

Exploring seed morphology of *Polygala* s.s. (Polygalaceae) for taxonomic purposes: a case study of the Angolan taxa

ANA M.S. COELHO^{1,3*}, JORGE A.R. PAIVA^{1,4} & FÁTIMA SALES^{1,2,5}

¹Centre for Functional Ecology, Laboratório Associado TERRA, Departamento de Ciências da Vida, Universidade de Coimbra, Calçada Martim de Freitas, 3000-456, Coimbra, Portugal

²Royal Botanic Garden Edinburgh, EH3 5LR, UK

³ bio.anacoelho@gmail.com;  <https://orcid.org/0000-0002-4980-1963>

⁴ jaropa@bot.uc.pt;  <https://orcid.org/0000-0001-9714-8893>

⁵ fsales@bot.uc.pt;  <https://orcid.org/0000-0003-2876-0610>

*Author for correspondence

Abstract

The complex seed morphology of *Polygala* subgen. *Polygala* is formally described for the Angolan taxa. Seeds were collected from herbarium specimens and microphotographs of lateral, dorsal, and ventral views were used to derive data on the measurements and shape of the structures. A standardised and illustrated explanation of quantitative attributes and descriptive terms for shapes was developed to improve consistency and facilitate comparison across taxa. An identification key of taxa based solely on seed features is also provided. The majority of the taxa (80%) can be segregated using seed characters alone, which demonstrates the value of seed morphology for the taxonomy of species in *Polygala* s.s.

Key words: caruncle, seed identification, seed microphotography, standardising seed description

Introduction

Genus numbers in the Polygalaceae L. have increased steadily over the last few decades. Phylogenetic studies and revisions revealed that *Polygala* L. is highly polyphyletic and several of its subgenera and sections were subsequently raised to genus status (e.g., Eriksen 1993, Persson 2001, Forest *et al.* 2007, Castro *et al.* 2009, Abbott 2011, Abbott & Pastore 2015, Pastore *et al.* 2019, 2023, 2026). Paiva (1998) attributed genus rank to the Africa-Asiatic *Heterosamara* Kuntze, being the African taxa recently segregated to the new genus *Paivanthus* J.F.B.Pastore (Pastore *et al.* 2026). For a while, only *Polygala* subgen. *Polygala* and the tropical Asiatic *P.* subgen. *Chodatia* Paiva were retained, the former maintaining, with minor changes, eleven sections within the so-called Old World Clade (OWC, Pastore *et al.* 2019). *Polygala* subgen. *Chodatia* was eventually raised to genus level as *Chodatia* (Paiva) J.F.B.Pastore (Pastore *et al.* 2026). The New World Clade (NWC, Pastore *et al.* 2019) of *P.* subgen. *Polygala* received genus status as *Senega* Spach, and the species of the OWC in *P.* sect. *Timutua* DC., were transferred to it and placed under *S.* subgen. *Senega* sect. *Tenues* (Chodat) J.F.B.Pastore (Pastore *et al.* 2023). Thus, *P.* sect. *Timutua* no longer occurs in Angola. The classic *P.* subgen. *Polygala* is here regarded as *Polygala* s.s. The complex taxonomic adjustments to the classification of *Polygala* s.l. are ongoing (Pastore *et al.* 2023, 2026), with new taxa regularly being added (e.g., Siebert *et al.* 2010, Dönmez *et al.* 2015, Wahlert *et al.* 2017, Pastore 2018, Vishnu & Nampy 2022, Liu *et al.* 2024, Lai *et al.* 2025).

Seed morphological variation in *Polygala*—now split into different genera—has occasionally been used for taxonomic purposes (e.g., Isaacs *et al.* 1993, Paiva 1998, Kerrigan 2012, Aydın 2020, Sarvi *et al.* 2022). Apparently, micromorphological seed characters are more consistent and effective to distinguish taxa in *Polygala* s.l. than ultra-micromorphology (Isaacs *et al.* 1993, Mathew & Teresa 2010, Aydın 2020). Seed coat sculpture under scanning electron microscopy alone has proven difficult for taxon identification and provides very few characters (Isaacs *et al.* 1993, Sarvi *et al.* 2022). A more comprehensive analysis of the complex seed morphology of *Polygala* s.l. may also add to existing contributions for clarification of seed dispersal mechanisms in diverse habitats (Berg 1975, Lack & Kay 1987).

The seeds of *Polygala s.l.* clearly show interesting structures (Paiva 1998, Kerrigan 2012, Pastore *et al.* 2023) (Fig. 1) but discrepancies in the terminology for these structures found in the literature calls for a detailed and standardised descriptive approach.

In *Polygala s.l.* a single anatropous ovule (Adema 1966) in each locule of the bilocular capsule develops into one pendulous seed. Anatropous ovules are inverted due to their unequal-sided development, which causes their 180° curvature. Their position as an organ—and, therefore, the resulting seed—can be regarded from the morphological or the anatomical viewpoint. Morphologically, the point of attachment of the funicle, the filament that connects the seed to the placenta, is near the micropyle. This point indicates the proximal extremity of the seed (e.g., Stearn 1992, Hickey & King 2000, Rudall 2007, Beentje 2010). At maturity, the funicle detaches from the seed leaving a scar known as a hilum. Anatomically, a vascular bundle connects the placenta to the ovule through the funicle and raphe along the ventral side of the ovule and ends in the chalaza (Endress 2011). Therefore, from the anatomical viewpoint, the chalazal extremity of the ovule/seed is the proximal one. Although *Polygala s.l.* seeds are inserted into the distal extremity of the fruit, this does not support the interpretation of Kerrigan (2012) of the seed apex at the micropylar extremity. Without explaining their option, many other authors have also considered the seed apex at the micropylar side and draw or photograph the seeds with the caruncle upwards (e.g., Adema 1966, Paiva 1998, Kerrigan 2012, Paiva 2016). In the present work we consider the position of the hilum fundamental for determining the proximal extremity of the seed given the non-dubious morphological location of the point of attachment of the funicle to the seed. In this we follow Ridley (1930).

The seeds of *Polygala s.l.* usually exhibit outgrowths for which the terminology proliferated and became inconsistent. These structures attract ants, which disperse them (Sernander 1906, Ridley 1930, Lisci *et al.* 1996, Castro *et al.* 2010, Lengyel *et al.* 2010). Due to this ecological role, these structures were named ‘elaiosomes’ (meaning “oil–body”). The terms relating to ontogeny and location were clearly described by Eriksen (1993) for the Polygalaceae: the exostome aril or caruncle; the funicular aril; and the chalazal aril. These originate in the exostome, the dermis of the outer integument surrounding the micropyle, near the hilum (Verkerke & Bouman 1980), located at the proximal extremity of the seed; the funicle; and the chalazal part of the seed coat, located at the distal extremity of the seed, respectively. The most common in *Polygala* is the exostome aril or caruncle, referred to as “caruncle” by the earliest authors (Chodat 1893, Gaertner 1788); a chalazal aril is also sometimes present (Forest *et al.* 2007). The term “aril” has a broad meaning, referring to any appendage that envelops the seed to varying degrees, requiring, in fact, precision regarding the part of the seed from which it originates. For simplicity, we use the term “caruncle” instead of “exostome aril” in the present work. The caruncle is a hairy or glabrous polymorphic structure that is usually 3-lobed, with two symmetrical ventral lobes facing the septum of the capsule and one opposite dorsal lobe (Fig. 1). The lobes often develop appendages from their epidermis (Paiva 1998); the caruncle ventral lobes develop around the funicle (Verkerke & Bouman 1980). The chalazal aril is smaller than the caruncle (Fig. 1) (Sernander 1906, Ridley 1930) and it is an outgrowth from the chalazal region of the seed coat (Eriksen 1993).

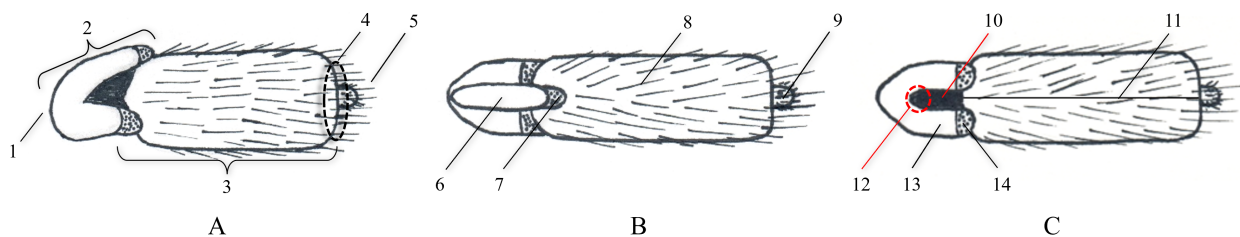


FIGURE 1. General morphology of *Polygala* seed. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. 1: Proximal extremity of the seed; 2: caruncle; 3: seed body; 4: chalazal region; 5: distal extremity of the seed; 6: caruncle dorsal lobe; 7: appendage of the dorsal lobe; 8: hair; 9: chalazal aril; 10: hilum; 11: raphe; 12: micropyle; 13: caruncle ventral lobe; 14: appendage of the ventral lobe. Drawings by Ana Coelho.

Angola constitutes an excellent case study for any floristic investigations in subsaharan Africa due to its variable territory. The country features an extensive central plateau, predominantly characterised by savannah, surrounded by various ecological units: the Zambezi Basin to the east, the Namib Desert to the southwest, and tropical forests to the north (White 1983). The Polygalaceae in Angola include 46 taxa in *Polygala s.s.*, three species in *Senega* subgen. *Senega* sect. *Tenues*, and two species each in *Atroxima* Stapf, *Carpolobia* G.Don., *Paivanthus*, and *Securidaca* L. (Paiva 1998, 2008, Pastore *et al.* 2023, 2026).

The current study aims to: (1) test the hypothesis that the rich morphological variability of seeds in the Angolan *Polygala* s.s. is enough to construct an identification key to the taxa; and (2) establish a clear methodology and terminology for seed description that can constitute a guide for standardising *Polygala* s.s. seed description; although this sample from Angola (46 taxa) is only 13.6% of the species in *Polygala* s.s. (ca. 337; Pastore *et al.* 2023, 2026), it should represent a wide enough range of seed morphology in this group as it also covers a wide range of ecological units and habitats in Africa.

Of the 46 taxa dealt with here, Paiva (1998) illustrated 40 in black-and-white drawings, of which 15 were from Angolan material. The six taxa not illustrated are *P. britteniana* Chodat, *P. gossweileri* Exell & Mendonça, *P. mossamedensis* Paiva, *P. nambalensis* Gürke, *P. oliveriana* Exell & Mendonça, and *P. poggei* Gürke.

Material and methods

Selected taxa:—A total of 46 Angolan taxa of *Polygala* s.s. were investigated. The taxa belong to five of the eleven sections of *Polygala* s.s. The classification of Paiva (1998) was followed for its stability in Angola (Table 1). Minor recent changes that impact this country and relate to *Senega*’s circumscription (Pastore *et al.* 2019, 2023) were incorporated.

Plant material:—The study examined 204 seeds collected from herbarium specimens. Approximately 600 herbarium specimens were investigated and 120 were used for seed analysis from the following herbaria: B, BM, COI, K, LISC, LISU, LUA, and LUAI (herbarium codes follow Thiers 2025). The latter are cited under each taxon (see “Seed account”). Seed number per herbarium specimen was significantly variable, (0–)1 – >10. Only five seeds per taxon were sampled to ensure a sampling method that could be applied to as many taxa as possible. Even so, there were eleven non-endemics without enough material from Angola, and their seeds were sourced from the nearest countries; three of these taxa had fewer than five seeds available; and *P. poggei* had no seed material available (Table 1). Half of the endemic taxa also had less than five seeds available (Table 1).

TABLE 1. The 46 Angolan taxa of *Polygala* s.s. studied and their classification; the subgeneric classification follows Paiva (1998); the exclusion of *P. africana* Chodat, *P. capillaris* E.Mey. ex Harv. subsp. *capillaris*, and *P. spicata* Chodat follows Pastore *et al.* (2023). Species are numbered as they come out in the identification key. The study used five seeds per taxon of Angolan origin; the exceptions are indicated in superscript; ^E—taxa endemic to Angola; [✧]—pair of taxa that key out together; [■]—seven taxa that key out together; DRC: Democratic Republic of the Congo.

Section	Subsection	Taxa in Angola
<i>Leptaleae</i> (Chodat) Paiva		14. <i>P. myriantha</i> Chodat
<i>Blepharidium</i> DC.	<i>Blepharidium</i>	42. <i>P. erioptera</i> DC.
	<i>Asiaticae</i> (Chodat) Paiva	19. <i>P. myrtillopsi</i> Welw. ex Oliv. ¹ Angola
	<i>Sphenopterae</i> (Chodat) Paiva	44. <i>P. sphenoptera</i> Fresen.
	<i>Arenariae</i> (Chodat) Paiva	3. <i>P. albida</i> Schinz subsp. <i>albida</i> 41. <i>P. albida</i> subsp. <i>stanleyana</i> (Chodat) Paiva 43. <i>P. arenaria</i> Willd. ³ Angola, ² Ivory Coast 1. <i>P. melilotoides</i> Chodat 45. <i>P. welwitschii</i> subsp. <i>pygmaea</i> (Gürke) Paiva 10. <i>P. welwitschii</i> Chodat subsp. <i>welwitschii</i> ^E
	<i>Sativae</i> Paiva	13. <i>P. angolensis</i> Chodat ¹ Angola; ^E 5. <i>P. britteniana</i> Chodat ³ Zambia; [✧] 12. <i>P. ganguelensis</i> Exell & Mendonça 40. <i>P. gomesiana</i> Welw. ex Oliv. 7. <i>P. macrostigma</i> Chodat 8. <i>P. mendoncae</i> E.M.A.Petit 4. <i>P. nambalensis</i> Gürke [✧] 2. <i>P. oliveriana</i> Exell & Mendonça ⁴ Angola; ^E 11. <i>P. paludicola</i> Gürke 6. <i>P. usafuensis</i> Gürke 30. <i>P. youngii</i> Exell ¹ Angola, ⁴ Zambia

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TABLE 1. (Continued)

Section	Subsection	Taxa in Angola
<i>Tetrasepalae</i> (Chodat) Paiva	<i>Tetrasepalae</i>	17. <i>P. antunesii</i> Gürke ^E 36. <i>P. laxifolia</i> Exell ^E 16. <i>P. luenensis</i> Paiva ⁴ Angola; ^E 32. <i>P. mossamedensis</i> Paiva ⁴ Angola; ^E 22. <i>P. resendeana</i> Paiva ¹ Angola; ^E 18. <i>P. rivularis</i> Gürke 21. <i>P. schinziana</i> Chodat ⁵ Zambia 35. <i>P. stenopetala</i> subsp. <i>casuarina</i> (Chodat) Paiva ^E
	<i>Ecristatae</i> Paiva	20. <i>P. fragilis</i> Paiva ² Angola, ³ Zambia 31. <i>P. petitiana</i> A.Rich. subsp. <i>petitiana</i> 34. <i>P. xanthina</i> Chodat ² Burundi, ³ Zambia
	<i>Hexandriae</i> Paiva	33. <i>P. acicularis</i> Oliv. ² Angola, ¹ Cameroon, ² Nigeria 23. <i>P. arenicola</i> Gürke [■] 24. <i>P. baumii</i> Gürke [■] 15. <i>P. dewevrei</i> Exell 25. <i>P. gossweileri</i> Exell & Mendonça ¹ Angola, ¹ Tanzania; [■] 26. <i>P. huillensis</i> Welw. ex Oliv. ^E ; [■] 27. <i>P. kalaxariensis</i> Schinz [■] 28. <i>P. nematophylla</i> Exell [■] — <i>P. poggei</i> Gürke ⁰ 29. <i>P. robusta</i> Gürke ³ Angola, ² DRC; [■]
<i>Chloropterae</i> (Chodat) Paiva		37. <i>P. krumanina</i> Burch. ex Ficalho & Hiern ³ South Africa, ¹ Zimbabwe
<i>Megatropis</i> Paiva	<i>Megatropis</i>	38. <i>P. guerichiana</i> Engl.
	<i>Heterolophus</i> Paiva	39. <i>P. leptophylla</i> Burch. var. <i>leptophylla</i> 9. <i>P. pallida</i> E.Mey. ex Harv.

Of the 46 taxa listed here, the results for 35 were based exclusively on material from Angola, for six the material used was a mixture of Angola and neighbouring countries, and for four the material was exclusively from outside Angola (Table 1). The specimens of *P. poggei* traced are in flower, thus the seed of the species is not described, and the species is not included in the key.

Distribution, habitat and ecology, and phenology:—Information on the distribution of *Polygala* s.s. in Angola was compiled from herbarium specimens, Paiva (2008), and *Conspectus Florae Angolensis* (Exell & Mendonça 1937, 1951). The names of Angolan provinces and their spelling were updated according to the Getty Thesaurus of Geographic Names (The J. Paul Getty Trust 2017). Information regarding the broader distribution and habitat and ecology was primarily sourced from Paiva (1998), occasionally from Paiva (2007, 2016). Herbarium specimens often provide limited ecological information, and different terms are frequently used inconsistently, a concern extensively discussed by Mengist (2019). Phenological (fruiting) data are given for Angola only and were collected from *Conspectus Florae Angolensis* (Exell & Mendonça 1937, 1951) and the herbarium specimens used for seed analysis. When information of fruiting time in Angola was not available, flowering in Angola is given instead.

Seed microphotography:—All seeds were photographed in lateral, dorsal, and ventral views using a Leica MZ9.5 binocular stereo-microscope coupled with a Leica MC190 HD microscope camera operated with the Leica software LAS Live Z Image Builder; photographs in Figs 14D–F, 34A–C, and 46 were obtained using a Leica Emspira 3 digital microscope operated with the Leica software LAS X. The total 612 microphotographs captured were used to derive data on seed measurements, using the Annotate software developed by ReColNat [RECOLNAT (ANR–11–INBS–0004)]. The microphotographs were also used to analyse shapes of seed structures.

Standardising seed descriptions:—*Polygala* seed morphology is complex. To standardise seed descriptions, certain quantitative feature and descriptive terms for shapes need comprehensive explanation to improve consistency in interpretation and to facilitate comparison across taxa. Considerations on particular features and significant details are described and illustrated (Figs. 2–10) as follows:

- Length of the seed body was measured in lateral view (Fig. 2A).
- Width of the seed body was measured at the seed body mid-length in lateral (Fig. 2A) and dorsal/ventral views (Fig. 2B/C), respectively.

- Maximum length and width of the smooth portion of the caruncle were measured in lateral view (Fig. 2D). The smooth portion does not include the caruncle appendages, which begin where the texture and/or colour changes.
- Seed body is laterally (1) strongly compressed when its width at mid-length in dorsal/ventral view is ca. half the width in lateral view; (2) slightly compressed when its width in dorsal/ventral view is more than half of the width in lateral view; (3) not compressed when its width in dorsal/ventral view is similar to the width in lateral view.
- Shape of the seed body is described in lateral view (Fig. 3).
- Hair density on the seed body contemplates the possibility of hair loss with age.
- Hairs are straight, $\pm$ curving or glochidiate (hook shaped).
- Hairs largely exceed the distal extremity of the seed body when they are longer than half the length of the seed body; they shortly exceed the distal extremity of the seed body when they are shorter than half the length of the seed body.
- The length of the appendages of the caruncle lobes is described in lateral view at lobe apex.
- Length of the appendages of the caruncle ventral lobes should be observed in lateral view. The appendages are said to form long rims when their length is approximately equal to or longer than that of the ventral lobes.
- Appendages of the caruncle ventral lobes may be restricted to the lobe apex or extend downwards (Fig. 4).
- The shape of the caruncle funicular gap (Fig. 5) refers to the gap between the two ventral lobes and appendages and could indicate the shape of the cross section of the funicle.
- The shape of the caruncle dorsal (Fig. 6) and ventral (Figs. 7 & 8) lobes is very variable.
- The chalazal region also has some diagnostic features (Fig. 9).

