The taxonomic position of *Pelargonium appendiculatum* (Geraniaceae)

Elizabeth M. Marais

Department of Botany, University of Stellenbosch, Private Bag X1, Matieland 7602, Republic of South Africa

e-mail: emm@land.sun.ac.za

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*Pelargonium appendiculatum* (L.f.) Willd., a deciduous geophyte with tuberous roots covered with peeling tunics, was, on account of morphological attributes, previously placed in section *Hoarea* (Sweet) DC., but DNA analysis revealed a closer linkage between *P. appendiculatum* and *P. hirtum* (Burm. f.) Jacq., *P. torulosum* E.M. Marais and *P. stipulaceum* (L.f.) Willd. The latter three species belong to section *Ligularia* (Sweet) Harv. s. str. A detailed comparison between the morphological characters of *P. appendiculatum* and those of the species of section *Ligularia* s. str. was made. Similarities in floral morphology confirm the closer relationship of *P. appendiculatum* with the species of section *Ligularia* and it should thus be transferred to this section.

**Keywords:** Geraniaceae, *Pelargonium*, section *Hoarea*, section *Ligularia*, taxonomy.

**Introduction**

Originally *Pelargonium appendiculatum* (L.f.) Willd. was described as a tuberous species with radical leaves (Linnaeus 1781) and in the subdivision of the genus *Pelargonium* L'Hér., De Candolle (1824) placed *P. appendiculatum* together with *P. triste* (L.) L'Hér. and *P. lobatum* (Burm. f.) L'Hér. in a subgroup of the section *Isopetalum* (Sweet) DC. because of their tuberous roots, short stems and divided leaves. Don (1831) stuck to the association of *P. appendiculatum* with *P. triste* and *P. lobatum*, but placed them in section *Pelargonium* DC. Ecklon and Zeyher (1835) defined the genus *Hoarea* Sweet as stemless species with tuberous roots covered with tunics, and were the first to place *P. appendiculatum* in the genus *Hoarea* since the tubers of *P. appendiculatum* do have peeling periderms. Harvey (1860) and Knuth (1912) followed Ecklon and Zeyher (1835) in the association of *P. appendiculatum* with stemless species of which the tubers are covered by peeling tunics, and regarded *P. appendiculatum* as a member of section *Hoarea* (Sweet) DC. Young plants of *P. appendiculatum* and plants growing in the protected environment of the garden, develop a single tuber with several stem-growing points which are typical for section *Hoarea*. In plants exposed to heavy grazing the stem-growing points develop into stem increments forming an extensive branched system. The annual increments, terminated by leaves, are clearly distinguishable on these branches. This branched system is atypical for section *Hoarea*. On the other hand both the stem increments and the tuberous roots are covered with peeling periderms and this, together with the apical crown of petiole remains, are typical for section *Hoarea*. The five fertile stamens of *P. appendiculatum* and the very long hypanthium together with a very short pedicel (1 mm) are also typical for section *Hoarea*, although these characters are not unique for section *Hoarea*. A unique character of *P. appendiculatum*, which is also atypical for section *Hoarea*, is the exceptionally large, persistent, ear-shaped stipules.

According to (Bakker et al. 1999) a phylogenetic analysis of the trnL (UAA) 3'exon-trnF (GAA) exon chloroplast DNA regions revealed a close linkage between *P. appendiculatum* and *P. hirtum* (Burm. f.) Jacq., *P. torulosum* E.M. Marais and *P. stipulaceum* (L.f.) Willd. Considering the large membranous stipules of *P. appendiculatum* which are very similar to that of *P. stipulaceum*, and the tendency of *P. appendiculatum* to form stem increments similar to those of *P. stipulaceum* and to a lesser degree to *P. torulosum* and *P. hystrix* Harv., a detailed comparison between the morphological characters of *P. appendiculatum* and the species proposed by Albers et al. (1992) to be included in section *Ligularia* (Sweet) Harv. s. str. (hereafter referred to only as section *Ligularia*) was made.

**Material and Methods**

Data for the present study have been accumulated from living plants collected in their natural habitats and cultivated in the Botanical Garden at the University of Stellenbosch, herbarium specimens and different resources of published data (Table 1).

**Results and Discussion**

Although *P. appendiculatum* is a geophyte, there is a tendency for it to become a subshrub. This fits in well with the majority of species included in section *Ligularia* which are subshrubs usually reaching a height of not more than 300 mm, although *P. stipulaceum* and *P. pulchellum* Sims can grow up to 500 mm and *P. fulgidum* (L.) L'Hér., a scrambler, can even reach a height of 1 m. Only *P. hystrix* develops a tuber (Van der Walt & Vorster 1981) and to a lesser extent *P. pulchellum* (Van der Walt 1977), but none of them develops flaking periderms covering the tuber.

