available specimens housed at MO, including unmounted duplicates not yet distributed, and on loan from P and G. High-resolution images of types were viewed on the P website, as types could not be obtained on loan. JSTOR Plants (<plants.jstor.org>) was used to search for type duplicates in other herbaria. Descriptions of leaf morphological characters, especially venation, followed Ellis et al. (2009). The former provincial boundaries are no longer recognized, but because the recently recognized regions were not cited in older literature or specimen labeling, geographic information includes the province, in brackets, as well as the region.

Because not all of the taxonomic problems in the *Casearia nigrescens* species complex have been resolved, the circumscription of *C. nigrescens* (variety *nigrescens*) in the strict sense remains somewhat unclear. It certainly appears that *C. elliptica* and probably at least one yet-unnamed segregate taxon should be distinguished from *C. nigrescens*, but intermediate specimens complicate the interpretation of the group. The type of *C. nigrescens* (Chapelier 19, "Côte Est") could not be obtained on loan for examination of comparative micromorphological characters. Sleumer (1971) presumed that it probably came from Mahavelona or Toamasina (then known as Foulpointe and Tamatave, respectively) since Chapelier collected only on the east coast, never in the interior, and predominantly at those two localities, where he resided (Dorr, 1997). A group of specimens was identified that came from northeastern coastal populations and that had leaves of similar size and shape to those of the type. These were considered to represent *C. nigrescens* var. *nigrescens*, s. str., for information on micromorphological features. Intermediates between specimens like these and the specimens pertaining to the segregate varieties were not observed.

A preliminary assessment of conservation status using the categories and criteria of IUCN (2022) was conducted for each taxon recognized. Collections lacking original coordinate data were assigned post-facto coordinates based on existing georeferences in the TROPICOS specimen database (<<https://www.tropicos.org>>) or Madagascar gazetteer (<<http://legacy.tropicos.org/GazetteerSearch.aspx?projectId=17>>); if necessary, generic coordinates representing the center of a large park or nearest landmark were used. GeoCAT (Bachman & Moat, 2012) was used to estimate extent of occurrence (EOO) and area of occupancy (AOO). The distribution map (Figure 1) was created with ArcGIS Pro Version 2.4.0 (Esri, 2019) using Esri's World Topographic Map as a basemap, incorporating layers depicting Madagascar's regional boundaries, with their names (Sheridan, 2021) and major cities (Poggio, 2020).

TAXONOMIC TREATMENT

1. *Casearia angustifructa* Ang. X. Wang & Appleg., nom. et stat. nov. Replaced name: *Casearia nigrescens* var. *ovata* H. Perrier, Mém. Mus. Natl. Hist. Nat. 13: 272. 1940. TYPE: Madagascar. Reg. Alaotra-Mangoro [Prov. Toamasina]: forêt d'Analamazaotra, 800 m, Feb. 1903, *Perrier de la Bâthie 4453* (holotype, P [barcode] P00077481 image!; isotype, L [bc] L0010706 image!).

Distribution, ecology, and preliminary conservation status. *Casearia angustifructa* is found in mid-eleva-



Figure 1. Geographic distribution of three segregate species of the *Casearia nigrescens* Tul. complex native to mid-elevation humid forests. © OpenStreetMap contributors, and the GIS user community.

tion humid forests (Figure 1); *Ravelonarivo et al.* 4135 was noted to be on “cuirasse” (a type of duricrust).

The extent of occurrence is estimated as 6593 km² and the area of occupancy as 20 km². In total, there are six collections representing four locations with respect to the threat of forest clearance. Two historical collections come from the protected area of Analamazaotra; the species has not been re-collected from this well-documented site since 1957, raising concerns about its status there. Three more recent collections were from forests near Zahamena, but none were clearly within the boundaries of the Reserve (Goodman et al., 2018: 890): two were to the north of the Reserve, and one (*Ravelonarivo et al.* 4135) was near the southeastern border or possibly just within it. A sixth collection was made east of Fianarantsoa, much farther south, near but apparently not within the present boundaries of Ranomafana National Park. Land outside the borders of all three of those protected areas has suffered severe loss of vegetation due to shifting cultivation and other anthropogenic damage, which is expected to continue so long as any vegetation remains. At Ranomafana, there

has been ongoing significant forest cover loss even within the park boundaries (Goodman et al., 2018). Therefore, we assess the species’ conservation status as Endangered [EN B2ab(iii)].