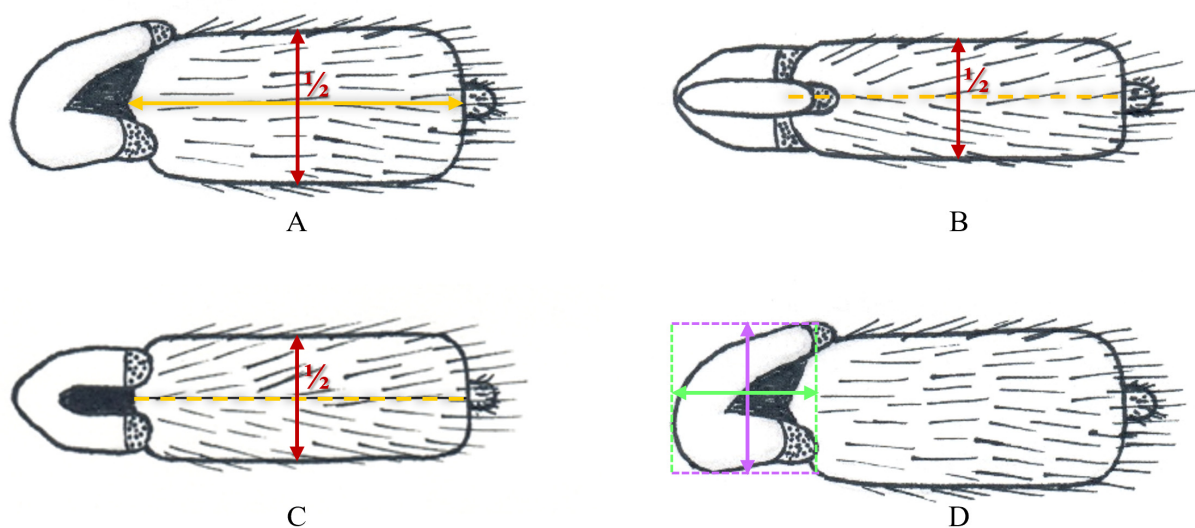


FIGURE 2. Measurements on seeds. **A.** Seed body measurements in lateral view. **B.** Seed body measurements in dorsal view. **C.** Seed body measurements in ventral view. **D.** Caruncle smooth portion measurements in lateral view. $\leftrightarrow$: seed body length; $\updownarrow \frac{1}{2}$: seed body width at mid-length; $\leftrightarrow$: caruncle smooth portion maximum length; $\updownarrow$: caruncle smooth portion maximum width; — — —: auxiliary lines. Drawings by Ana Coelho.

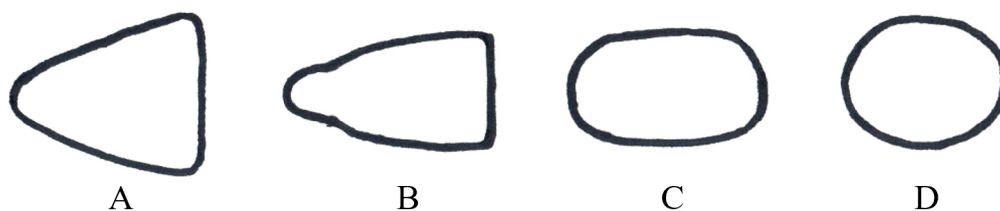


FIGURE 3. Shape of the seed body in lateral view. **A.** Obtriangular. **B.** Subobtriangular. **C.** Elliptic. **D.** Subcircular. Drawings by Ana Coelho.

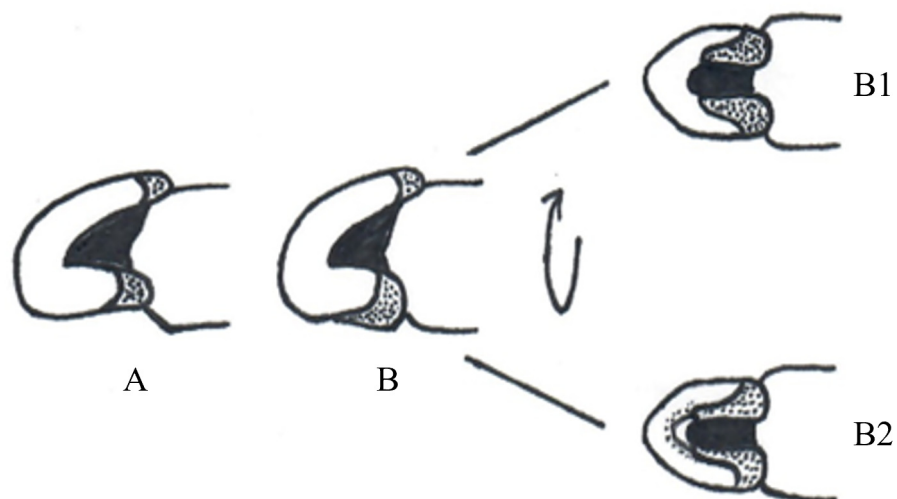


FIGURE 4. Projection of the appendages along the caruncle ventral lobes. **A.** Lateral view of appendages restricted to lobe apex. **B.** Lateral view of appendages at lobe apex and decurrent; **B1.** Ventral view of appendages at lobe apex and decurrent; **B2.** Ventral view of appendages at lobe apex and decurrent plus joining. Drawings by Ana Coelho.

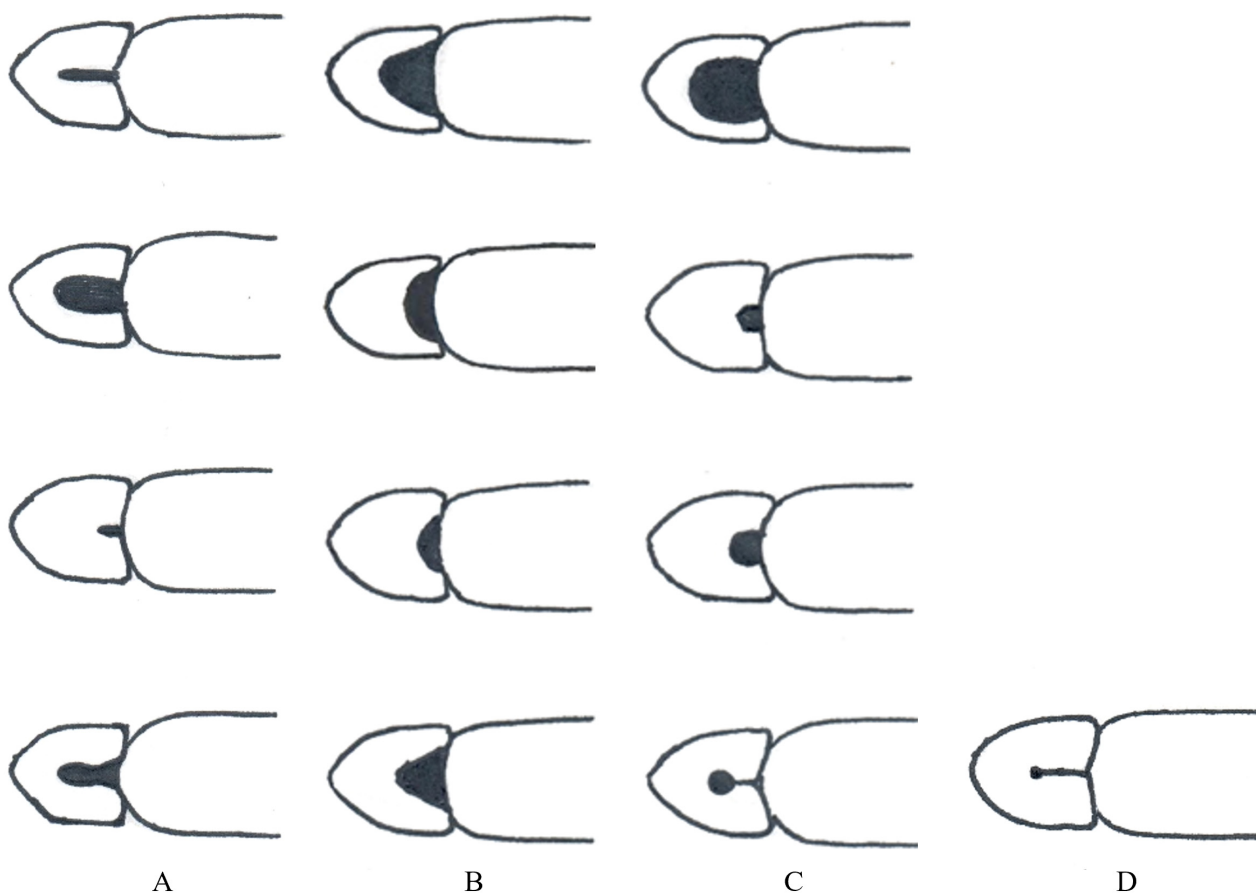


FIGURE 5. Shape of the caruncle funicular gap. **A.** Narrow. **B.** Wider at base. **C.** $\pm$ Circular. **D.** Minute. Drawings by Ana Coelho.

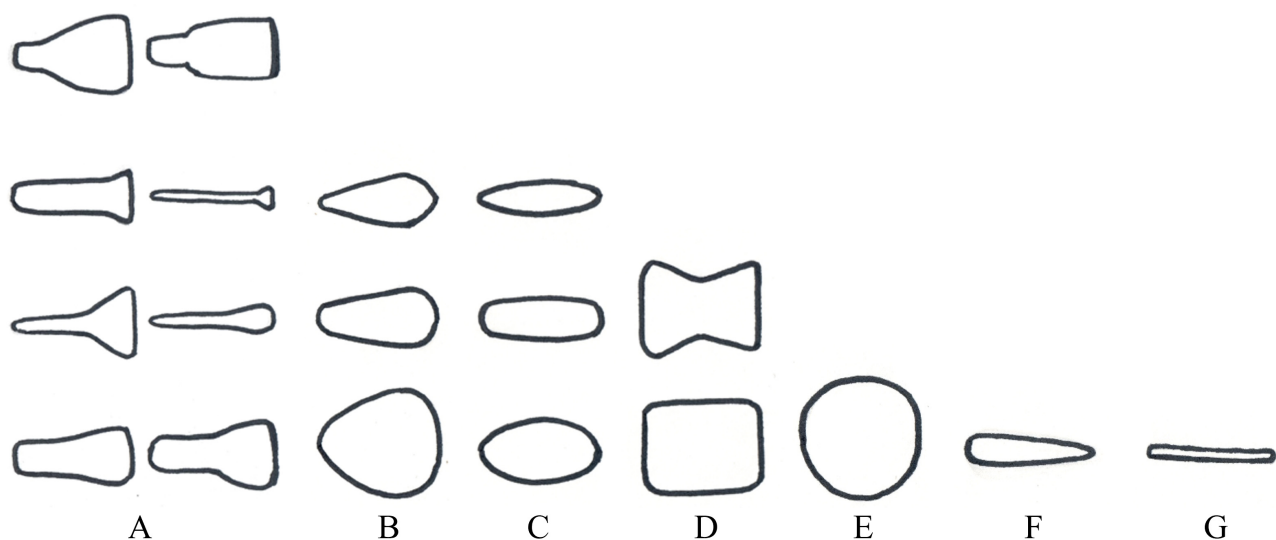


FIGURE 6. Shape of the caruncle dorsal lobe in dorsal view **A.** Clavate. **B.** Obovate. **C.** Elliptic. **D.** Sub-rectangular. **E.** Circular. **F.** Narrowly ovate. **G.** Linear. The dorsal lobe is said to be inconspicuous when not clearly visible in dorsal view. Drawings by Ana Coelho.

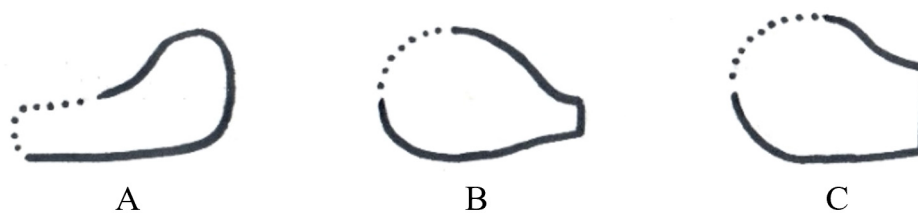


FIGURE 7. Shape of the caruncle ventral lobes in lateral view. **A.** Dolabriform towards apex. **B.** Globose but very narrow at apex. **C.** Globose and wide at apex. Dotted lines indicate the joint with the adjacent caruncle tissue. Less well-defined morphologies were also observed. Drawings by Ana Coelho.

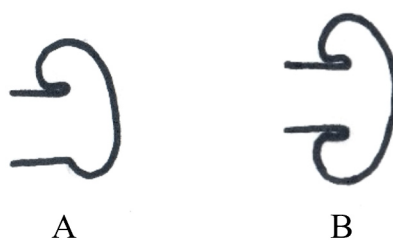


FIGURE 8. Shape of the caruncle ventral lobes apex in lateral view, including appendages: clearly auriculate **A.** on one side or **B.** on both. Drawings by Ana Coelho.

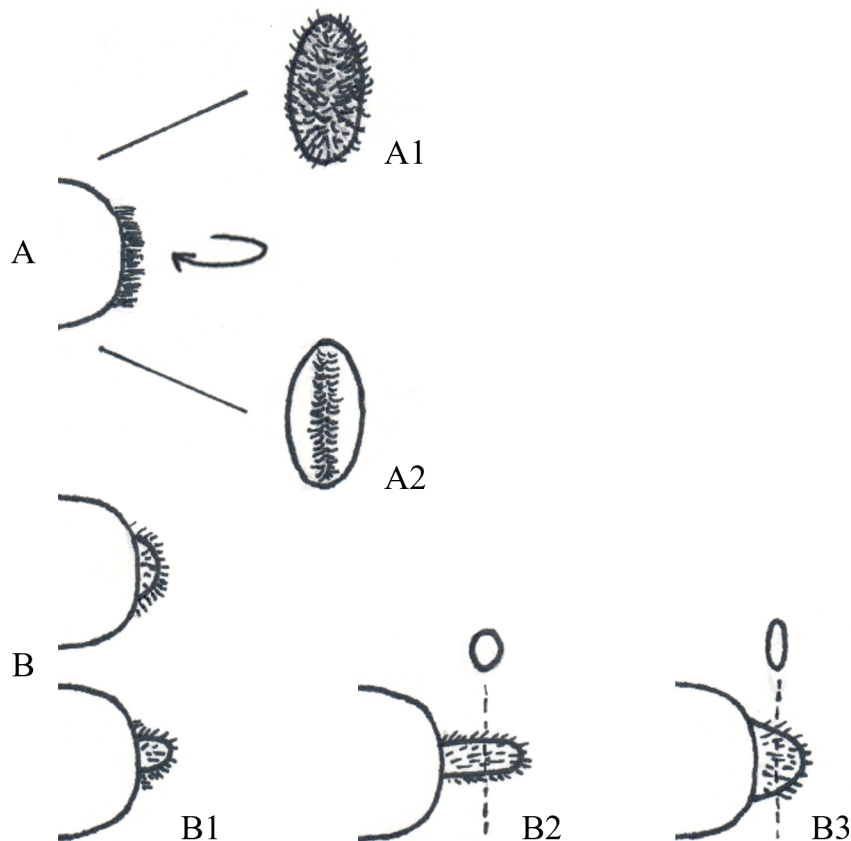


FIGURE 9. Chalazal region. **A.** With tuft of hairs; **A1.** Wide tuft; **A2.** Narrow tuft. **B.** With aril; **B1.** Aril short; **B2.** Aril long and $\pm$ terete; **B3.** Aril long and flattened. Drawings by Ana Coelho.

Results

Key to *Polygala* s.s. of Angola based exclusively on seed characters

Polygala poggei was excluded from the key due to the absence of seed material.

1. Seed body glabrous 1. *P. melilotoides*
- Seed body hairy 2
2. Hairs largely exceeding the distal extremity of the seed body 3
- Hairs not, scarcely or shortly exceeding the distal extremity of the seed body 8
3. Seeds laterally strongly compressed 2. *P. oliveriana*
- Seeds laterally slightly compressed 4
4. Chalazal region with a wide tuft of hairs (Fig. 9A1) 3. *P. albida* subsp. *albida*
- Chalazal region without tuft of hairs 5
5. Chalazal region with a long and $\pm$ terete hairy aril (Fig. 9B2) 4. *P. nambalensis*; 5. *P. britteniana*
- Chalazal region with a short hairy aril (Fig. 9B1) 6
6. Appendages of caruncle ventral lobes restricted to lobe apex (Fig. 4A), then caruncle funicular gap is $\pm$ circular (Fig. 5C); when appendages of caruncle ventral lobes are at lobe apex and decurrent plus joining (Fig. 4B2), then caruncle funicular gap is wider at base (Fig. 5B) 6. *P. usafuensis*
- Appendages of caruncle ventral lobes at lobe apex and decurrent plus joining; the caruncle funicular gap is $\pm$ circular 7
7. Seed body $3.0\text{--}3.4 \times 2.0\text{--}2.1$ mm in lateral view; caruncle smooth portion ca. $0.8 \times 1.2\text{--}1.4$ mm in lateral view 7. *P. macrostigma*
- Seed body $2.6\text{--}2.9 \times 1.6\text{--}1.7$ mm in lateral view; caruncle smooth portion $0.6\text{--}0.7 \times 1.0\text{--}1.1$ mm in lateral view 8. *P. mendoncae*
8. Caruncle very narrow in ventral view; seed body obtriangular in lateral view (Fig. 3A) 9. *P. pallida*
- Caruncle wide in ventral view; seed body not obtriangular in lateral view 9
9. Appendages of caruncle ventral lobes very large and inflated 10. *P. welwitschii* subsp. *welwitschii*