The annual increments on the branches of *P. appendiculatum* are clearly distinguishable, forming moniliform, succulent stems.

**Table 1** List of taxa and references used for morphological characters

<table>
<thead>
<tr>
<th>Species</th>
<th>Reference(s)</th>
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</thead>
<tbody>
<tr>
<td><em>P. appendiculatum</em> (L.f.) Willd</td>
<td>Van der Walt &amp; Vorster (1988); Marais (1994)</td>
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<td><em>P. crossipes</em> Harv.</td>
<td>Van der Walt (1977)</td>
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<tr>
<td><em>P. fulgidum</em> (L.) L'Hér.</td>
<td>Van der Walt (1977)</td>
</tr>
<tr>
<td><em>P. hirtum</em> (Burm. f.) Jacq.</td>
<td>Van der Walt (1977)</td>
</tr>
<tr>
<td><em>P. hystrix</em> Harv.</td>
<td>Van der Walt &amp; Vorster (1981); Marais (1990)</td>
</tr>
<tr>
<td><em>P. oreophilum</em> Schltr.</td>
<td>Van der Walt &amp; Vorster (1981)</td>
</tr>
<tr>
<td><em>P. pulchellum</em> Sims</td>
<td>Van der Walt (1977)</td>
</tr>
<tr>
<td><em>P. stipulaceum</em> (L.f.) Willd.</td>
<td>Marais et al. (1981); Van der Walt &amp; Vorster (1981); Marais (1990)</td>
</tr>
<tr>
<td><em>P. torulosum</em> E.M. Marais</td>
<td>Marais (1990)</td>
</tr>
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very similar to that of *P. stipulaceum*. However, the most striking character which *P. appendiculatum* shares with section *Ligularia* is the exceptionally large, persistent, ear-shaped stipules, like in *P. stipulaceum*. *P. pulchellanum* and sometimes *P. fulgidum*.

The closely spaced, finely divided, deciduous leaves of *P. appendiculatum* fit in well with the majority of species of section *Ligularia* and the cream-coloured to pale yellow flowers are similar to those of *P. stipulaceum*, *P. torulosum* and *P. hystrix* (Marais 1990). The similarities in the flowers of these four species also include the spathulate to ligulate petals, the long, straight, protruding stamens which are more or less the same length as or slightly longer than the sepals, and the very long hypanthia. Although the hypanthium length of *P. appendiculatum* (60–100 mm) exceeds that of all the species in section *Ligularia*, the combination of a very short pedicel (0.5–1 mm) together with a long hypanthium (> 40 mm) is shared with *P. stipulaceum*, *P. torulosum* and *P. hystrix* (Marais 1990).

Although the majority of species in section *Ligularia* have seven fertile stamens, *P. torulosum* has only four fertile stamens and *P. hystrix* four or five. Thus, *P. appendiculatum* with five fertile stamens is not an exception and does fit into section *Ligularia* in this respect.

According to Marais (1990) and Stafford and Gibby (1992) the tectum of the pollen grains of section *Ligularia* varies between striate/reticulate, coarsely reticulate and reticulate. The striate/reticulate tectum of *P. appendiculatum* (Marais 1994) fits in well with that of *P. torulosum*, *P. hystrix*, *P. stipulaceum*, *P. hirtum* and *P. oceplatum* Schlr. The size of the pollen grains of *P. appendiculatum* (77–85 µm) Marais (1994) is very similar to that of *P. hirtum* (69–84 µm), *P. oceplatum* (74–84 µm) and *P. serviculatum* J.JA. van der Walt (64–82 µm) (Albers et al. in press).

The chromosome numbers of the nine species of section *Ligularia* (Albers et al. 1992) as well as that of *P. appendiculatum* (Gibby et al. 1996) are all 2n = 22 and all the species concerned belong to the group of *Pelargonium* species with small chromosomes (Bakker et al. 1999).

Although the type of tuber and the peeling periderms of the tuber as well as the stem increments of *P. appendiculatum* fit in very well in section *Hoarea*, and although other similarities in the morphology between *P. appendiculatum* and other *Hoarea* species do exist, no species in section *Hoarea* resembles *P. appendiculatum* to the same extent in terms of floral morphology than *P. stipulaceum*, *P. torulosum* and *P. hystrix*. With regard to flower and pollen morphology, the ear-shaped stipules, the tendency to form stem increments and chromosome number, *P. appendiculatum* fits in well with section *Ligularia* as suggested by the DNA results and should be placed in this section.