Notes. The taxon previously known as *Casearia nigrescens* var. *ovata* can be distinguished from other members of the *C. nigrescens* complex by its moderately sized, often rather broadly elliptical, thin-textured leaves with usually well-developed acuminate apices and convex to concavo-convex bases; see Table 1. (The leaves are usually not ovate, and Perrier de la Bâthie [1940] chose the epithet despite describing the leaves as “*feuilles ovales*” [“leaves elliptical”], possibly in error.) Its staminal filaments are pubescent, at least sometimes more densely so than in variety *nigrescens*, and its fruits are longer than those of variety *nigrescens* but narrower in shape, with a more acute apex, a character that sets it apart from most other Malagasy species of *Casearia*, as Perrier (1940) observed in remarking “*capsule aiguë*.”

The epithet *ovata* could not be elevated to species level because of the prior existence of *Casearia ovata*

Table 1. Distinctions between *Casearia nigrescens* Tul. (variety *nigrescens*) s. str. (from selected collections from the northeast with resemblance to the type) and the segregate species *C. angustifructa* Ang. X. Wang & Appleg., *C. onivensis* (H. Perrier) Ang. X. Wang & Philpott, and *C. subtrinervia* Ang. X. Wang & Appleg.

	<i>C. nigrescens</i> s. str.	<i>C. angustifructa</i>	<i>C. onivensis</i>	<i>C. subtrinervia</i>
Habit, reported	tree to 10 m or shrub, flowering at 2 m	tree to 12 m, 16 cm DBH, flowering at 2.5 m	shrub to 3 m	small tree to 6 m
Twigs	reddish (to dark or pale) brown, sometimes glaucous; lenticels few, usually not very prominent	variable in color, sometimes glaucous; lenticels few, especially on younger twigs, to moderately dense; older twigs may have irregular, pale, raised areas unlike individual lenticels	pale tan to grayish; younger twigs sometimes minutely papillate; lenticels usually moderately dense, raised and pale (sometimes partly dense but less prominent)	pale grayish (to dark) brown, sometimes glaucous; lenticels often numerous, raised, giving twigs a bumpy surface, sometimes pale
Leaf shape and size	obovate to oblong-elliptical, usually rather narrowly, (5)–7–13.5 × (2)–2.5–4.5 cm	elliptical to broadly (aberrantly narrowly) elliptical (to somewhat ovate), often somewhat irregular, (3.5)–5–9.5(–11) × (1.6)–2.3–4.5(–4.8) cm	elliptical, usually rather narrowly (to oblanceolate or obovate especially in smaller leaves), (2.5)–4.3–8.3(–10.5) × (1)–1.8–3(–3.5) cm	broadly elliptical to broadly obovate-elliptical (orbicular), (1.7)–2.7–6(–7) × 2.2–4 cm
Leaf texture	moderately coriaceous	thin (to slightly thickened)	somewhat thickened, but easily friable	moderately coriaceous (thin, probably when young)
Leaf apex	cuspidate (partly rounded to emarginate)	acuminate, usually shortly so (cuspidate)	short-acuminate to acute or rounded-obtuse	emarginate, rounded, or cuspidate
Leaf base	narrowly convex (cuneate)	broadly convex, often attenuate at extreme base	convex, usually narrowly (cuneate, attenuate at extreme base)	broadly convex to rounded, often attenuate at extreme base
Leaf venation	secondary veins (5 to) 7 to 10, eucamptodromous (to apically brochidodromous), sometimes widely spaced at base	secondary veins 6 to 9, brochidodromous, sometimes festooned, especially on larger leaves, sometimes basally eucamptodromous	secondary veins ca. 6 to 8(to 9), brochidodromous, sometimes festooned; sometimes irregularly spaced and shaped, even recurving somewhat; tertiary veins connecting secondary veins sometimes of almost equal gauge	secondary veins (5/6/7), brochidodromous, sometimes basally eucamptodromous; tertiary veins sometimes strong
Floral characters	pedicels, sepals glabrous (sepals may be minutely ciliate); some filaments pubescent at top, most glabrous	pedicels, sepals glabrous; filaments may be rather densely pubescent	pedicels, sepals sometimes partly sparsely pubescent or sepals minutely ciliate, but not consistently; filaments glabrate or short-pubescent?	pedicels, sepals glabrous; filaments glabrous or glabrate?
Fruit (dried, pressed)	ca. 9–12 × 8.1–8.8 mm, broadly ellipsoid, somewhat ridged, yellow, apex rounded with persistent style base	ca. 15–18 × 7.5 mm, ellipsoid, somewhat ridged, yellow?, apex acute (in young fruits, style persistent)	ca. (11?)–13–19 × (8?)–10–13.5 mm, broadly ellipsoid or irregular and wrinkled (possibly immature), little ridged or with a flat ridge formed by pressing, yellow to orange, apex broadly obtuse usually with persistent style base	ca. 9–14 × 8.5–11.5 mm, broadly ellipsoid to oblong-ellipsoid or globose, often not strongly ridged when mature, orange, apex rounded, sometimes with persistent style or style base

(Lam.) Willd., so a replacement name has to be published. The epithet *angustifructa* was chosen to call attention to the relatively uncommon, hence informative, fruit shape.