-	Appendages of caruncle ventral lobes inconspicuous or forming short or long rims, not inflated	10
10.	Appendages of ventral lobes restricted to lobe apex (Fig. 4A)	11
-	Appendages of ventral lobes at lobe apex and decurrent (Fig. 4B1), often joining (Fig. 4B2)	31
11.	Caruncle glabrous	11. <i>P. paludicola</i>
-	Caruncle hairy	12
12.	Seed body hairs scattered	13
-	Seed body hairs dense	19
13.	Seed body hairs straight	12. <i>P. ganguelensis</i>
-	Seed body hairs $\pm$ curving	14
14.	Appendages of caruncle ventral lobes forming long rims at lobe apex (i.e., length is equal to or longer than that of ventral lobes)	15
-	Appendages of caruncle ventral lobes forming short rims at lobe apex (i.e., length is shorter than that of ventral lobes)	16
15.	Seeds laterally strongly compressed	13. <i>P. angolensis</i>
-	Seeds laterally not compressed or slightly compressed	14. <i>P. myriantha</i>
16.	Apex of caruncle ventral lobes clearly auriculate (including the appendages) in lateral view (Fig. 8)	15. <i>P. dewevrei</i>
-	Apex of caruncle ventral lobes not auriculate (including the appendages) in lateral view	17
17.	Caruncle smooth portion 0.8–1.2 $\times$ 0.9–1.5 mm in lateral view; caruncle dorsal lobe obovate (Fig. 6B), occasionally elliptic (Fig. 6C) in dorsal view	16. <i>P. luenensis</i>
-	Caruncle smooth portion 0.3–0.5 $\times$ 0.6–0.8 mm in lateral view; caruncle dorsal lobe elliptic in dorsal view (Fig. 6C)	18
18.	Seed body 2.1–2.8 $\times$ 1.3–1.6 mm in lateral view; caruncle smooth portion ca. 0.5 $\times$ 0.6–0.8 mm in lateral view; caruncle funicular gap $\pm$ circular (Fig. 5C) to wider at base (Fig. 5B)	17. <i>P. antunesii</i>
-	Seed body 1.7–2.0 $\times$ 0.9–1.0 mm in lateral view; caruncle smooth portion ca. 0.3–0.4 $\times$ 0.6 mm in lateral view; caruncle funicular gap wider at base (Fig. 5B)	18. <i>P. rivularis</i>
19.	Appendages of caruncle ventral lobes forming long rims at lobe apex (i.e., length is equal to or longer than that of ventral lobes)	20
-	Appendages of caruncle ventral lobes inconspicuous or forming short rims at lobe apex (i.e., length is shorter than that of ventral lobes)	22
20.	Chalazal region with a wide tuft of hairs (Fig. 9A1); seed body ca. 2.5 $\times$ 1.9 mm in lateral view	19. <i>P. myrtillopsis</i>
-	Chalazal region without tuft of hairs; seed body 1.1–2.2 $\times$ 0.8–1.2 mm in lateral view	21
21.	Seed body ca. 1.1 $\times$ 0.8 mm in lateral view	11. <i>P. paludicola</i>
-	Seed body 2.0–2.2 $\times$ 1.1–1.2 mm in lateral view	20. <i>P. fragilis</i>
22.	Chalazal region with a narrow tuft of hairs (Fig. 9A2)	21. <i>P. schinziana</i>
-	Chalazal region without tuft of hairs	23
23.	Seeds laterally strongly compressed	22. <i>P. resendeana</i>
-	Seeds laterally not or slightly compressed	24
24.	Apex of caruncle ventral lobes clearly auriculate (including the appendages) in lateral view (Fig. 8)	23. <i>P. arenicola</i> ; 24. <i>P. baumii</i> ; 25. <i>P. gossweileri</i> ; 26. <i>P. huillensis</i> ; 27. <i>P. kalaxariensis</i> ; 28. <i>P. nematophylla</i> ; 29. <i>P. robusta</i>
-	Apex of caruncle ventral lobes not auriculate (including the appendages) in lateral view	25
25.	Seed body 1.5–2.1 $\times$ 0.8–1.2 mm in lateral view	26
-	Seed body 2.4–4.6 $\times$ 1.1–2.4 mm in lateral view	27
26.	Caruncle dorsal lobe obovate in dorsal view (Fig. 6B); caruncle smooth portion 0.2–0.3 $\times$ 0.4–0.5 mm in lateral view	30. <i>P. youngii</i>
-	Caruncle dorsal lobe clavate (Fig. 6A) or elliptic (Fig. 6C) in dorsal view; caruncle smooth portion 0.5–0.7 $\times$ 0.6–0.7 mm in lateral view	31. <i>P. petitiiana</i> subsp. <i>petitiiana</i>
27.	Caruncle ventral lobes dolabriform towards apex in lateral view (Fig. 7A)	32. <i>P. mossamedensis</i>
-	Caruncle ventral lobes not dolabriform towards apex in lateral view	28
28.	Caruncle ventral lobes globose but very narrow at apex in lateral view (Fig. 7B)	33. <i>P. acicularis</i>
-	Caruncle ventral lobes globose and wide at apex in lateral view (Fig. 7C)	29
29.	Caruncle funicular gap $\pm$ circular (Fig. 5C); seed body 2.7–3.1 $\times$ 1.3–1.6 mm in lateral view, 0.8–1.0 mm wide in dorsal/ventral view	34. <i>P. xanthina</i>
-	Caruncle funicular gap wider at base (Fig. 5B); seed body 3.2–4.6 $\times$ 1.7–2.4 mm in lateral view, 1.3–1.6 mm wide in dorsal/ventral view	30
30.	Chalazal region with a minute aril; hairs shortly exceeding the distal extremity of the seed body (clearly seen in dorsal/ventral views)	35. <i>P. stenopetala</i> subsp. <i>casuarina</i>
-	Chalazal region without aril; hairs scarcely exceeding the distal extremity of the seed body (clearly seen in dorsal/ventral views)	36. <i>P. laxifolia</i>
31.	Caruncle dorsal lobe longer than ventral lobes in lateral view	32
-	Caruncle dorsal and ventral lobes $\pm$ the same length in lateral view	34
32.	Chalazal region without aril; seed body 2.1–2.4 $\times$ 1.1–1.3 mm in lateral view; caruncle smooth portion 0.5–0.7 $\times$ 0.7–0.9 mm in lateral view	37. <i>P. krumanina</i>
-	Chalazal region with aril; seed body longer; caruncle smooth portion larger in lateral view	33
33.	Chalazal region with a long and flattened hairy aril (Fig. 9B3), occasionally short; seed body 3.2–3.6 $\times$ 1.3–1.6 mm in lateral view; caruncle smooth portion 1.3–1.4 $\times$ 1.1–1.4 mm in lateral view	38. <i>P. guerichiana</i>
-	Chalazal region with a short hairy aril (Fig. 9B1); seed body 2.9–3.1 $\times$ 1.1–1.4 mm in lateral view; caruncle smooth portion 1.3–1.6 $\times$ 0.9–1.0 mm in lateral view	39. <i>P. leptophylla</i> var. <i>leptophylla</i>
34.	Caruncle glabrous; caruncle dorsal lobe sub-rectangular in dorsal view (Fig. 6D)	40. <i>P. gomesiana</i>
-	Caruncle hairy; caruncle dorsal lobe not sub-rectangular in dorsal view	35

35.	Chalazal region with a wide tuft of hairs (Fig. 9A1)	36
-	Chalazal region without tuft of hairs	39
36.	Caruncle funicular gap $\pm$ circular (Fig. 5C)	41. <i>P. albida</i> subsp. <i>stanleyana</i>
-	Caruncle funicular gap narrow (Fig. 5A) or wider at base (Fig. 5B)	37
37.	Seed body subobtriangular with hairs spreading towards apex; appendages of caruncle ventral lobes forming short rims	42. <i>P. erioptera</i>
-	Seed body not subobtriangular with hairs not spreading towards apex; appendages of caruncle ventral lobes forming long rims, occasionally short	38
38.	Seed body $1.6\text{--}1.9 \times 0.9\text{--}1.0$ mm in lateral view; caruncle funicular gap narrow (Fig. 5A); appendages of caruncle ventral lobes forming long rims	43. <i>P. arenaria</i>
-	Seed body $2.1\text{--}2.5 \times 1.3\text{--}1.7$ mm in lateral view; caruncle funicular gap wider at base (Fig. 5B); appendages of caruncle ventral lobes occasionally short	44. <i>P. sphenoptera</i>
39.	Seed body $2.2\text{--}2.4 \times 1.0\text{--}1.1$ mm in lateral view, ca. 0.7 mm wide in dorsal/ventral view	37. <i>P. krumanina</i>
-	Seed body smaller in lateral view, 0.4–0.7 mm wide in dorsal/ventral view	40
40.	Caruncle dorsal lobe inconspicuous or narrowly ovate (Fig. 6F) in dorsal view; caruncle smooth portion $0.2\text{--}0.3 \times 0.1\text{--}0.4$ mm in lateral view; seed body $0.9\text{--}1.4 \times 0.4\text{--}0.6$ mm in lateral view, ca. 0.4 mm wide in dorsal/ventral view	14. <i>P. myriantha</i>
-	Caruncle dorsal lobe clavate in dorsal view (Fig. 6A); caruncle smooth portion $0.4\text{--}0.5 \times 0.4\text{--}0.5$ mm in lateral view; seed body $1.3\text{--}1.7 \times 0.7\text{--}0.9$ mm in lateral view, 0.6–0.7 mm wide in dorsal/ventral view	45. <i>P. welwitschii</i> subsp. <i>pygmaea</i>

Taxonomy and seed accounts

The synonyms given are the most commonly used in Angola. The first sentence of each description outlines the general morphology of the seed. Each taxon is described and illustrated with selected microphotographs of a single seed from lateral, dorsal, and ventral views (Figs 10–54). Extra microphotographs illustrate the cases of greater seed morphological variation. See Figs 2–9 for clarification of specific morphological terms.

1. *P. melilotoides* Chodat in Bot. Jahrb. Syst. 48(1–2): 320 (1912)—Fig. 10.

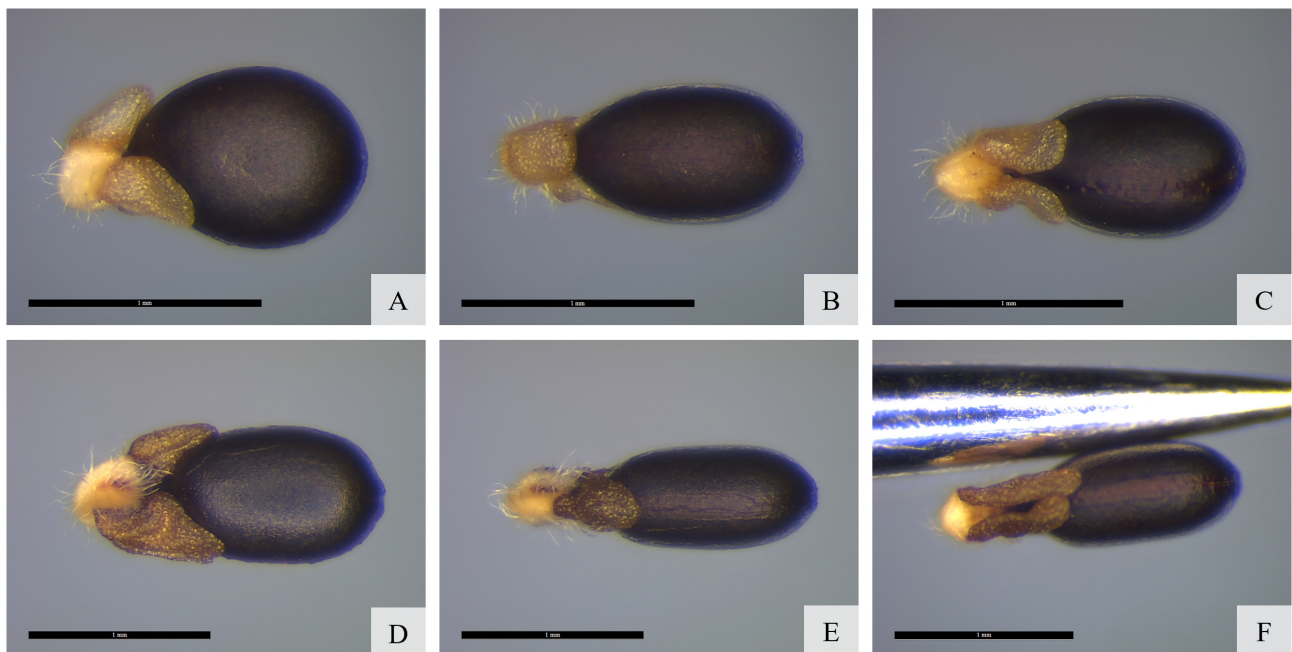


FIGURE 10. Seeds of *P. melilotoides* have variable morphology. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. **A–C:** *Exell & Mendonça* 310—COI00100969; **D–F:** *Exell & Mendonça* 556—BM001173011. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic or subcircular in lateral view, body glabrous, caruncle 3-lobed. *Seed body* $0.9\text{--}1.2 \times 0.7\text{--}0.8$ mm in lateral view, $0.5\text{--}0.6$ mm wide in dorsal/ventral view. *Caruncle* hairy, wide in ventral view; smooth portion $0.2\text{--}0.4 \times 0.2\text{--}0.3$ mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe elliptic in dorsal view, apparently inconspicuous when its appendage conceals it (Fig. 10B); appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes very large and inflated and restricted to lobe apex, or also decurrent; funicular gap narrow or $\pm$ circular.

Distribution:—Angola: Lunda Norte, Lunda Sul, Malanje. Tropical Africa, south of the Equator and north of the Tropic of Capricorn.

Habitat & ecology:—Grassland, savannah, and open woodland; ruderal; loose sandy soil; 800–2000 m.

Phenology:—Fruiting: Apr.

Comments:—In the protologue: “*Seminibus ovoideis lucidis nudis; carunculae lobo dorsali horizontaliter patente inflato aliis lateralibus majore vel etiam minore.*”

This is the only Angolan taxon here observed with a glabrous seed body; this feature is maintained in the *Flora Zambesiaca* area (Exell 1960). However, material from Zambia is hairy (Paiva 1998, Lám. 34h). It is also one of the two Angolan taxa with very large and inflated caruncle appendages (see *P. welwitschii* Chodat subsp. *welwitschii*). It is possible that this character state is also present in *P. arenaria* Willd. and *P. welwitschii* subsp. *pygmaea* (Gürke) Paiva, but more material would be needed to assess the occurrence of such character.

Specimens used for seed analysis:—ANGOLA. Lunda Sul: margens do rio Erva, 1075 m, 5 April 1937, *Exell & Mendonça 310* (COI00100969); Lunda [Sul]: Vila Henrique de Carvalho [Saurimo], ca. 1400 m, 14 April 1937, *Exell & Mendonça 556* (BM001173011); Lunda Sul: Dala, ca. 1250 m, 27 April 1937, *Exell & Mendonça 1240* (COI00103150).

2. *P. oliveriana* [published as ‘*oliverana*’] Exell & Mendonça in Consp. Fl. Angol. 1: 100 (1937)—Fig. 11.

= *Polygala sparsiflora* var. *β* Oliv., Fl. Trop. Afr. [Oliver *et al.*] 1: 128 (1868)



FIGURE 11. Seed of *P. oliveriana*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Welwitsch 1018*—LISU. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally strongly compressed, elliptic in lateral view, body hairy, chalazal region with a short hairy aril, caruncle 3-lobed. *Seed body* 1.8–2.0 × 1.1–1.2 mm in lateral view, 0.6–0.7 mm wide in dorsal/ventral view; hairs straight or ± curving, dense, largely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.5–0.6 × 0.7–0.8 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate in dorsal view; ventral lobes dolabriform towards apex in lateral view; appendages of ventral and dorsal lobes similar in length to appendages of ventral lobes longer; appendages of ventral lobes form short to long rims and are restricted to lobe apex; funicular gap ± circular.

Distribution:—Angolan endemic: Malanje.

Habitat & ecology:—Wet grassland.

Phenology:—Fruiting: Mar.

Comments:—Some seeds examined are broken.

Specimen used for seed analysis:—ANGOLA. [Malanje]: Pungo Andongo, near river Cuanza between Condo and Quisonde, March 1857, *Welwitsch 1018* (LISU, type of *P. oliveriana*).

3. *P. albida* Schinz in Verh. Bot. Vereins Prov. Brandenburg 29(2): 53 (1888) **subsp. albida**—Fig. 12.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a wide tuft of hairs, caruncle 3-lobed. *Seed body* 1.7–2.3 × 1.2–1.5 mm in lateral view, 0.8–1.0 mm wide in dorsal/ventral view; hairs straight, dense, largely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.4–0.6 × 0.7–0.9 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral and dorsal lobes similar in length to appendages of ventral lobes longer; appendages of ventral lobes form short to long rims and are at lobe apex and decurrent, often joining; funicular gap ± circular, occasionally narrow.



FIGURE 12. Seed of *P. albida* subsp. *albida*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Exell & Mendonça 1921*—COI00103133. Scale bar = 1 mm. Photography by Ana Coelho.

Distribution:—Angola: Benguela, Bié, Huambo, Huíla, Kwanza Norte. Sub-Saharan Africa to Natal.

Habitat & ecology:—Woodland; cultivated ground and roadside; 900–1800 m.

Phenology:—Fruiting: Jan–Jun, Aug.

Comments:—In the protologue: “*Samen 1–1,5 mm lang und mit seidenartigen Haaren bedeckt, die den basalen Teil schopfartig verhüllen.*”

The type of *Polygala livingstoniana* Chodat collected by Pogge in Massumba must refer to the locality in the Democratic Republic of the Congo (see map of Pogge travels in Figueiredo *et al.* 2020). Therefore, the specimen is not cited here under synonymy.

Specimens used for seed analysis:—ANGOLA. Benguela: entre Cuima e Caconda, 14 May 1937, *Exell & Mendonça 1921* (COI00103133); Benguela: entre Cuima e Caconda, 2 June 1937, *Exell & Mendonça 2468* (BM); [Huambo] (Benguela on label): Nova Lisboa [Huambo], 17 May 1937, *Carrisso & Sousa 72* (COI00103134); Huambo: Huambo, 1700 m, 12 August 1963, *Silva 2586* (COI00103132).

4. *P. nambalensis* Gürke in Kunene-Sambesi-Exped. [Warburg]: 276 (1903)—Fig. 13.

= *Polygala guerkei* Chodat in Bot. Jahrb. Syst. 48 (1–2): 318 (1912)

= *Polygala phyllostigma* (Chodat) Exell & Mendonça in Consp. Fl. Angol. 1: 98 (1937)

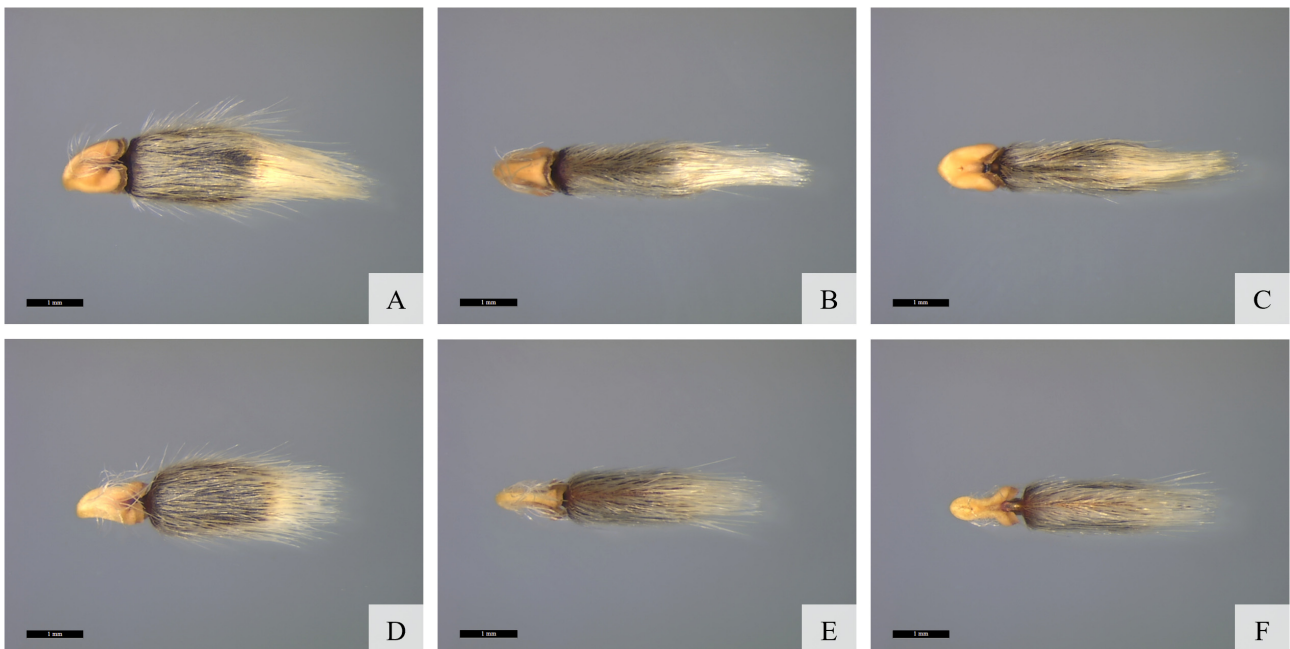


FIGURE 13. Seeds of *P. nambalensis* have variable morphology with a wide or very narrow caruncle. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. A–C: *Exell & Mendonça 814*—COI00103154; D–F: *Gossweiler 11600*—COI00067245. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a long and $\pm$ terete hairy aril, caruncle 3-lobed. *Seed body* 2.1–2.7 $\times$ 1.1–1.4 mm in lateral view, 0.9–1.1 mm wide in dorsal/ventral view; hairs straight, dense, largely exceeding the distal extremity of the seed body. *Caruncle* hairy, very narrow or wide in ventral view; smooth portion 1.0–1.2 $\times$ 0.7–1.0 mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe clavate in dorsal view; ventral lobes dolabriform towards apex in lateral view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap $\pm$ circular or wider at base.

Distribution:—Angola: Benguela, Bié, Cunene, Huíla, Kuando Kubango, Lunda Sul. Topical Africa.

Habitat & ecology:—Open and xerophyte woodland and grassland, sometimes wet; 1000–2200 m.

Phenology:—Fruiting: Feb, Apr, Sep–Oct.

Specimens used for seed analysis:—ANGOLA. Kuando Kubango: Serpa Pinto [Menongue], Caiundo, Chana Cubati (Tandané), andados 30 km para nordeste do Salonga, 23 September 1971, *Santos & Barroso* 2958 (LUAI); Lunda [Sul]: entre Muriege e Nova Chaves, 1050 m, 20 April 1937, *Exell & Mendonça* 814 (COI00103154); Lunda [Sul]: Henrique de Carvalho (Saurimo), proximum flumen Chicapa, 1015 m, April 1937, *Gossweiler* 11600 (COI00067245).

5. *P. britteniana* Chodat in J. Bot. 34: 198 (1896)—Fig. 14.

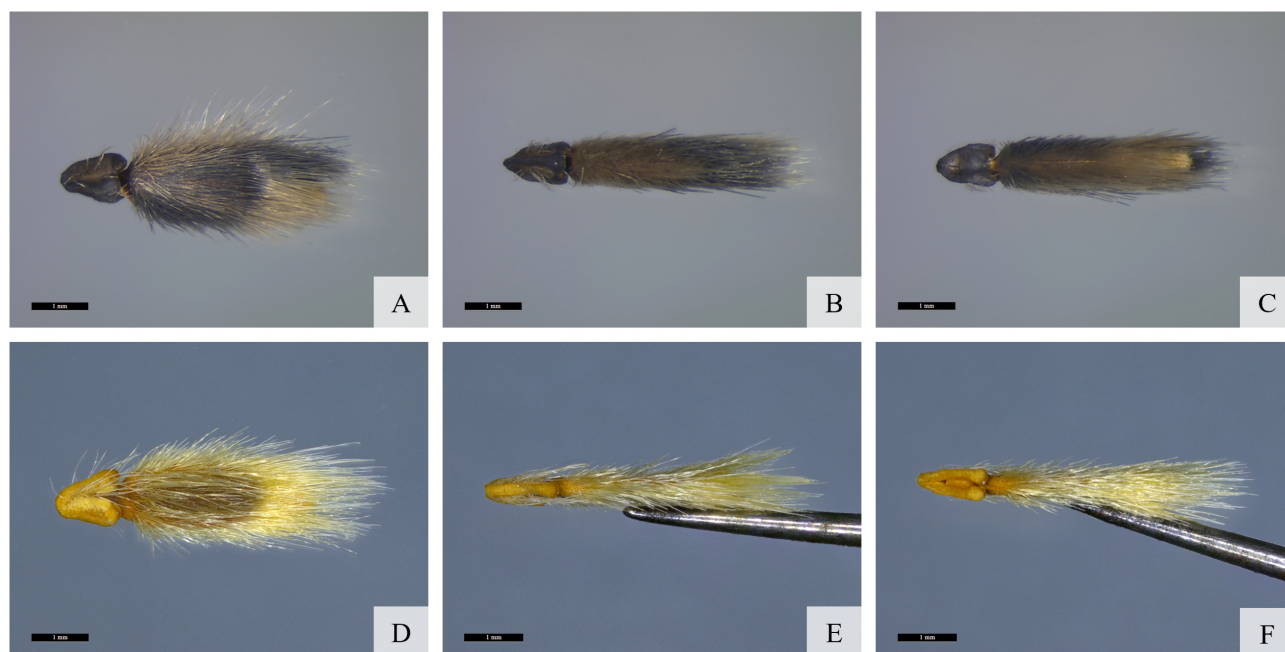


FIGURE 14. Seed of *P. britteniana*. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. **A–C,** mature seed blackened: *Scott–Elliot* 8256—K000231697; **D–F,** immature seed normally coloured: *Greenway & Brenan* 8237—BM. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a long and $\pm$ terete hairy aril, caruncle 3-lobed. *Seed body* ca. 2.5–2.6 $\times$ 1.3 mm in lateral view, ca. 0.8 mm wide in dorsal/ventral view; hairs straight, dense, largely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. 1.0–1.1 $\times$ 0.9 mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe clavate in dorsal view; ventral lobes dolabriform towards apex in lateral view; appendages of ventral and dorsal lobes inconspicuous or similar in length, then those of ventral lobes form short rims and are restricted to lobe apex; funicular gap wider at base.

Distribution:—Angola: Huambo. Tropical Africa: Zambia.

Habitat & ecology:—Savannah and open woodland, with possibility of fire; 700–1750 m.

Phenology:—Flowering: Sep (COI00111702, COI00111703).

Comments:—In the protologue: “*Semina oblonga, pilis adpressis sericea; caruncula in semine haud equitans sed eo superposita leviter triloba et obtuse conica, glabra.*”

The seeds of the type material are almost black. This should not be the result of burning and the hairs are in good condition. The mounting sheet of the specimen has some almost black deposits that can be related to the darkening of

the seeds. Immature material was added to the illustrations to clarify the true nature of the colour of the seed surface, but this material was not used for extracting other characters. Exell (1960) mentioned “one doubtful record from Angola” and Paiva (2008) does not list the species for Angola. However, the following Angolan specimens were observed here: Huambo: Cuma, 1750 m, 196[?], *Daman* 2245 (COI00111701); Huambo: Chianga, 11 September 1964, *Silva* 992 (COI00111702); Huambo: Subúrbios de Nova Lisboa [Huambo], próximo da Chiva, junto do r[io] Caluapanda, 19 September 1970, *Moreno* 243 (COI00111703); they do not have seed material, therefore, were not used in this study.

Specimens used for seed analysis:—ZAMBIA. Stevenson Road, 4–5000 ft, November 1893, *Scott-Elliot* 8256 (K000231697, type of *P. britteniana*); [Northern Province]: 5 miles S. of Abercorn [Mbala], on Kasama Road, 19 October 1947, *Greenway & Brenan* 8237 (BM).

6. *P. usafuensis* Gürke in. Bot. Jahrb. Syst. 30: 337 (1901)—Fig. 15.

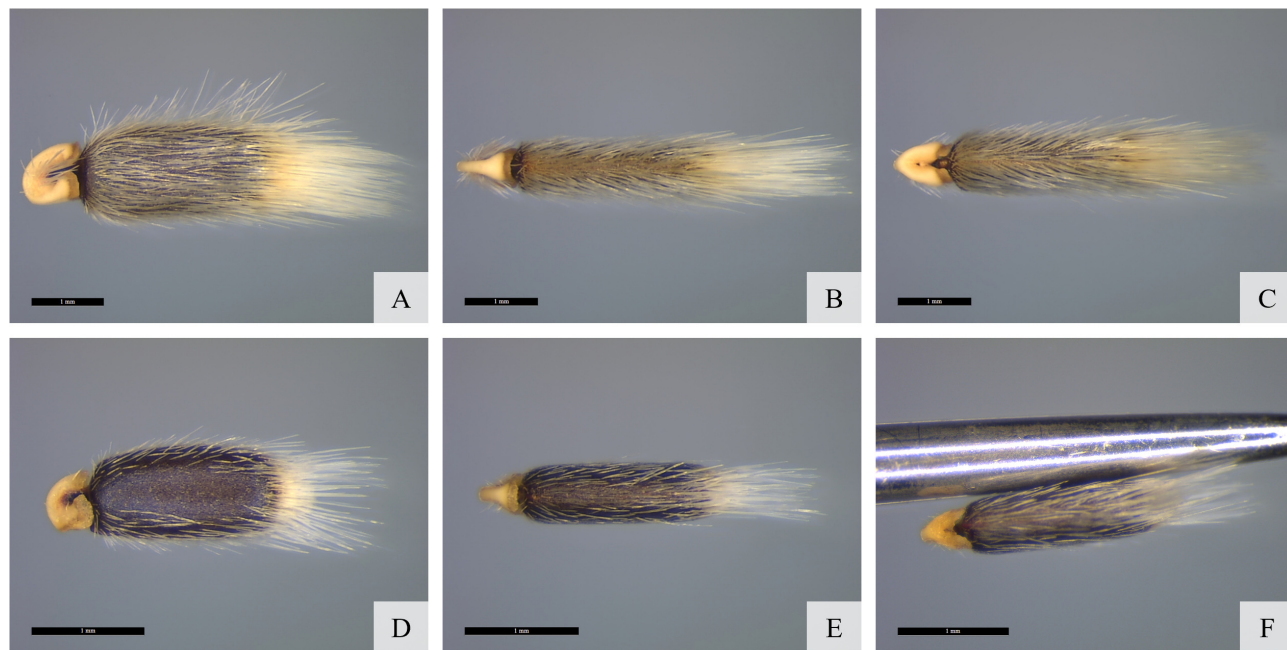


FIGURE 15. Seeds of *P. usafuensis* have variable morphology. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. **A–C:** *Henriques* 63–LUAI; **D–F:** *Exell & Mendonça* 1724—COI00103205. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a short hairy aril, caruncle 3-lobed. *Seed body* 1.7–2.8 × 0.8–1.3 mm in lateral view, 0.5–0.9 mm wide in dorsal/ventral view; hairs straight, scattered to dense, largely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.3–0.7 × 0.5–0.9 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate in dorsal view; ventral lobes dolabriform towards apex, or not, in lateral view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex, or also decurrent plus joining; funicular gap ± circular or wider at base.

Distribution:—Angola: Benguela, Bié, Huambo, Huíla, Lunda Sul. Tropical Africa: Central African Republic to Mozambique.

Habitat & ecology:—Savannah and open woodland, with possibility of fire; 700–1750 m.

Phenology:—Fruiting: Mar, May–Jun, Aug.

Comments:—In the protologue: “...seminibus oblongis, adpresse-hirsutis; arillo trilobo, semine superposita, exappendiculato.”

Specimens used for seed analysis:—ANGOLA. Benguela: Ganda, Estação Zootécnica, ca. 1750 m, 30 March 1962, *Teixeira & Andrade* 7295 (LUA); Bié: entre Coimba e o rio Cuanza, 1300 m, 7 May 1937, *Exell & Mendonça* 1724 (COI00103205); Huambo: Chianga, 1700 m, 12 August 1968, *Silva* 2587 (COI00103208); Huíla: Sá da Bandeira [Lubango], Tchivinguiro, 1 June 1962, *Henriques* 63 (LUAI).

7. *P. macrostigma* Chodat in Bot. Jahrb. Syst. 48(1–2): 319 (1912)—Fig. 16.

= *Polygala splendens* Exell in J. Bot. 64 (Suppl. 1): 22 (1926)



FIGURE 16. Seed of *P. macrostigma*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Lopes, Silva & Murta 3696*—COI00103149. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a short hairy aril, caruncle 3-lobed. *Seed body* 3.0–3.4 × 2.0–2.1 mm in lateral view, 1.0–1.3 mm wide in dorsal/ventral view; hairs straight, dense, largely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. 0.8 × 1.2–1.4 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are at lobe apex, also decurrent plus joining; funicular gap ± circular.

Distribution:—Angola: Benguela, Kwanza Norte, Kwanza Sul, Malanje, Uíge. Tropical Africa.

Habitat & ecology:—Savannah, open woodland, and wetland; 600–2500 m.

Phenology:—Fruiting: Mar, Jun–Jul, Sep.

Comments:—In the protologue: “... *seminibus (haud maturis) oblongis, arillo trilobo superposito.*”

Seeds very similar to those of *P. mendoncae* E.M.A.Petit but larger.

Specimens used for seed analysis:—ANGOLA. Kwanza Sul: Calulo, 990 m, 3 June 1968, *Forst 126* (LUA); Malanje: arredores de Malanje, ca. 40 km para B[rito] Godins, Gangassol, N’gola, 6 July 1971, *Lopes, Silva & Murta 3696* (COI00103148, COI00103149).

8. *P. mendoncae* E.M.A.Petit in Bull. Jard. Bot. État Bruxelles 26: 259 (1956)—Fig. 17.



FIGURE 17. Seed of *P. mendoncae*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Exell & Mendonça 1458*—COI00005656. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a short hairy aril, caruncle 3-lobed. *Seed body* 2.6–2.9 × 1.6–1.7 mm in lateral view, 1.0–1.2 mm wide in dorsal/ventral view; hairs straight, dense, largely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.6–0.7 × 1.0–1.1 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are at lobe apex, also decurrent plus joining; funicular gap ± circular.

Distribution:—Angola: Lunda Sul, Moxico. Tropical Africa: Democratic Republic of the Congo, Zambia.

Habitat & ecology:—Deciduous woodland; 1000–1500 m.

Phenology:—Fruiting: Apr.

Comments:—In the protologue: “*Semina cylindrica, 3–3,75 mm longa, pilosa, basi pilis ± 1,5 mm longis obtecta, apice arillo trilobato et ± 1 mm longo ornata.*”

Seeds very similar to those of *P. macrostigma* but smaller.

Specimens used for seed analysis:—ANGOLA. Lunda [Sul]: Dala, 29 April 1937, *Exell & Mendonça 1458* (COI00005656, type of *P. mendoncae*); Lunda [Sul]: Xassengue, near river Cuango, 1000 m, April 1937, *Gossweiler 11781* (BM, type of *P. mendoncae*).

9. *P. pallida* E.Mey. ex Harv. in Fl. Cap. (Harvey) 1: 93 (1860)—Fig. 18.

= *Polygala pearsonii* Exell in J. Bot. 65: 343 (1927)



FIGURE 18. Seed of *P. pallida*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. The unique obtriangular shape of the seed implied an equilibrium position in dorsal and ventral views that shows the caruncle at an unusual angle. A–C: *Correia 365*—LUAI. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally strongly compressed, obtriangular in lateral view, body hairy, chalazal region with a minute aril, caruncle 3-lobed very small. *Seed body* 1.4–1.6 × 0.8–1.0 mm in lateral view, 0.4–0.5 mm wide in dorsal/ventral view; hairs straight, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, very narrow in ventral view; smooth portion 0.3–0.4 × 0.3–0.4 mm in lateral view; dorsal lobe longer than ventral lobes in lateral view, linear in dorsal view; appendage of dorsal lobe inconspicuous; appendages of ventral lobes form short rims and are at lobe apex, also decurrent plus joining; funicular gap ± circular.

Distribution:—Angola: Namibe. Southwest Africa: Botswana, Namibia, South Africa (Northwest Cape).

Habitat & ecology:—Desert sandy plain.

Phenology:—Fruiting: Apr, Jun.

Comments:—This is the only Angolan taxon with obtriangular seed body in lateral view; also with the narrowest caruncle in dorsal/ventral views.

Specimens used for seed analysis:—ANGOLA. [Namibe]: Mossamedes [Namibe], River Curoca, 23 April 1909, *Pearson 2200* (K000231676, type of *P. pearsonii*); [Namibe]: Moçamedes [Namibe]: entre a estrada para P. Alexandre [Tômbua] e o mar, a 5 km de Moçamedes [Namibe] sul, 5 June 1959, *Correia 365* (COI00103155, LUAI).

10. *P. welwitschii* Chodat in Mém. Soc. Phys. Genève 31(2): 341, tab. XXVII, fig. 40b [proximal extremity of seed] (1893) **subsp. welwitschii**—Fig. 19.

= *Polygala arenaria* var. *andongensis* Oliv., Fl. Trop. Afr. [Oliver *et al.*] 1: 128 (1868)

Seeds laterally slightly compressed, elliptic or subcircular in lateral view, body hairy, chalazal region with a minute aril, occasionally without, caruncle 3-lobed. *Seed body* 1.1–1.5 × 0.7–1.1 mm in lateral view, 0.6–0.8 mm wide in dorsal/ventral view; hairs straight or ± curving, dense, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.1–0.4 × 0.3–0.5 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view, sometimes minute; dorsal lobe inconspicuous or clavate in dorsal view; appendages of ventral and dorsal lobes similar in length to appendages of ventral lobes longer; appendages of ventral lobes very large and inflated and restricted to lobe apex, or also decurrent; funicular gap narrow.

Distribution:—Angolan endemic: Kwanza Norte, Kwanza Sul, Lunda Sul, Malanje.

Habitat & ecology:—Grassland; 700–1200 m.

Phenology:—Fruiting: Mar–May.

Comments:—In the protologue: “*Semina ovoidea pilis sericeis adpressis vestita sed basi haud longiore pilosa, 1,8 mm. longa...*”.