Additional specimens examined. MADAGASCAR. **Alaotra-Mangoro [Toamasina]:** commune de Manakambahiny Est entre Sahamalaza et Nonokambo, 17°45'28"S 048°45'50"E, 815 m, 28 Nov. 2001, *Andrianjafy et al.* 257 (MO); forêt d'Analamazaotra-Périnet, 6 Nov. 1957, *Service Forestier 18396* (P [2 sheets]). **Analanjiofo [Toamasina]:** à l'ouest du village d'Ambatoaranana, région de Moango, nord-est de la RNI de Zahamena, 17°33'30"S 048°53'20"E, 900 m, 24 Jan. 1994, *Randrianjanaka et al.* 53 (MO). **Atsinanana [Toamasina]:** distr. Brickaville, com. Maroseranana, fkt. Ambatolampy, 18°23'49"S 48°48'38"E, 973 m, 22 Jan. 2012, *Ravelonarivo et al.* 4135 (MO). **Matsiatra Ambony [Fianarantsoa]:** Andrambovato (E de Fianarantsoa), forêt à mousses, 10 Feb. 1949, *Service Forestier 261* (P).

2. *Casearia onivensis* (H. Perrier) Ang. X. Wang & Philpott, comb. nov., stat. nov. Basionym: *Casearia nigrescens* var. *onivensis* H. Perrier, Mém. Mus. Natl. Hist. Nat. 13: 272. 1940. TYPE: Madagascar. Reg. Alaotra-Mangoro [Prov. Toamasina]: forêt d'Andasibe sur l'Onive, vers 900 m d'alt. (à mousses et à sous-bois herbacé), Feb. 1925, *Perrier de la Bâthie 17050* (lectotype, designated by Sleumer [1970: 414], P [bc] P00077479 image!; isotype, L fragm. [bc] L0010708 image!).

Distribution, ecology, and preliminary conservation status. *Casearia onivensis* is endemic to mid-elevation humid forests in the Alaotra-Mangoro region (Figure 1). All known collections were probably made somewhere within or in the vicinity of the two protected areas of Analamazaotra and Zahamena. However, the location of historical collections is unclear, and habitat outside the protected areas is severely threatened, with much already destroyed. *Cours 2084* was assigned the coordinates of Nickelville (a nickel deposit near the town of Ambotondrazaka), the only locality mentioned on the label. The extent of occurrence is estimated at 396 km², and the area of occupancy is estimated at 20 km². There are four locations with respect to the threat of deforestation: (1) the protected area of Analamazaotra (from which it has not been recently re-collected, but where it may still be extant); (2) the protected area of Zahamena; (3) the collecting locality of *Hong-Wa 168*, which appears to have been just outside the boundary of Zahamena, on land under severe threat of deforestation; and (4) the poorly defined collecting locality of *Cours 2084*, which is from an area that, outside protected areas, has since undergone considerable forest loss and degradation, including from surface mining of nickel. That collection was likely not from a protected area, as none was mentioned on the label. Thus, there are four known locations, of which two are protected—

though the species has not been confirmed to persist at one of those—and two are under severe threat, one of them likely already eradicated. These factors justify assessing the conservation status of *C. onivensis* as Endangered [EN B1ab(ii,iii,iv)+B2ab(ii,iii,iv)].

Notes. *Casearia onivensis* is distinguished from *C. nigrescens* by its typically smaller and narrower, thinner-textured leaves with festooned brochidodromous secondary veins, probably smaller plant size (only shrubby habit is reported, though collections are few), twigs with usually plentiful lenticels, perhaps slightly longer, sparsely pubescent pedicels, and larger fruits (which are broadly ellipsoid, not narrow with an acute apex like those of *C. angustifructa*; Table 1). Due to the lack of flowering material for *C. onivensis*, the utility of flowering characters is uncertain.

Other narrow-leaved specimens of the *Casearia nigrescens-elliptica* complex from this region are atypical of variety *nigrescens*, commonly having elliptical leaves with rounded leaf apices. While it is possible that these populations should be excluded from variety *nigrescens* in future if sufficient supporting characters are identified, they cannot be included in *C. onivensis*. Their leaves are frequently much larger, with apices commonly rounded; as for variety *nigrescens* s. str., their maximum fruit size is smaller than in *C. onivensis*, their twigs less prominently lenticellate, and their habit larger (to 15 m). The collection *Hong-Wa 168* is placed in *C. onivensis* because of its shrubby habit and small leaves often with acute apices, but unlike any other specimen placed here, it has numerous, many-flowered clusters of buds that are partly cauliflorous, being borne on large, leafless twigs as well as first-year twigs. Further investigation of this population would be desirable.