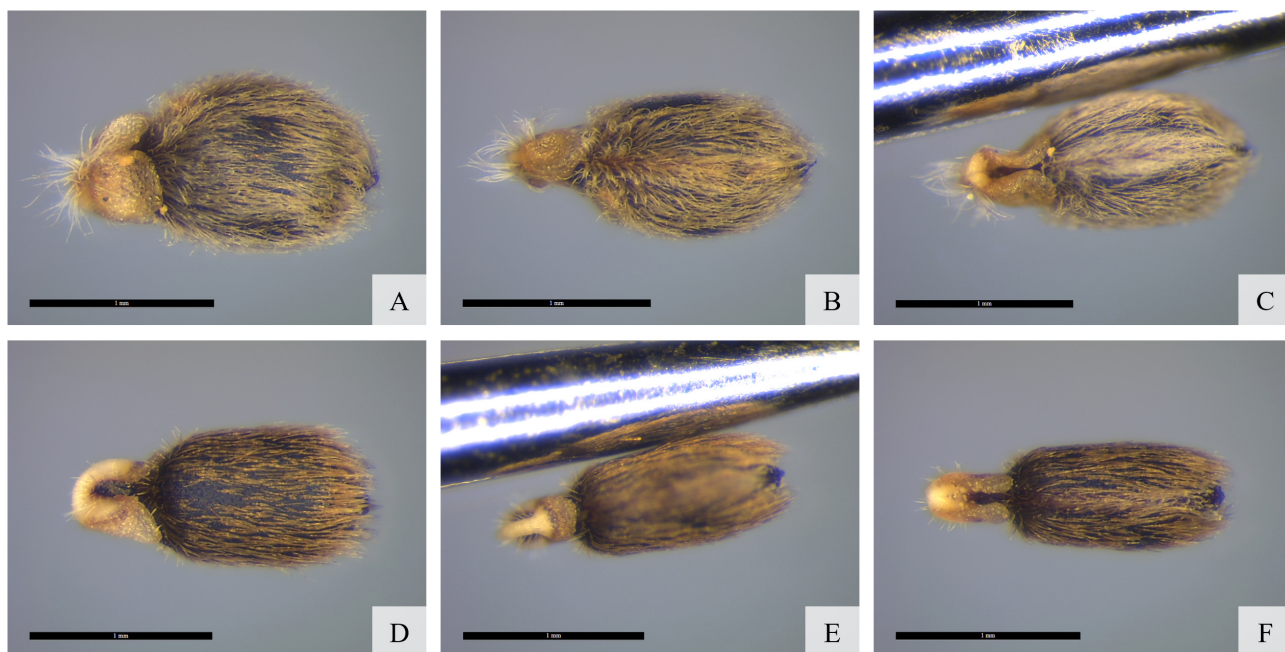


FIGURE 19. Seeds of *P. welwitschii* subsp. *welwitschii* have variable morphology. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. A–C: *Welwitsch 1013*—BM001173009; D–F: *Exell & Mendonça 105*—COI00103172. Scale bar = 1 mm. Photography by Ana Coelho.

This is one of the two Angolan taxa with very large and inflated caruncle appendages (see *P. melilotoides*). It is possible that this character state is also present in *P. arenaria* and *P. welwitschii* subsp. *pygmaea*, but more material would be needed to assess the occurrence of such character.

Specimens used for seed analysis:—ANGOLA. [Kwanza Norte]: Pungo Andongo, 2400–3800 ft, March 1854, *Welwitsch 1013* (BM001173009); Kwanza Norte: Pungo Andongo, 1150 m, 31 March 1937, *Exell & Mendonça 203* (COI00103171); [Kwanza Sul]: Quimbala, Banza-Catumbi, 28 March 1937, *Barbosa & Correia 8863* (LUAI); Malanje: Rio Lucala, Cataratas Duque de Bragança, 1100 m, 28 March 1937, *Exell & Mendonça 105* (COI00103172).

11. *P. paludicola* Gürke in Kunene-Sambesi-Exped. [Warburg]: 279 (1903)—Fig. 20.

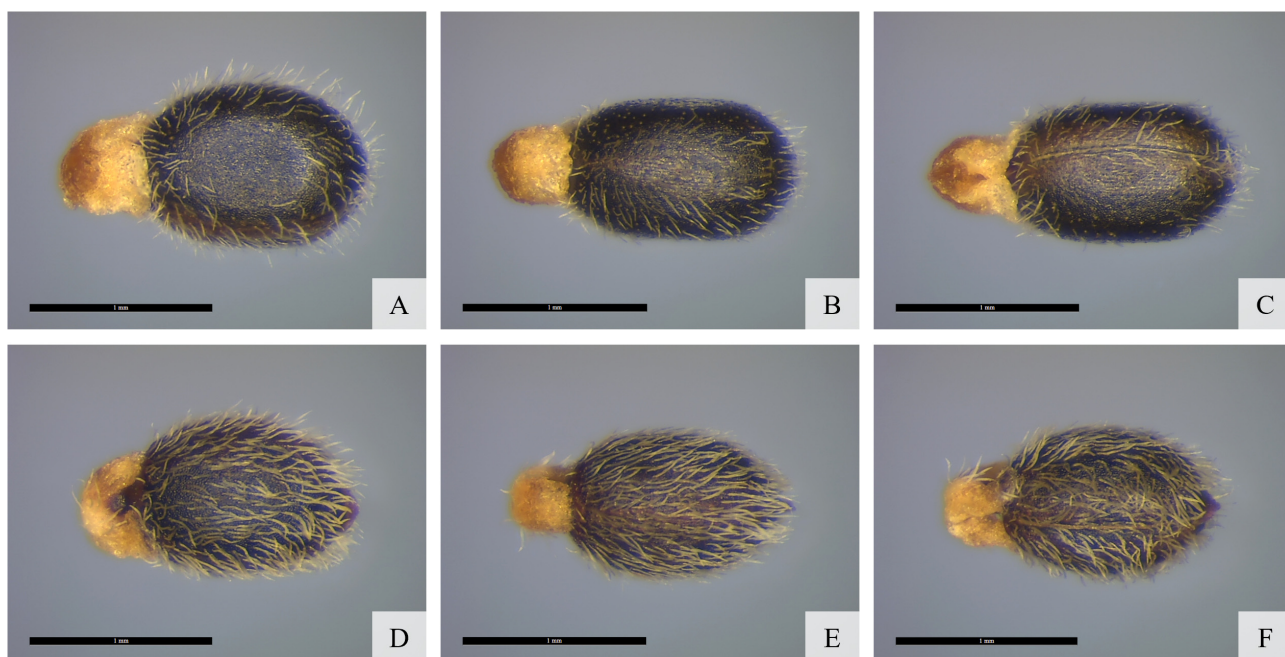


FIGURE 20. Seeds of *P. paludicola* have variable morphology. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. A–C: *Silva 1962*—COI00103156; D–F: *Gossweiler 2783 p.p.*—BM001173012. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally not to slightly compressed, elliptic or subcircular in lateral view, body hairy, chalazal region with or without a minute aril, caruncle 3-lobed. *Seed body* 1.0–1.3 × 0.8–0.9 mm in lateral view, 0.6–0.8 mm wide in dorsal/ventral view; hairs ± curving, scattered to dense, scarcely exceeding the distal extremity of the seed body. *Caruncle* glabrous or hairy, wide in ventral view; smooth portion 0.1–0.3 × 0.2–0.4 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view, sometimes minute; dorsal lobe inconspicuous or obovate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form long rims and are restricted to lobe apex; funicular gap minute or wider at base.

Distribution:—Angola: Benguela, Bié, Huambo, Huíla, Kuando Kubango, Lunda Sul, Moxico. Tropical Africa: Democratic Republic of the Congo, Zambia.

Habitat & ecology:—Wet grassland; 1000–1800 m.

Phenology:—Fruiting: Feb–Mar, Aug.

Comments:—In the protologue: “... *semine ovoideo, pilis adpressis sericeo; arillo tripartito.*”

Specimens used for seed analysis:—ANGOLA. Huambo: N. Lisboa [Huambo], Chianga, 1750 m, 14 February 1967, *Silva* 1962 (COI00103156); Huambo: arredores de Nova Lisboa [Huambo], Chiva, 19 March 1971, *Silva* 3495 (BM); [Kuando Kubango]: skirting the river Campulua affluent of Cuito, 20 February 1906, *Gossweiler* 2783 p.p. (BM001173012).

12. *P. ganguelensis* Exell & Mendonça in Consp. Fl. Angol. 1: 100 (1937)—Fig. 21.



FIGURE 21. Seed of *P. ganguelensis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Mendes* 2103—LISC098057. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a minute aril, caruncle 3-lobed. *Seed body* 1.6–1.7 × 1.0–1.1 mm in lateral view, 0.6–0.7 mm wide in dorsal/ventral view; hairs straight, scattered, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.2–0.4 × 0.5–0.6 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short to long rims and are restricted to lobe apex; funicular gap ± circular.

Distribution:—Angola: Benguela, Bié, Huíla, Kuando Kubango, Moxico. Tropical Africa: Cameroon, Democratic Republic of the Congo, Gabon, Zambia.

Habitat & ecology:—Wet grassland; 1000–1500 m.

Phenology:—Fruiting: Jan–May.

Specimens used for seed analysis:—ANGOLA. Huíla: Ganguelas, Vila Artur de Paiva [Cuvango], margens do Cubango, 1450 m, 14 January 1960, *Mendes* 2103 (LISC098057); [Kuando Kubango]: nas margens pantanosas do rio Cuchi, perto do sobado Mucure–Ganguela, May 1906, *Gossweiler* 3150 (BM000564821, type of *P. ganguelensis*).

13. *P. angolensis* Chodat in Bot. Jahrb. Syst. 48(1–2): 318 (1912)—Fig. 22.

= *Polygala ficalhoana* Exell & Mendonça in Consp. Fl. Angol. 1: 99 (1937)

Seed laterally strongly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* ca. 1.7 × 1.1 mm in lateral view, ca. 0.6 mm wide in dorsal/ventral view; hairs ± curving, scattered, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. 0.3 × 0.5 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe obovate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form long rims and are restricted to lobe apex; funicular gap wider at base.



FIGURE 22. Seed of *P. angolensis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Dekindt 255*—BM. Scale bar = 1 mm. Photography by Ana Coelho.

Distribution:—Angolan endemic: Bié, Huíla.

Habitat & ecology:—Wet meadow; 1700–1850 m.

Phenology:—Fruiting: Aug, Oct–Nov.

Comments:—In the protologue: “... *seminibus ovoideo-cylindricis hirsutulicis haud sericeis haud basi comosis, arillo breviter appendiculato, in semine breviter equitante.*”

Specimen used for seed analysis:—ANGOLA. Huíla: Lopolo, 1850 m, 26 August 1902, *Dekindt 255* (LISC, type of *P. angolensis*).

14. *P. myriantha* Chodat in Bot. Jahrb. Syst. 48(1–2): 321 (1912)—Fig. 23.

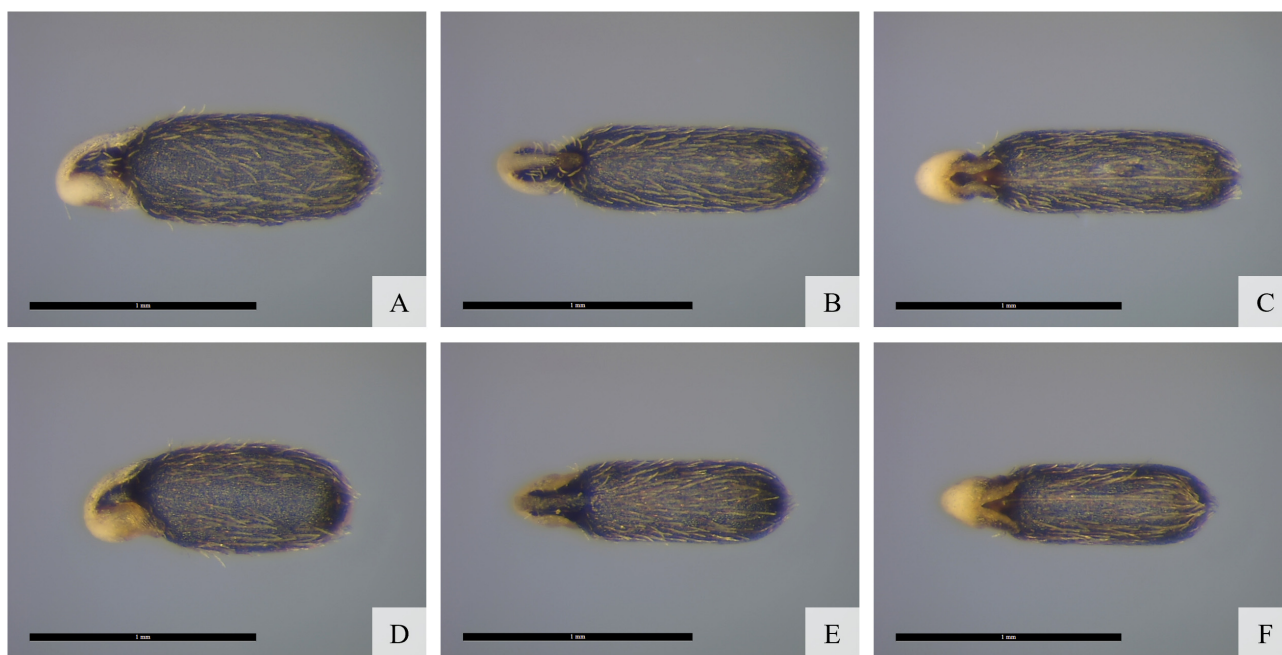


FIGURE 23. Seeds of *P. myriantha* have variable morphology. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. A–C: *Monteiro & Murta 1854*—COI00103153; D–F: *Nolde 730*—BM. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally not to slightly compressed, elliptic in lateral view, body hairy, chalazal region with a minute aril, caruncle 3-lobed. *Seed body* 0.9–1.4 × 0.4–0.6 mm in lateral view, ca. 0.4 mm wide in dorsal/ventral view; hairs ± curving, scattered, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.2–0.3 × 0.1–0.4 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe inconspicuous or narrowly ovate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form long rims and are restricted to lobe apex, or also decurrent plus joining; funicular gap narrow or wider at base.

Distribution:—Angola: Benguela, Bié, Kuando Kubango, Lunda Sul, Malanje. Tropical Africa.

Habitat & ecology:—Savannah and open woodland.

Phenology:—Fruiting: Jan–May.

Comments:—In the protologue: “... *semine oblongo pilis sparsis piloso; arillo trilobo vix equitante semine 4 × brevior.*”

Specimens used for seed analysis:—ANGOLA. Bié: 15 May 1966, *Monteiro & Murta 1854* (COI00103153); Huila: Perto de Dongo, Cubangue, Ganguela, 25 April 1906, *Gossweiler 3114* (COI00005953); Malanje: Quela, April 1938, *Nolde 730* (BM).

15. *P. dewevrei* Exell in J. Bot. 70: 186 (1932)—Fig. 24.



FIGURE 24. Seed of *P. dewevrei*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Monteiro & Murta 1777*—COI00103216. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed or occasionally strongly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 1.8–2.2 × 1.1–1.3 mm in lateral view, 0.5–0.9 mm wide in dorsal/ventral view; hairs ± curving, scattered, not or scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.4–0.5 × 0.6–0.7 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe obovate or elliptic in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap minute to ± circular or wider at base.

Distribution:—Angola: Bié, Lunda Sul, Moxico. Tropical Africa: Democratic Republic of the Congo, Zambia.

Habitat & ecology:—Termite mound and wetland; 1000–1400 m.

Phenology:—Fruiting: Apr–May, Sep.

Specimens used for seed analysis:—ANGOLA. Bié: 30 September 1965, *Monteiro & Murta 1777* (COI00103216); [Lunda Sul]: Xassengue, Caiango, 1000 m, April 1937, *Gossweiler 11844* (BM); Moxico: rio Simogi, ca. 1240 m, 6 May 1937, *Exell & Mendonça 1659* (COI00103142).

16. *P. luenensis* Paiva in Portug. Acta Biol. (B), 9: 175, tab. II, fig. 9 [seed] (1968)—Fig. 25.



FIGURE 25. Seed of *P. luenensis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Gossweiler 3601*—BM001173010. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally not to slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 2.1–2.8 × 1.3–1.6 mm in lateral view, 0.7–1.3 mm wide in dorsal/ventral view; hairs ± curving, scattered, not or scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.8–1.2 × 0.9–1.5 mm in lateral view; dorsal and ventral lobes ± the same length or dorsal lobe longer in lateral view; dorsal lobe obovate, occasionally elliptic, in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap wider at base.

Distribution:—Angolan endemic: Kuando Kubango, Moxico.

Habitat & ecology:—Grassland; 1000–1250 m.

Phenology:—Fruiting: Apr–May.

Comments:—In the protologue: “*Semina ellipsoidea 3×1,5 mm, nigra, breviter pubescentia, carunculata, caruncula 1 mm longa, appendicibus brevibus.*”

Specimens used for seed analysis:—ANGOLA. [Kuando Kubango]: river Kuartiri, 16 April 1906, *Gossweiler 3601* (BM001173010); Moxico: Vila Luso [Luena], rio Luena, 1240 m, 4 May 1937, *Exell & Mendonça 1594* (COI00005653, type of *P. luenensis*).

17. *P. antunesii* Gürke in Bot. Jahrb. Syst. 32(1): 131 (1902)—Fig. 26.



FIGURE 26. Seed of *P. antunesii*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Humbert 16536*—BM. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly to strongly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 2.1–2.8 × 1.3–1.6 mm in lateral view, 0.6–1.0 mm wide in dorsal/ventral view; hairs ± curving, scattered, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. 0.5 × 0.6–0.8 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe elliptic in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap ± circular to wider at base.

Distribution:—Angolan endemic: Benguela, Huíla, Namibe.

Habitat & ecology:—Xerophytic shrubland and woodland; 1700–2000 m.

Phenology:—Fruiting: Mar–Apr, Jun, Aug.

Comments:—In the protologue: “... *seminibus cylindricis pilis sparsis obtectis; arillo 3-partito, superposito.*”

Specimens used for seed analysis:—ANGOLA. Benguela: Hochland zwischen Ganda und Caconda, ca. 1700 m, March 1934, *Hundt 890* (COI00103140); Huíla: Humpata, Posto Zootécnico, 20 June 1937, *Exell & Mendonça 3005* (COI00103139); Huíla: Chela, near Humpata, 2000 m, August 1937, *Humbert 16536* (BM).

18. *P. rivularis* Gürke in Kunene-Sambesi-Exped. [Warburg]: 278 (1903)—Fig. 27.

= *Polygala rarifolia* auct. var. *melanophleba* Welw. ex Oliv., Fl. Trop. Afr. [Oliver *et al.*] 1: 133 (1868)



FIGURE 27. Seed of *P. rivularis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Silva 3489*—COI00103218. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed or occasionally not compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 1.7–2.0 × 0.9–1.0 mm in lateral view, 0.8–1.1 mm wide in dorsal/ventral view; hairs ± curving,

scattered, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. $0.3\text{--}0.4 \times 0.6$ mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe elliptic in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap wider at base.

Distribution:—Angola: Bié, Huambo, Huíla, Kuando Kubango, Kwanza Sul, Lunda Sul, Moxico. Tropical Africa: Democratic Republic of the Congo, Zambia.

Habitat & ecology:—Wetland; 1000–1750 m.

Phenology:—Fruiting: Nov–Apr.

Comments:—In the protologue: “... *seminibus late ellipsoideis, pilis patentibus sparsis vestitis; caruncula rotundata, uncinato-hemisphaerica, semini superposita.*”

Specimens used for seed analysis:—ANGOLA. Huambo: Nova Lisboa [Huambo], Chianga, 1750 m, 14 February 1967, *Silva* 1963 (COI00103161); Huambo: arredores de Nova Lisboa [Huambo], Chiva, 1700 m, 19 March 1971, *Silva* 3489 (COI00103218); Lunda [Sul]: Dala, Luma, Cassai, rio Coxi, 28 April 1937, *Exell & Mendonça* 1389 (COI00103160).

19. *P. myrtilloopsis* Welw. ex Oliv., Fl. Trop. Afr. [Oliver *et al.*] 1: 130 (1868)—Fig. 28.



FIGURE 28. Seed of *P. myrtilloopsis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Welwitsch* 1029—LISU. Scale bar = 1 mm. Photography by Ana Coelho.

Seed laterally strongly compressed, elliptic in lateral view, body hairy, chalazal region with a wide tuft of hairs, caruncle 3-lobed. *Seed body* ca. 2.5×1.9 mm in lateral view, ca. 0.8 mm wide in dorsal/ventral view; hairs $\pm$ curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. 0.8×1.1 mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral lobes longer than dorsal; appendages of ventral lobes form long rims and are restricted to lobe apex; funicular gap $\pm$ circular.

Distribution:—Angola: Benguela, Bié, Huíla. Tropical Africa: Democratic Republic of the Congo.

Habitat & ecology:—Savannah; up to 1800 m.

Phenology:—Fruiting: Nov.

Specimen used for seed analysis:—ANGOLA. Huíla: prope Lopollo, 3800–5500 ft, November 1859, *Welwitsch* 1029 (LISU256084, type of *P. myrtilloopsis*).

20. *P. fragilis* Paiva in Portug. Acta Biol. (B), 9: 176, tab. II, fig. 12 [seed] (1968)—Fig. 29.



FIGURE 29. Seed of *P. fragilis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Drummond & Cookson* 6490—K. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed or occasionally not compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 2.0–2.2 × 1.1–1.2 mm in lateral view, 0.7–1.1 mm wide in dorsal/ventral view; hairs ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. 0.2–0.3 × 0.5 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe obovate to circular in dorsal view; appendages of ventral lobes longer than dorsal; appendages of ventral lobes form long rims and are restricted to lobe apex; funicular gap ± circular to wider at base.

Distribution:—Angola: Kuando Kubango, Moxico. Tropical Africa: Zambia.

Habitat & ecology:—Wet grassland; 1100–1300 m.

Phenology:—Fruiting: Mar, Nov.

Comments:—In the protologue: “*Semina ellipsoidea 3×1,5 mm, nigra, breviter pubescentia, carunculata, caruncula 1 mm longa, appendicibus brevibus.*”

Specimens used for seed analysis:—ANGOLA. [Kuando Kubango] (Bié on the label): Cuito Cuanavale, vale do rio Tumbo, ca. 1280 m, 7 March 1960, *Mendes 2919* (LISC083853, type of *P. fragilis*); Moxico: 7 miles over Angola border W. of Sikongo, Kalabo District, 15 November 1959, *Drummond & Cookson 6490* (K000231686, type of *P. fragilis*). ZAMBIA. [Western Province]: Kalabo, 16 November 1959, *Drummond & Cookson 6505* (BM, K).

21. *P. schinziana* Chodat in Mém. Soc. Phys. Genève 31(2): 364, tab. XXVIII, fig. 38c [proximal extremity of seed] (1893)—Fig. 30.

= *Polygala benguellensis* Gürke in Kunene-Sambesi-Exped. [Warburg]: 277 (1903)



FIGURE 30. Seed of *P. schinziana*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Brummitt, Chisumpa & Polhill 14265*—K. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly to strongly compressed, elliptic in lateral view, body hairy, chalazal region with a narrow tuft of hairs, caruncle 3-lobed. *Seed body* 3.1–3.4 × 1.7–1.9 mm in lateral view, 0.8–1.1 mm wide in dorsal/ventral view; hairs ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.9–1.1 × 0.8–0.9 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe linear or clavate in dorsal view; ventral lobes dolabriform towards apex in lateral view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap narrow.

Distribution:—Angola: Bié, Kuando Kubango. North Southern Africa.

Habitat & ecology:—Steppe; 900–1200 m.

Phenology:—Fruiting: Dec [ANGOLA. [Bengo/Cuanza Sul]: An der Longamündung, 1150 m, 17 December 1899, *Baum 554* (COI00005490)].

Comments:—In the protologue: “*Semina cylindrica pilis sericeis densis munita. Caruncula superposita, appendicibus haud uncinatis.*”

This is the only Angolan taxon where the chalazal region has a narrow tuft of hairs.

Specimens used for seed analysis:—ZAMBIA. [Western Province]: Sesheke District, Masese forest Station, 1050 m, 3 November 1975, *Brummitt, Chisumpa & Polhill 14265* (K); Western [Province]: Kalabo District, in the Lukona local forest 3.3 km W. from Lukona Basic School, 1140 m, 20 March 1996, *Luwiika, Harder & Zimba 370* (COI00098237).

22. *P. resendeana* Paiva in Portug. Acta Biol. (B), 9: 172, tab. II, fig. 7 [seed] (1968)—Fig. 31.



FIGURE 31. Seed of *P. resendeana*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Teixeira & Andrade 8000a*—LISC. Scale bar = 1 mm. Photography by Ana Coelho.

Seed laterally strongly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* ca. 2.4×1.5 mm in lateral view, ca. 0.8 mm wide in dorsal/ventral view; hairs straight, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. 0.9×1.1 mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap $\pm$ circular.

Distribution:—Angolan endemic: Benguela, Huambo.

Habitat & ecology:—Shrubby grassland, riverside; 1600–1750 m.

Phenology:—Fruiting: Sep–Oct.

Comments:—In the protologue: “*Semina ellipsoidea, 3,5 \times 1,4* mm, *albo-pubescentia, carunculata, caruncula 1 mm longa, appendicibus brevibus.*”

Paiva (2008) did not list the species for Angola, but the following Angolan specimens were observed here: Huambo: Chianga, anhara do rio Culimaála, margem direita do rio Culimaála, 1700 m, 06 September 1964, *Teixeira & Andrade 8000* (COI00005452, type of *P. resendeana*) and Huambo: Arredores de Nova Lisboa [Huambo], Chiva, 1750 m, 09 September 1970, *Silva 3259* (COI00111700), plus the type specimen from LISC with the single seed available for study.

Specimen used for seed analysis:—ANGOLA: Huambo: Nova Lisboa [Huambo], anhara de Culimaála, margem direita do rio Culimaála, ca. 1700 m, 1 October 1964, *Teixeira & Andrade 8000a* (LISC083866, type of *P. resendeana*).

23. *P. arenicola* Gürke in Kunene-Sambesi-Exped. [Warburg]: 273 (1903)—Fig. 32.

= *Polygala arenicola* var. *angustifolia* Exell in J. Bot. 64 (Suppl. 1): 23 (1926)



FIGURE 32. Seed of *P. arenicola*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Young 1382*—BM. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed or occasionally not compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* $2.4\text{--}2.7 \times 1.1\text{--}1.4$ mm in lateral view, 0.8–1.1 mm wide in dorsal/ventral view; hairs $\pm$ curving, dense, not or scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion $0.8\text{--}1.0 \times 0.9\text{--}1.1$ mm in lateral view; dorsal and ventral lobes $\pm$ the same length, occasionally dorsal lobe longer, in lateral view; dorsal lobe elliptic or obovate in dorsal view; appendages of ventral and dorsal lobes similar in length,

sometimes those of dorsal lobe inconspicuous; appendages of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap $\pm$ circular.

Distribution:—Angola: Bié, Kuando Kubango, Lunda Sul, Moxico. Tropical Africa: Democratic Republic of the Congo, Zambia.

Habitat & ecology:—Savannah, woodland edges, and wetland; 900–1350 m.

Phenology:—Fruiting: Mar–Apr.

Comments:—In the protologue: “... *arillo superposito corneolo*.”

Specimens used for seed analysis:—ANGOLA. [Kuando Kubango]: Cassuango, rio Cuiriri, Ganguela, March 1906, *Gossweiler* 3698 (COI00005382, type of *P. arenicola* var. *angustifolia*); Lunda [Sul]: Dala, Biula, rio Chiji, 1250 m, 27 April 1937, *Exell & Mendonça* 1206 (COI00103214); Moxico: R[io] Luena, Vila Luzo [Luena], 1932, *Young* 1382 (BM).

24. *P. baumii* Gürke in Kunene-Sambesi-Exped. [Warburg]: 276 (1903)—Fig. 33.

= *Polygala congestiflora* I.M.Johnst. in Contr. Gray Herb. 73: 37 (1924)

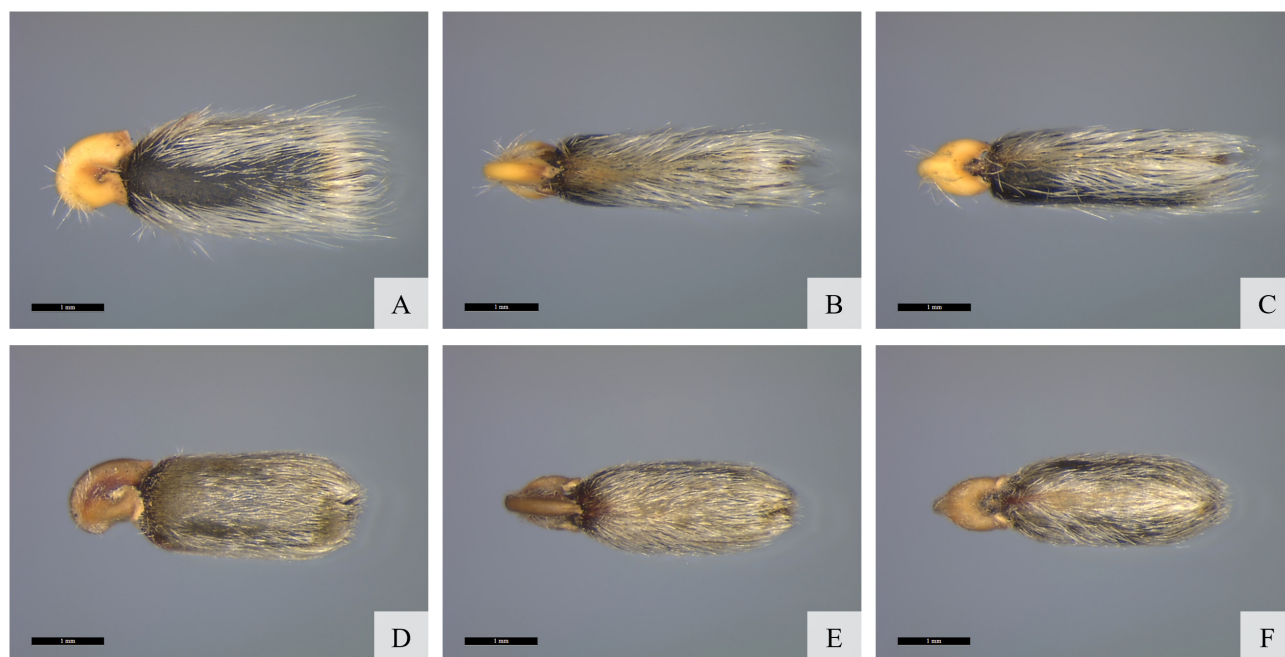


FIGURE 33. Seeds of *P. baumii* have variable morphology. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. **A–C:** *Teixeira & Andrade* 5314—LUA; **D–F:** *Gossweiler* 3734—LISC098017. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed or occasionally not compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 2.7–3.4 $\times$ 1.3–1.9 mm in lateral view, 0.8–1.3 mm wide in dorsal/ventral view; hairs straight or $\pm$ curving, dense, scarcely or shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.9–1.0 $\times$ 1.0–1.2 mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe obovate or elliptic in dorsal view; appendages of ventral and dorsal lobes inconspicuous or similar in length, then those of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap $\pm$ circular to wider at base.

Distribution:—Angola: Bié, Huíla, Kuando Kubango, Lunda Sul. Tropical Africa: Democratic Republic of the Congo, Zambia.

Habitat & ecology:—Deciduous woodland and savannah on sandy soil; 110–1700 m.

Phenology:—Fruiting: Jan–Jun, Nov.

Comments:—In the protologue: “*Die Samen sind 4 mm lang, schwarzbraun, aber dicht mit seidenglänzenden, weissen, anliegenden Haaren bedeckt. Der Arillus ist hornig, 3-teilig.*”

Specimens used for seed analysis:—ANGOLA. [Huíla]: Sá da Bandeira [Lubango], a 8 km de Sá da Bandeira no caminho para Benguela, ca. 1680 m, 2 May 1961, *Teixeira & Andrade* 5314 (LUA); [Kuando Kubango]: pr. de Cassuango, Cuiriri–Ganguela, March 1906, *Gossweiler* 3734 (COI00005974, LISC098017); [Lunda Sul]: Alto Chicapa, R[iver] Camutongola, 22 June 1954, *Machado* ANG.VI.54-149 (LISC098020).

25. *P. gossweileri* Exell & Mendonça in J. Bot. 74: 133 (1936)—Fig. 34.

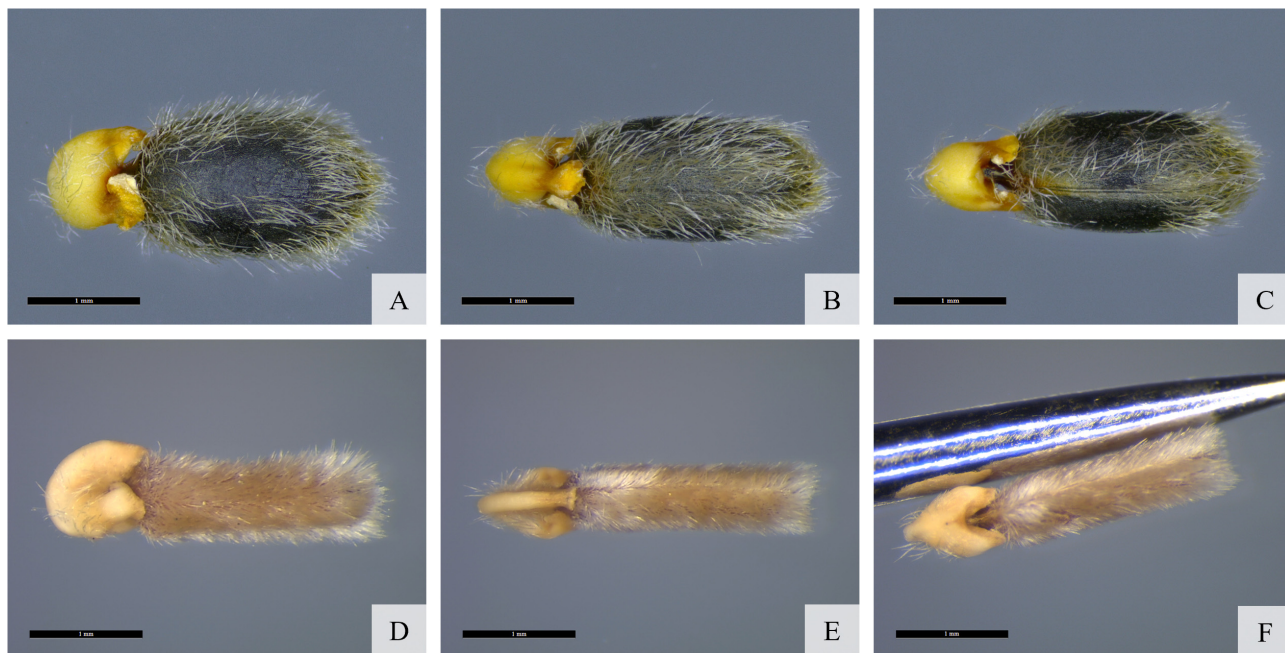


FIGURE 34. Seeds of *P. gossweileri* have variable morphology. **A, D.** Lateral view. **B, E.** Dorsal view with, respectively, wide and narrow caruncle lobes and appendages. **C, F.** Ventral view. **A–C,** mature seed: *Milne-Redhead & Taylor 8018*—B, Tanzania; **D–F,** immature seed: *Moreno & Lopes 352*—COI00103263, Angola. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally not compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* ca. 2.0×1.2 mm in lateral view, ca. 1.1 mm wide in dorsal/ventral view; hairs $\pm$ curving, dense, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion ca. 0.5×0.9 mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe elliptic in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap wider at base.

Distribution:—Angola: Bié, Moxico. Tropical Africa: Malawi, Tanzania, Zambia.

Habitat & ecology:—Grassland and wetland edges; 950–1650 m.

Phenology:—Fruiting: Oct.

Comments:—In the protologue: “... *seminibus oblongis 2.2 mm. longis sericeis apice arillatis.*”

Generally, we observed that the caruncle is mostly formed before the seed body matures. The only mature seed material available was that of the specimen from Tanzania (Fig. 34A–C). However, its caruncle is distinct especially in dorsal view from the other two specimens available, these from Angola but both immature. One of these specimens is a type (COI00005390) and the other is here illustrated (Fig. 34D–F). The two Angolan materials are very similar in their seeds, but the type specimen itself is similar to the Tanzanian specimen; the second Angolan specimen is distinct. The differences are striking in the inflorescence type and pedicel length. Such inconsistencies are the reason for, exceptionally, illustrating here an immature seed (see Discussion). The description above is of the Tanzanian mature seed.

Specimens used for seed analysis:—ANGOLA. Bié: entre Silva Porto [Cuito] e Chinguar, próximo do rio Cuchi (?), 21 March 1971, *Moreno & Lopes 352* (COI00103263). TANZANIA. [Ruvuma]: Songea District, 11 km W. of Songea, Ulamboni Valley, 960 m, 1 January 1956, *Milne-Redhead & Taylor 8018* (B).

26. *P. huillensis* Welw. ex Oliv., Fl. Trop. Afr. [Oliver *et al.*] 1: 133 (1868)—Fig. 35.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* $2.6\text{--}3.1 \times 1.3\text{--}1.5$ mm in lateral view, $0.9\text{--}1.2$ mm wide in dorsal/ventral view; hairs $\pm$ curving, dense, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion $0.8\text{--}1.0 \times 0.9\text{--}1.0$ mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe obovate or elliptic in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap $\pm$ circular.



FIGURE 35. Seed of *P. huillensis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Santos 39*—LUAI. Bar = 1 mm. Photography by Ana Coelho.

Distribution:—Angolan endemic: Huíla.

Habitat & ecology:—Grassland and xerophytic shrubland.

Phenology:—Fruiting: Jan, Oct–Nov.

Comments:—In the protologue: “*Seeds pubescent.*”

Specimens used for seed analysis:—ANGOLA. Huíla: Palanca, 7 October 1955, *Mendes 332* (LISC, LUAI); Huíla: Munhino, 2 November 1955, *Santos 39* (LUAI); Huíla: arredores da M[issão] Católica, 19 November 1955, *Santos 117* (LUAI).

27. *P. kalaxariensis* Schinz in Verh. Bot. Vereins Prov. Brandenburg 29: 52 (1888)—Fig. 36.

= *Polygala huillensis* var. *buxifolia* Welw. ex Hiern, Cat. Afr. Pl. (Hiern) 1: 46 (1896)

= *Polygala dekindtii* Gürke in Bot. Jahrb. Syst. 32: 131 (1902)

= *Polygala kubangensis* Gürke in Kunene-Sambesi-Exped. [Warburg]: 275 (1903)



FIGURE 36. Seed of *P. kalaxariensis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Correia 1459*—LUAI. Bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 2.6–4.0 × 1.3–1.8 mm in lateral view, 1.0–1.5 mm wide in dorsal/ventral view; hairs ± curving, dense, not or scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.9–1.1 × 1.0–1.3 mm in lateral view; dorsal and ventral lobes ± the same length or dorsal lobe longer in lateral view; dorsal lobe elliptic or obovate in dorsal view; appendages of ventral and dorsal lobes inconspicuous or similar in length, then those of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap ± circular or wider at base.