Additional specimens examined. MADAGASCAR. **Alaotra-Mangoro [Toamasina]:** forêt au nord de la route de Nickelville, 29 Dec. 1944, *Herb. Inst. Sci. Mad. [Cours] 2084* (MO); Andranomalaza, 3 km ouest de Anosivola, 17°41'01"S 048°38'52"E, 960 m, 24 Oct. 2003, *Hong-Wa 168* (MO); Analamazaotra, Oct. 1925, *Louvel 50* (P image!); Vohitsingitry, à 10 km SE du village d'Andranomalaza Sud, à l'intérieur du parc, à 1 km de la limite, à côté de la rivière d'Andrinano, 17°39'14"S 048°39'49"E, 1140 m, 19 Feb. 2000, *Rabenantoandro et al.* 148 (MO); Vinanitelo, à 4 km au SE d'Andranomalaza Sud, 17°39'14"S 048°39'49"E, 1140 m, 18 Feb. 2000, *Randrianjanaka et al.* 532 (MO).

3. *Casearia subtrinervia* (H. Perrier) Ang. X. Wang & Appleq., comb. nov., stat. nov. Basionym: *Casearia nigrescens* var. *subtrinervia* H. Perrier, Mém. Mus. Natl. Hist. Nat. 13: 272. 1940. TYPE: Madagascar. Reg. Alaotra-Mangoro [Prov. Toamasina]: forêt d'Analamazaotra, forêt des cimes, 900 m, 1923, *Perrier de la Bâthie 4653* (holotype, P [bc]

P00077482 image!; isotype, L fragm. [bc] L0010709 image!).

Distribution, ecology, and preliminary conservation status. *Casearia subtrinervia* is endemic to a small area in the vicinity of Analamazaotra (Figure 1). Its habitat includes sclerophyllous thicket on ferricrete plateau (Rakotomalaza et al. 1045).

The extent of occurrence is estimated to be 21 km² and the area of occupancy to be 12 km². A historical subpopulation existed in the protected area of Analamazaotra, and there are two modern collections from the nearby Phelps Dodge (now AMSA) mining site, where mining activities continue. The mining project attempted to identify locally endemic species and take action to propagate them off-site, but these collections were identified as *Casearia nigrescens*, then broadly or very broadly defined, so were not recognized to be a local endemic in need of special protection. Assuming that the species persists in Analamazaotra, there are two known locations with respect to the threat of habitat loss from mining, and an inferred decline in the area, extent or quality of habitat can be inferred for one of those. Therefore, this species' conservation status is assessed as Endangered [EN B1ab(iii)+B2ab(iii)].

Notes. *Casearia subtrinervia* has slender twigs, which often bear many pale, raised lenticels, and small, coriaceous, broadly elliptical to suborbicular leaves with brochidodromous secondary veins, commonly with emarginate apices and rounded bases (Table 1). It should be noted that the basal secondary veins of the leaves usually do not extend to the distal portion of the leaf, as the epithet might be taken to imply otherwise. The broadly elliptical leaves of *C. subtrinervia* may also be compared to those of *C. elliptica*, whose leaves are much larger, with cuspidate apices and convex bases. That species also often, though not always, has sturdier twigs, and young twigs generally have fewer or less prominent lenticels.

Additionally, there is a group of usually small-leaved specimens in the *Casearia nigrescens*–*C. elliptica* complex in coastal forests of southeastern Madagascar whose placement has not yet been clarified that bear some resemblance to *C. subtrinervia* but with a more elongated leaf shape. These can be distinguished by their grooved but not densely lenticellate twigs and usually somewhat obovate leaves with convex to cuneate bases and rounded to mucronate (or emarginate) apices. They may represent another yet-unnamed species that should be distinguished from *C. elliptica*, but we are not ready to recognize them as such at this time.

Additional specimens examined. MADAGASCAR. **Alaotra-Mangoro** [Toamasina]: Ampitambe/Ambobihary, Ambatovy,

Ampagandiantradraka, 18°51'44"S 048°17'03"E, 1131 m, 18 Dec. 2011, *Andriamiarinoro et al.* 206 (MO); Phelps Dodge project site, ca. 15 air-km NE of Moramanga, ca. 11 km E of Antanambao, Ambatovy, ferricrete plateau NE, 18°51'07"S 048°18'47"E, 1100 m, 30 Jan. 1997, *Rakotomalaza et al.* 1045 (MO [2 sheets]).

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