Distribution:—Angola: Bié, Huíla, Kuando Kubango. Democratic Republic of the Congo, Namibia, Zambia, Zimbabwe.

Habitat & ecology:—Grassland on sandy soil; 1150–2400 m.

Phenology:—Fruiting: Feb, Apr, Oct–Dec.

Comments:—In the protologue: “*Die Samen sind länglichoval, ca. 3 mm lang und mit seidenartigen anliegenden Haaren bedeckt.*”

The distribution of the species needs further investigation especially the outlier in the DRC near Kinshasa.

Specimens used for seed analysis:—ANGOLA. Huíla: Humpata, região das Neves, Estação Zootécnica, 13 December 1961, *Correia 1459* (LUAI); Huíla: Tunda-Vala, a 100 m da picada Tunda-Vala, escarpa da Chela, a 2200

m do miradouro, 17 April 1962, *Teixeira & Almeida 5691* (LUA); Huíla: Sá da Bandeira [Lubango], 16 April 1972, *Couto 210* (LUAI); [Kuando Kubango]: pr. de Mu[e]nongue, Vila Serpa Pinto [Menongue]–Ganguela, 23 April 1906, *Gossweiler 3123* (COI00005961).

28. *P. nematophylla* Exell in J. Bot. 64 (Suppl. 1): 23 (1926)—Fig. 37.



FIGURE 37. Seed of *P. nematophylla*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Mendes 3010a*—LISC098160. Bar = 1 mm. Photography by Ana Coelho.

Seeds laterally not to slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 3.4–4.0 × 1.4–2.0 mm in lateral view, 1.4–1.6 mm wide in dorsal/ventral view; hairs ± curving, dense, scarcely or shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 1.2–1.4 × 1.2–1.4 mm in lateral view; dorsal lobe longer than ventral lobes in lateral view, obovate in dorsal view; appendages of ventral and dorsal lobes similar in length, sometimes those of dorsal lobe inconspicuous; appendages of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap ± circular.

Distribution:—Angola: Bié, Kuando Kubango. Tropical Africa: Zambia.

Habitat & ecology:—Grassland; 900–1350 m.

Phenology:—Fruiting: Feb–Apr, Oct.

Comments:—In the protologue: “... *seminibus sericeo-pubescentibus; caruncula trilobata*.”

Specimens used for seed analysis:—ANGOLA. Kuando Kubango: Cuito Cuanavale, vale do rio Tumbo, ca. 1280 m, 7 March 1960, *Mendes 2893* (LISC098158); Kuando Kubango: Cuito Cuanavale, Longa, vale do rio Cuiriri, no cruzamento com a estrada para Cuito Cuanavale, ca. 1320 m, 10 March 1960, *Mendes 3010a* (LISC098160).

29. *P. robusta* Gürke in Kunene-Sambesi-Exped. [Warburg]: 274 (1903)—Fig. 38.



FIGURE 38. Seed of *P. robusta*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Devred 2981*—K. Bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 3.7–4.5 × 1.8–2.2 mm in lateral view, 1.4–1.8 mm wide in dorsal/ventral view; hairs ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 1.4–1.6 × 1.4–1.7 mm in lateral view; dorsal and ventral lobes ± the same length or dorsal lobe longer in lateral view, elliptic or obovate in dorsal view; appendages of ventral and dorsal lobes inconspicuous or similar in length, then those of ventral lobes form short rims and are restricted to lobe apex; apex of ventral lobes together with appendages are clearly auriculate in lateral view; funicular gap narrow or ± circular.

Distribution:—Angola: Bié, Kuando Kubango, Lunda Sul. Tropical Africa: Democratic Republic of the Congo, Zambia.

Habitat & ecology:—Savannah and gallery woodland; 1250–1750 m.

Phenology:—Fruiting: Jan–Feb, Apr.

Comments:—In the protologue: “*Die (noch nicht völlig entwickelten) Samen sind mit langen, dichten, seidenglänzenden Haaren bedeckt. Der Arillus ist 3-teilig...*”

The photographs shown are of a seed from the Democratic Republic of the Congo because the material from Angola was slightly corroded.

Specimens used for seed analysis:—ANGOLA. [Kuando Kubango]: Chana de Hampuebo, Rio Cuartir, Ganguela, January 1906, *Gossweiler 2851* (LISC098180). DEMOCRATIC REPUBLIC OF THE CONGO. [Kinshasa]: Leopoldville [Kinshasa], Kwango Territory, Tshilualua, March 1956, *Devred 2981* (K).

30. *P. youngii* Exell in J. Bot. 73: 227 (1935)—Fig. 39.

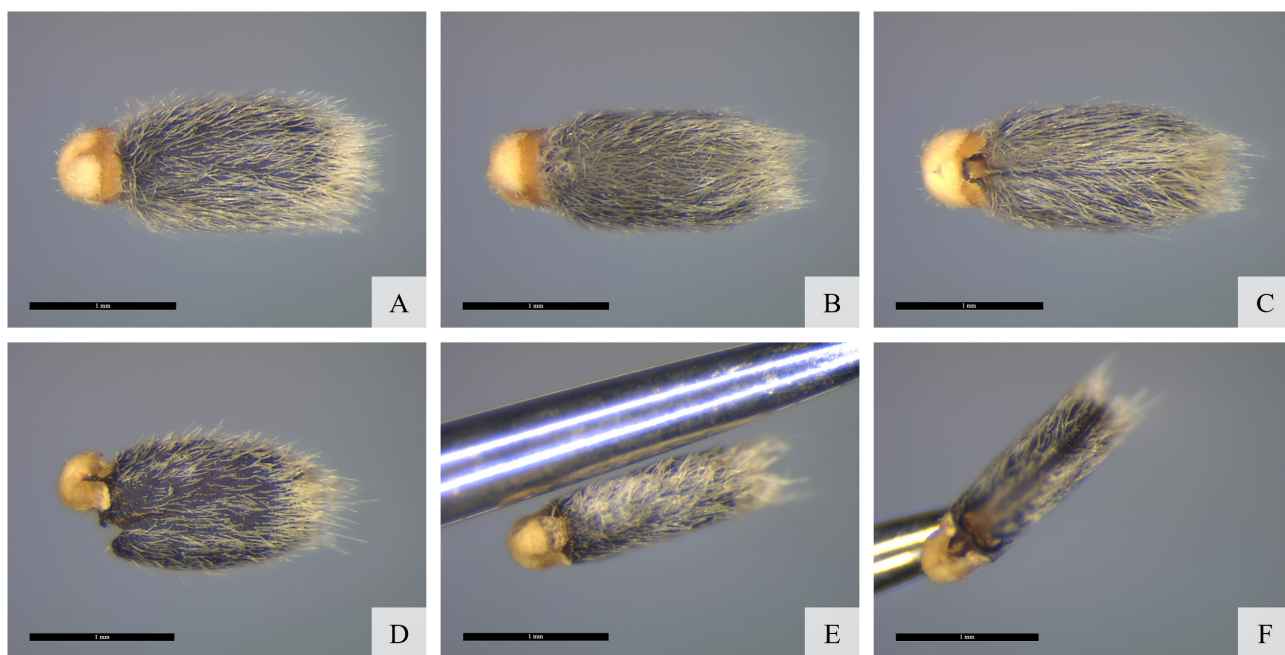


FIGURE 39. Seeds of *P. youngii* have variable morphology. **A, D.** Lateral view. **B, E.** Dorsal view. **C, F.** Ventral view. **A–C:** *Brummitt, Chisumpa & Polhill 13987*—COI00103264, Zambia; **D–F:** *Young 1163*—BM, Angola. Material from Angola differs, but very little, from that of Zambia. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 1.5–1.7 × 0.8–1.0 mm in lateral view, 0.5–0.8 mm wide in dorsal/ventral view; hairs ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.2–0.3 × 0.4–0.5 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe obovate in dorsal view; ventral lobes globose and wide at apex in lateral view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap ± circular.

Distribution:—Angola: Lunda Sul. Tropical Africa: Democratic Republic of the Congo, Zambia.

Habitat & ecology:—Wet grassland; 1200–1350 m.

Phenology:—Fruiting: Oct.

Comments:—In the protologue: “... *seminibus cylindricis, 1.5–1.6 × 0.8–0.9 mm., dense pubescentibus apice arillatis, arillo trilobato, lobis haud appendiculatis.*”

The Angolan seed examined is broken (Fig. 39D).

Specimens used for seed analysis:—ANGOLA. Lunda [Sul]: Vila Henrique de Carvalho [Saurimo], 25 October 1932, *Young 1163* (BM). ZAMBIA. North-Western Prov.: Mwinilunga D[J]obeka Dambo, 45 km W. of Mwinilunga, 1350 m, 22 January 1975, *Brummitt, Chisumpa & Polhill 13987* (COI00103264).

31. *P. petitiana* A.Rich. Tent. Fl. Abyss. 1: 37 (1847) **subsp. *petitiana***—Fig. 40.



FIGURE 40. Seed of *P. petitiana* subsp. *petitiana*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Gomes & Silva 2786*—COI00103157. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with or without a minute aril, caruncle 3-lobed. *Seed body* 1.8–2.1 × 1.0–1.2 mm in lateral view, 0.6–0.8 mm wide in dorsal/ventral view, hairs straight or ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.5–0.7 × 0.6–0.7 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate or elliptic in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap ± circular.

Distribution:—Angola: Bié, Huambo, Malanje. Tropical Africa.

Habitat & ecology:—Very variable, from grassland and wetland to savannah and open woodland; 0–2100 m.

Phenology:—Fruiting: Jan–May.

Specimens used for seed analysis:—ANGOLA. [Huambo] (Benguela on label): Pedra do Alemão, próx. de Nova Lisboa [Huambo], 1700 m, 9 May 1937, *Exell & Mendonça 1698* (COI00103158); Bié: Silva Porto [Cuito], Ceilunga, ca. 1660 m, 6 February 1970, *Gomes & Silva 2786* (COI00103157); Huambo: Nova Lisboa [Huambo], Chianga, 1750 m, 8 February 1967, *Silva 1949* (COI00103159).

32. *P. mossamedensis* Paiva in Portug. Acta Biol. (B) 9: 173, tab. II, fig. 14 [seed] (1968)—Fig. 41.



FIGURE 41. Seed of *P. mossamedensis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Santos 1050*—COI00067248. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a minute aril, occasionally without, caruncle 3-lobed. *Seed body* 3.0–3.8 × 1.5–1.7 mm in lateral view, ca. 0.9 mm wide in dorsal/ventral view; hairs straight or ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.8–1.0 × 0.8–0.9 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe obovate or clavate in dorsal view; ventral lobes dolabriform towards apex in lateral view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap narrow, occasionally ± circular.

Distribution:—Angolan endemic: Namibe.

Habitat & ecology:—Rocky steppe of shrubs and subshrubs; 400–500 m.

Phenology:—Fruiting: Apr–May.

Comments:—In the protologue: “*Semina ellipsoidea, 5 × 2 mm, carunculata, caruncula 1 mm longa, appendicibus brevioribus.*”

Specimens used for seed analysis:—ANGOLA. Moçamedes [Namibe]: near river Mucungo, road Moçamedes [Namibe] – San Nicolau [Bentiaba], 26 April 1968, *Kers 3644* (LISC098132); [Namibe]: Moçamedes [Namibe], Chipia, 500 m, 7 May 1957, *Teixeira 2223* (COI00067246, type of *P. mossamedensis*); [Namibe]: Moçamedes [Namibe], Dois Irmãos / Caraculo, 10 May 1962, *Santos 1050* (COI00067248, type of *P. mossamedensis*).

33. *P. acicularis* Oliv. in Fl. Trop. Afr. [Oliver *et al.*] 1: 132 (1868)—Fig. 42.



FIGURE 42. Seed of *P. acicularis*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Monteiro & Murta 185*—LUAI. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 3.0–3.5 × 1.6–1.8 mm in lateral view, 0.9–1.2 mm wide in dorsal/ventral view; hairs ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.8–1.2 × 1.0–1.3 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe obovate in dorsal view; ventral lobes globose but very narrow at apex in lateral view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap wider at base.

Distribution:—Angola: Cabinda, Uíge. Tropical Africa.

Habitat & ecology:—Grassland, savannah, and wetland edges; 350–1600 m.

Phenology:—Fruiting: Jun.

Comments:—This is the only Angolan taxon with caruncle ventral lobes globose but very narrow at apex in lateral view.

Specimens used for seed analysis:—ANGOLA. Cabinda: Junto à Chiaca, 7 June 1960, *Monteiro & Murta 185* (LUAI). CAMEROON. Kounden, 1600 m, *s.d.*, *Muerillon 995* (K). NIGERIA. [Kogi State]: top of Patti Mt, [ca. 450 m], 25 October 1908, *Dalziel 89* (K); Adamawa Division [State]: Vogel [Dimlang] Peak area, Silang[?] to Dak[h]emi, 920 m, 15 November 1957, *Hepper 1369* (K).

34. *P. xanthina* Chodat in Bot. Jahrb. Syst. 48(1–2): 325 (1912)—Fig. 43.



FIGURE 43. Seed of *P. xanthina*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Robinson 5090*—LISC. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 2.7–3.1 × 1.3–1.6 mm in lateral view, 0.8–1.0 mm wide in dorsal/ventral view; hairs straight or ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.6–0.8 × 0.9–1.0 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate or obovate in dorsal view; ventral lobes globose and wide at apex in lateral view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap ± circular.

Distribution:—Angola: Malanje. East and Central Tropical Africa.

Habitat & ecology:—Grassland and savannah; 1000–1750 m.

Phenology:—Flowering: Mar–Apr (COI00111705, COI00111704).

Comments:—In the protologue: “... *seminibus (juvenilibus) cylindricis arillo superposito.*”

Paiva (2008) did not list the species for Angola, but the following Angolan specimens were observed here: Malanje: rio Cuango, próximo de Xa-Sengue [Xassengue], 1075 m, 08 April 1937, *Exell & Mendonça 451* (COI00111704) and Malanje: Quela, March 1938, *Nolde 667* (COI00111705); they were not used in this study because they do not have mature seeds.

Specimens used for seed analysis:—BURUNDI. Bubanza, 1100 m, 14 June 1966, *Lewalle 932* (K). N. RHODESIA [ZAMBIA]. Abercorn [Mbala] District: Lunzuwa [Lunzua?], 20 April 1962, *Robinson 5090* (LISC098894).

35. *P. stenopetala* subsp. *casuarina* (Chodat) Paiva in Fontqueria 50: 220 (1998)—Fig. 44.

≡ *Polygala viminalis* var. *casuarina* Chodat in Bot. Jahrb. Syst. 48(1–2): 322 (1912)



FIGURE 44. Seed of *P. stenopetala* subsp. *casuarina*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Exell & Mendonça 1678*—BM. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a minute aril, caruncle 3-lobed. *Seed body* 3.3–4.6 × 2.0–2.4 mm in lateral view, 1.3–1.6 mm wide in dorsal/ventral view; hairs straight or ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.9–1.0 × 1.1–1.3 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate or obovate in dorsal view; ventral lobes globose and wide at apex in lateral view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are restricted to lobe apex; funicular gap wider at base.

Distribution:—Angolan endemic: Benguela, Bié, Huambo, Huíla, Kuando Kubango, Kwanza Norte, Lunda Sul, Malanje.

Habitat & ecology:—Grassland and xerophytic shrubland; 1100–2200 m.

Phenology:—Fruiting: Dec–Jun.

Specimens used for seed analysis:—ANGOLA. [Huambo] (Benguela on label): Pedra do Alemão, near Nova Lisboa [Huambo], 1700 m, 9 May 1937, *Exell & Mendonça 1678* (BM); [Malanje]: Malanje, 1160 m, 30 March 1937, *Exell & Mendonça 224* (COI00103162).

36. *P. laxifolia* Exell in J. Bot. 65: 345 (1927)—Fig. 45.



FIGURE 45. Seed of *P. laxifolia*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Exell & Mendonça 2082*—COI00103146. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 3.2–4.1 × 1.7–2.2 mm in lateral view, 1.3–1.5 mm wide in dorsal/ventral view; hairs straight, dense, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.8–1.3 × 1.1–1.4 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe obovate in dorsal view; ventral lobes globose and wide at apex in lateral view; appendages of ventral and dorsal lobes inconspicuous or similar in length, then those of ventral lobes form short rims and are restricted to lobe apex; funicular gap wider at base.

Distribution:—Angolan endemic: Huíla, Namibe.

Habitat & ecology:—Xerophytic shrubland; 1700–2000 m.

Phenology:—Fruiting: Jan, May, Nov.

Specimens used for seed analysis:—ANGOLA. Huíla: Estação Zootécnica da Humpata, próximo da represa, ca. 1900 m, 7 November 1957, *Teixeira 2735* (COI00103145); Namibe: Serra da Chela, escarpas para a Humbia, 1900 m, 17 May 1937, *Exell & Mendonça 2082* (COI00103146).

37. *P. krumanina* Burch. ex Ficalho & Hiern in Trans. Linn. Soc. London, Bot. ser. 2, 2(1): 16 (1881)—Fig. 46.



FIGURE 46. Seed of *P. krumanina*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Burchell 2425*—K000231829. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, subobtriangular to elliptic in lateral view, body hairy, caruncle 3-lobed. *Seed body* 2.1–2.4 × 1.0–1.3 mm in lateral view, 0.7–0.9 mm wide in dorsal/ventral view; hairs straight or ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.5–0.7 × 0.7–0.9 mm in lateral view; dorsal and ventral lobes ± the same length or dorsal lobe longer in lateral view; dorsal lobe linear to elliptic; appendages of ventral and dorsal lobes similar in length or appendage of dorsal lobe longer; appendages of ventral lobes form long rims and are at lobe apex and decurrent, often joining; funicular gap ± circular or wider at base.

Distribution:—Angola: Moxico. South of Kalahari Desert and surrounding areas: Zimbabwe (west), South Africa (northeast).

Habitat & ecology:—Steppe.

Phenology:—Fruiting: Aug.

Comments:—Given the significant disjunction from the general area of distribution in South Africa, the species was doubtfully given for Angola (Paiva 1998, 2008). Although the only information available on the Angolan isotype in LISU is *Serpa Pinto 29*, the introduction to “*On Central-African plants collected by Major Serpa Pinto*” of Ficalho & Hiern (1881), in which the species was first described, provides a detailed account of the collection based on the collector’s own two-volume diary (Pinto 1881). The coordinates of Pinto (1881) clearly indicate to Moxico in Angola, near the source of the Ninda River (14° 46’ S, 20° 56’ E; Pinto 1881), as he described: “... *leveí das nascentes do rio Ninda algumas plantas, que estão em poder do Snr. Conde de Ficalho, para serem estudadas.*” [English translation: ... I took some plants from the source of the Ninda River, which are in the possession of the Count of Ficalho, to be studied.] (Pinto 1881). At 1143 metres of elevation, the area was swampy, and the surrounding vegetation was spiny.

Specimens used for seed analysis:—SOUTH AFRICA. [Cape Province]: Krúman [Kuruman], near the ruins of Bachapin, 16 November 1812, *Burchell 2425* (K000231829, type of *P. krumanina*). ZIMBABWE. [Bulawayo]: Bulawayo, *s.d.*, *Rogers 13731* (BM).

38. *P. guerichiana* [published as ‘*gürichiana*’] Engl. in Bot. Jahrb. Syst. 19(1): 141 (1894)—Fig. 47.
= *Polygala mendesii* Paiva in Portug. Acta Biol. (B), 9: 170, tab. I, fig. A; tab. II, fig. 1 [seed] (1968)



FIGURE 47. Seed of *P. guerichiana*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Correia 226*—LUI. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly to strongly compressed, subobtriangular or elliptic in lateral view, body hairy, chalazal region with a long and flattened aril with hairs sometimes glochidiate, occasionally short, caruncle 3-lobed. *Seed body* 3.2–3.6 × 1.3–1.6 mm in lateral view, 0.6–0.8 mm wide in dorsal/ventral view; hairs straight, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 1.3–1.4 × 1.1–1.4 mm in lateral view; dorsal lobe longer than ventral lobes in lateral view, linear or narrowly ovate in dorsal view; appendages of ventral lobes longer than dorsal, sometimes those of dorsal lobe inconspicuous; appendages of ventral lobes form long rims and are at lobe apex, also decurrent plus joining; funicular gap ± circular.

Distribution:—Angola: Namibe. Southwest Africa: Namibia.

Habitat & ecology:—Rocky steppe of shrubs and succulents; 500–800 m.

Phenology:—Fruiting: May.

Comments:—This is the only Angolan taxon with chalazal region with a long and flattened hairy aril.

Specimens used for seed analysis:—ANGOLA. [Namibe]: Moçamedes [Namibe], entre o rio Curoca e Espinheira, 24 May 1959, *Correia 226* (LUI); [Namibe]: Andados 55 km de Moçamedes [Namibe] para Dois Irmãos, ca. 500 m, 6 May 1960, *Mendes 3961* (LISC083857, type of *P. mendesii*).

39. *P. leptophylla* Burch. in Trav. S. Africa 1: 400 (1822) **var. leptophylla**—Fig. 48.



FIGURE 48. Seed of *P. leptophylla* var. *leptophylla*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Teixeira et al. 12919*—LUA. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly to strongly compressed, elliptic in lateral view, body hairy, chalazal region with a short hairy aril, caruncle 3-lobed. *Seed body* 2.9–3.1 × 1.1–1.4 mm in lateral view, 0.6–0.8 mm wide in dorsal/ventral view; hairs straight or ± curving, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 1.3–1.6 × 0.9–1.0 mm in lateral view; dorsal lobe longer than ventral lobes in lateral view, linear in dorsal view; appendages of ventral lobes longer than dorsal, sometimes those of dorsal lobe inconspicuous; appendages of ventral lobes form long rims and are at lobe apex, also decurrent plus joining; funicular gap narrow or ± circular.

Distribution:—Angola: Namibe. Southwest Africa (Namaqualand and Kalahari): Botswana, Namibia, South Africa.

Habitat & ecology:—Steppe; up to 1500 m.

Phenology:—Fruiting: Mar.

Specimens used for seed analysis:—ANGOLA. Namibe: Entre Chapeu-Armado e S. Nicolau, *s.d.*, *Castro 139* (COI00103147); [Namibe]: Moçamedes [Namibe], próximo de Moçamedes no alto do platô [Platô] ca. 50 m, 11 March 1969, *Teixeira et al. 12919* (LUA).

40. *P. gomesiana* Welw. ex Oliv., Fl. Trop. Afr. [Oliver *et al.*] 1: 126 (1868)—Fig. 49.



FIGURE 49. Seed of *P. gomesiana*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Teixeira et al. 12222*—LUA. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly or occasionally strongly compressed, elliptic in lateral view, body hairy, chalazal region with a minute aril, caruncle 3-lobed. *Seed body* 2.0–2.2 × 1.4–1.6 mm in lateral view, 0.7–1.2 mm wide in dorsal/ventral view; hairs straight, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* glabrous, wide in ventral view; smooth portion 0.4–0.5 × 0.6–0.7 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe sub-rectangular in dorsal view; appendages of ventral and dorsal lobes inconspicuous or similar in length, then those of ventral lobes form short rims and are at lobe apex and decurrent, sometimes joining; funicular gap ± circular, occasionally wider at base.

Distribution:—Angola: Benguela, Bié, Huíla, Kuando Kubango, Kwanza Norte, Kwanza Sul, Lunda, Malanje, Moxico. Tropical Africa: Zambia.

Habitat & ecology:—Wet grassland; 900–2000 m.

Phenology:—Fruiting: Nov–Mar, May.

Comments:—This is the only Angolan taxon with sub-rectangular caruncle dorsal lobe in dorsal view.

Specimens used for seed analysis:—ANGOLA. Huíla: Humpata, perímetro Florestal da Humpata, 2000 m, 7 May 1958, *Teixeira 3440* (COI00103144); Kuando Kubango: am Kubango oberh. d. Kucio, 1120 m, 3 November 1899, *Baum 371* (COI00103217); Kwanza Norte: Camabatela, ca. 1200 m, 29 February 1968, *Teixeira et al. 12222* (LUA).

41. *P. albida* subsp. *stanleyana* (Chodat) Paiva, Fontqueria 50: 191 (1998)—Fig. 50.

≡ *Polygala stanleyana* Chodat in Mém. Soc. Phys. Genève 31(2, 2): 340, tab. XXVII, fig. 39 (1893)



FIGURE 50. Seed of *P. albida* subsp. *stanleyana*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Silva 2657*—COI00103136. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally strongly compressed, elliptic in lateral view, body hairy, chalazal region with a wide tuft of hairs, caruncle 3-lobed. *Seed body* 1.8–1.9 × 1.0–1.3 mm in lateral view, 0.5–0.7 mm wide in dorsal/ventral view; hairs straight, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth

portion $0.3\text{--}0.5 \times 0.6\text{--}0.8$ mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral and dorsal lobes similar in length to appendages of ventral lobes longer; appendages of ventral lobes form short to long rims and are at lobe apex and decurrent, often joining; funicular gap $\pm$ circular.

Distribution:—Angola: Benguela, Bié, Huambo, Huíla, Kwanza Norte, Lunda Sul, Malanje, Uíge. Tropical Africa, south of the Tropic of Cancer.

Habitat & ecology:—Grassland, savannah, and open woodland; ruderal; 0–2000 m.

Phenology:—Fruiting: Nov–May, Jul.

Specimens used for seed analysis:—ANGOLA. Huambo: Planalto de Benguela, Quípeio – N. Lisboa [Huambo], 1700 m, 10 May 1937, *Gossweiler 11133* (COI00005979); Huambo: Chianga – Nova Lisboa [Huambo], 1600 m, July 1948, *Borges 14176* [coll. no. is a Gossweiler number in Gossweiler's field book] (COI00005980); Kwanza Norte: Cazengo, Centro de Estudos de Salazar, 700 m, 1 April 1969, *Silva 2657* (COI00103136); Lunda [Sul]: Dala, ca. 1200 m, 29 April 1937, *Exell & Mendonça 1469* (COI00103138).

42. *P. erioptera* DC., Prodr. [A.P. de Candolle] 1: 326 (1824)—Fig. 51.

= *Polygala erioptera* var. *angolensis* Chodat in Mém. Soc. Phys. Genève, 31(2): 344 (1893)

= *Polygala erioptera* subsp. *petraea* (Chodat) Paiva, Fontqueria 50: 172 (1998)



FIGURE 51. Seed of *P. erioptera*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Exell & Mendonça 2379*—BM. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly to strongly compressed, subobtriangular in lateral view, body hairy, chalazal region with a wide tuft of hairs, caruncle 3-lobed. *Seed body* $2.2\text{--}2.5 \times 1.1\text{--}1.3$ mm in lateral view, $0.6\text{--}0.7$ mm wide in dorsal/ventral view; hairs straight, dense, spreading towards apex, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion $0.6\text{--}0.7 \times 0.5\text{--}0.7$ mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form short rims and are at lobe apex and decurrent, sometimes joining; funicular gap narrow or wider at base.

Distribution:—Angola: Benguela, Cunene, Huíla, Kwanza Norte, Kwanza Sul, Luanda, Namibe. Tropical and subtropical Africa, Arabian Peninsula, and tropical Asia.

Habitat & ecology:—Steppe, grassland, open bushland, and woodland; ruderal and weed; rocky ground; 0–2000 m.

Phenology:—Fruiting: Jan–Dec.

Specimens used for seed analysis:—ANGOLA. Kwanza Sul: Porto Amboim, não muito afastado da praia do Atlântico, 10 m, 31 March 1933, *Gossweiler 9767* (COI00005966); Luanda: prop. Viana, 90 m, 19 July 1966, *Silva 1790* (COI00103143); Mossamedes [Namibe]: Tampa, 800 m, 1 April 1937, *Exell & Mendonça 2379* (BM).

43. *P. arenaria* Willd., Sp. Pl., ed. 4 [Willdenow] 3(2): 880 (1803)—Fig. 52.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a wide tuft of hairs, caruncle 3-lobed. *Seed body* $1.6\text{--}1.9 \times 0.9\text{--}1.0$ mm in lateral view, $0.7\text{--}0.8$ mm wide in dorsal/ventral view; hairs straight, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion $0.4\text{--}0.5 \times 0.5\text{--}0.6$ mm in lateral view; dorsal and ventral lobes $\pm$ the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral lobes longer than dorsal; appendages of ventral lobes form long rims and are at lobe apex, also decurrent plus joining; funicular gap narrow.



FIGURE 52. Seed of *P. arenaria*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Rocha* 93—LISC098000. Scale bar = 1 mm. Photography by Ana Coelho.

Distribution:—Angola: Kwanza Norte, Kwanza Sul, Malanje. Tropical Africa.

Habitat & ecology:—Savannah and woodland; cultivated ground and roadside; 0–1700 m.

Phenology:—Fruiting: Mar, Jun, Oct.

Comments:—The appendages of caruncle ventral lobes form long rims somewhat similar to the very large and inflated in *P. welwitschii* subsp. *welwitschii*.

Specimens used for seed analysis:—ANGOLA. Malanje: Cambo Sungingi, 28 March 1953, *Rocha* 93 (LISC098000). IVORY COAST. Woroba Worodougou Séguéla, km 5 road Diarabana – Tababouko, ca. 30 km N. of Séguéla, 8°14'N 6°38'W, 400 m, 24 October 1979, *de Kruif* 469 (COI00092300).

44. *P. sphenoptera* Fresen in Mus. Senckenberg. 2: 274 (1837)—Fig. 53.

= *Polygala filifera* Chodat in Bot. Jahrb. Syst. 48(1–2): 315 (1912)



FIGURE 53. Seed of *P. sphenoptera*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: *Antunes s.n.*—COI00103219. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a wide tuft of hairs, caruncle 3-lobed. *Seed body* 2.1–2.5 × 1.3–1.7 mm in lateral view, 0.7–1.0 mm wide in dorsal/ventral view; hairs straight, dense, shortly exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.4–0.7 × 0.8–0.9 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate, occasionally elliptic, in dorsal view; appendages of ventral lobes longer than dorsal, occasionally similar in length; appendages of ventral lobes form long rims, occasionally short, and are at lobe apex and decurrent, often joining; funicular gap wider at base.

Distribution:—Angola: Huíla, Kwanza Norte, Namibe. East Africa: from Ethiopia to South Africa.

Habitat & ecology:—Evergreen bushland, grassland, and wooded grassland; 0–2600 m.

Phenology:—Fruiting: Oct–Nov.

Specimens used for seed analysis:—ANGOLA. Huíla: *s.d.* [sometime 1882–1904], *Antunes s.n.* (COI00103219); Huíla: Quilengues, Impulo, 16 November 1959, *Santos* 233 (LUA); Kwanza Norte: Vila Salazar [N'dalatando], *s.d.*, *Gossweiler s.n.* (LUA).

45. *P. welwitschii* subsp. *pygmaea* (Gürke) Paiva, Fontqueria 50: 189 (1998)—Fig. 54.

≡ *Polygala pygmaea* Gürke in Pflanzenw. Ost-Afrikas C: 234 (1895)

= *Polygala lepidota* Welw. ex Exell in J. Bot. 64 (Suppl. 1): 22 (1926)



FIGURE 54. Seed of *P. welwitschii* subsp. *pygmaea*. **A.** Lateral view. **B.** Dorsal view. **C.** Ventral view. A–C: Exell & Mendonça 2019—COI00103167. Scale bar = 1 mm. Photography by Ana Coelho.

Seeds laterally slightly compressed, elliptic in lateral view, body hairy, chalazal region with a minute aril, occasionally without, caruncle 3-lobed. *Seed body* 1.3–1.7 × 0.7–0.9 mm in lateral view, 0.6–0.7 mm wide in dorsal/ventral view; hairs straight or ± curving, dense, scarcely exceeding the distal extremity of the seed body. *Caruncle* hairy, wide in ventral view; smooth portion 0.4–0.5 × 0.4–0.5 mm in lateral view; dorsal and ventral lobes ± the same length in lateral view; dorsal lobe clavate in dorsal view; appendages of ventral and dorsal lobes similar in length; appendages of ventral lobes form long rims and are at lobe apex and decurrent; funicular gap narrow to wider at base.

Distribution:—Angola: Bié, Cunene, Huíla, Kuando Kubango, Lunda Sul. Tropical Africa, south of the Equator.

Habitat & ecology:—Wet grassland and savannah; 900–2000 m.

Phenology:—Fruiting: Feb–May, Jul.

Comments:—In the protologue: “... *seminibus pilis adpressis sparse sericeis; caruncula uncinata, semini superposita.*”

The material here observed was densely hairy, although the protologue refers to sparsely hairy seeds. The appendages of caruncle ventral lobes form long rims somewhat similar to the very large and inflated appendages in *P. welwitschii* subsp. *welwitschii*.

Specimens used for seed analysis:—ANGOLA. Huíla: entre Sá da Bandeira [Lubango] e Humpata, 1900 m, 16 May 1937, Exell & Mendonça 2019 (COI00103167); Huíla: Humpata, 1875 m, 22 July 1954, Pritchard 323 (COI00103166); Huíla: Perímetro da Humpata, ao lado da barragem do Perímetro, 1900 m, 29 April 1958, Teixeira 3590 (COI00103168).

P. poggei Gürke in Bot. Jahrb. Syst. 14(3): 309 (1891).

Distribution:—Angola: Lunda. South of tropical Africa: Democratic Republic of the Congo.

Habitat & ecology:—Mountain shrubby grassland; 1300–1750 m.

Phenology:—Flowering: Sep [in protologue: *Westafrika, zwischen Kimbundo und dem Quango unter 10° s. Br.* (Pogge, Mitte Sept. 1876, *blühend*); B†].

Comments:—The only specimens found were in flower: ANGOLA. [Lunda]: Pogge 29 (BM000564900, type of *P. poggei*) and DEMOCRATIC REPUBLIC OF THE CONGO. Parc National de L’Upemba, 1750 m, 1 August 1949, Witte s.n. (COI00105835).

Specimens used for seed analysis:—Seeds were not available.

Discussion

Our objective of identifying the Angolan *Polygala* s.s. based only on seed characters was largely achieved. It is quite remarkable that 80% of the taxa were segregated solely on seed characters. The main difficulty in constructing the identification key was the narrow overlap in character states between some taxa. Such difficulty only became apparent

during our detailed analysis, as previous superficial observations had suggested greater discontinuities between taxa. A preliminary statistical multivariate analyses of seed characters did not identify strong evidence for distinct and well-defined clusters of taxa (Coelho 2022) and did not support higher ranks based on seed characters. We understand that seeds possess useful taxonomic traits at specific level and there are instances where seeds proved important at higher ranks of the classification. Such is the case of three Angolan species [*Senega africana* (Chodat) J.F.B.Pastore, *S. capillaris* (E.Mey. ex Harv.) J.F.B.Pastore subsp. *capillaris*, and *S. spicata* (Chodat) J.F.B.Pastore] that are clearly distinct from *Polygala* s.s. by the smaller seeds with no caruncle and more or less glochidiate hairs (Paiva 1998; Coelho 2022), and now segregated to *Senega* subgen. *Senega* sect. *Tenues* (Pastore *et al.* 2023).

Most of the remaining 20% of taxa that we were not able to segregate in the key are in *Polygala* sect. *Tetrasepalae* subsect. *Hexandriae* Paiva; these are: *P. arenicola*, *P. baumii*, *P. gossweileri*, *P. huillensis*, *P. kalaxariensis*, *P. nematophylla*, and *P. robusta* (although seeds tend to be larger). They are either restricted to southeast Angola, or they extend to neighbouring countries. Altogether, these species are a difficult taxonomic group. The plants grow in areas with contrasting environments throughout the year and they have a quite different facies during the rainy season and the very dry periods (Paiva 1998). Major factors in determining seed traits in *Polygala* are the habitats and the dispersal agents available in them (e.g. Verkerke 1985, Lack & Kay 1987, Paiva 1998).

The case of *P. gossweileri* seems to be complex. The species has been poorly collected and the three specimens available are clearly insufficient — it is possible that more than one taxon is present in this sample. *Polygala* sect. *Tetrasepalae* subsect. *Hexandriae* in Angola should be further investigated. *Polygala nambalensis* and *P. britteniana*, in *P.* sect. *Blepharidium* subsect. *Sativae* Paiva, were also not possible to segregate in the key and should be further investigated as well. Identification of synapomorphies in the taxa not segregated in the identification key is difficult at present, as only the sequences of nucleotides of *P. kalaxariensis* and *P. nambalensis* are available in GenBank (accessed on 04 December 2025).

Unique seed character states are not common but they facilitate the identification of *P. acicularis* (caruncle ventral lobes globose but very narrow at apex in lateral view), *P. gomesiana* (sub-rectangular dorsal lobe in dorsal view), *P. guerichiana* (chalazal region with a long and flattened hairy aril), *P. melilotoides* (glabrous seed body), *P. pallida* (seed body obtriangular in lateral view), and *P. schinziana* (chalazal region with a narrow tuft of hairs). The apex of ventral lobes together with appendages clearly auriculate in lateral view is observed only in *P.* sect. *Tetrasepalae* (Chodat) Paiva, although not present in all taxa.

Polygala melilotoides and *P. welwitschii* subsp. *welwitschii* possess very large and inflated caruncle appendages, a character state probably also shared by *P. arenaria* and *P. welwitschii* subsp. *pygmaea*, as pointed out above. More material would be necessary to assess the occurrence of this character.

Not much is known about the chalazal aril. The tufts of hairs in the chalazal region are very dense and can mask arils. This should be further investigated, but it would involve the destruction of the material. Eighteen of the studied taxa possess a chalazal aril, nine in *P.* sect. *Blepharidium* subsect. *Sativae*. The size of this structure often varies within the same taxon and it is minute in ten of them. *Polygala nambalensis* and *P. britteniana*, in *P.* sect. *Blepharidium* subsect. *Sativae*, are the only taxa where the chalazal region has a long and ± terete hairy aril.

In *Flora Zambesiaca* are illustrated seeds of fifteen taxa that also occur in Angola and they are largely similar to the Angolan material.

Conclusions

Based on the results obtained for the Angolan material here investigated, seed characters in *Polygala* s.s. are of taxonomic importance at species level. It was possible to construct an identification key using seed characters only, although some taxa were particularly difficult or even impossible to segregate. These taxa need further investigation.

Given the importance of seeds in the *Polygala* s.s. taxonomy and identification, field botanists are strongly encouraged to include mature fruits in their collections.

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