**Taxonomy of *P. appendiculatum***

*Pelargonium appendiculatum* (L.f.) Willd., Species Plantarum 3: 651 (1800); Pers.: 228 (1806); DC.: 662 (1824); Spreng.: 53 (1826); G. Don: 736 (1831); Steud.: 677 (1840); Steud.: 283 (1841); Harv.: 270 (1860); Knuth: 349 (1912); Van der Walt & Vorster: 7, fig. (1988). TYPE - Western Cape Province: ‘Habitat in Africa’ sub LINN 83892 (LINN, lectot, designated here).

*Geranium appendiculatum* L.f.: 304 (1781); Murray: 618 (1784); Cav.: 262, t. 121, f. 2 (1787); Thunb.: 116 (1800); Thunb.: 529 (1823).

*Hoarea appendiculata* (L.f.) Ekcl. & Zeyh.: 65 (1835).

*Geraniopsemnium appendiculatum* (L. f.) Kunze: 94 (1891).

An aromatic geophyte 150–300 mm tall when in flower. Tubers: a turnip-shaped root, branched, forming numerous stem-growing points in older plants; branches covered with flaking periderms, 10–25 mm in diameter; tuberous system forming clumps up to 500 mm in diameter. Leaves greyish green, petiole: lamina elliptic to ovate in outline, irregularly hypogynious or tripogynious, 30–110 mm long; pinnae 12–35 mm long, deeply incised, segments 0.5–1 mm wide, apices rounded, densely villose interspersed with glandular hairs; petiole 10–130 mm long and 2–5 mm in diameter. Rigid, erecto-patent, villose with glandular hairs interspersed; stipules very conspicuous, oblong or ear-shaped, rigid, patent, adnate to petals for two thirds of their length, 15–30 mm long and 8–12 mm wide, densely hisrate with appressed hairs. Inflorescence: scape 10–30 mm long, 2–7 mm in diameter, branched, bearing 2–3 pseudo-umbelllets with (4–)6–15 flowers each: peduncles 40–140 mm long, 2–5 mm in diameter, green, densely covered with short glandular hairs interspersed with long soft patent non-glandular hairs; bracts lanceolate to ligulate, 7–9 mm long; 1.5–5 mm wide, adaxially hisrate with appressed hairs and abaxially hisrate with long patent hairs interspersed with short glandular hairs. Pedicel ca. 0.5 mm long. Hypanthium 60–100 mm long, green, indumentum as on peduncle. Sepals 5, lanceolate, apices acute, 9–13 mm long, 1.3–3 mm wide, posterior one erect, others recurved, green with margins white, indumentum abaxially as on peduncle. Petals 5, pale yellow, patent during anthesis; posterior two spathulate with small pale pink or dark red blotches in the centre, bases cuneate, epigynous margin 17–23 x 4–7 mm; anterior three ligulate, bases attenuate, epigynous margin 15–20 x 2–4 mm. Stamens: staminal column 1–3 mm long, white; perfect stamens 5, initially straight, bending downwards during senescence, posterior one 8–10 mm long, lateral two 9–11.5 mm long, anterior two 11–13 mm long, white; staminodes 4–5 mm long; anthers yellow, ca. 2 mm long, pollen orange. Gynoecium ovary 4.5–6 mm long; style 3.5–4 mm long, pale green; stigma branches 2.5–3 mm long, pale green. Fruit: bases of mericarps ca. 7 mm long, without glandular hairs, tails 50–55 mm long. (Illustration: Van der Walt & Vorster 1988)

**Diagnostic features and affinities**

*P. appendiculatum* is characterised by the exceptionally large, ear-shaped stipules, hence the specific epithet. The colour and the form of the petals, as well as the structure of the androecium are very similar to those of *P. stipulaceum*, *P. torulosum* and *P. hystrix*. All species have pale yellow, spathulate to ligulate petals and stamens more or less the same length as or slightly longer than the sepals. Initially the stamens are straight, but during senescence they bend downwards. All these species have very long hypanthia together with very short pedicels. Because of the exceptionally long hypanthia of *P. appendiculatum* (60–100 mm) and *P. stipulaceum* (40–60 mm) as well as their flower colour, geographic ranges and flowering time, Manning and Goldblatt (1997) regarded these two species as probably belonging to the *Mucigisthychus longirostris* pollination guild. However, autogamy for *P. appendiculatum* should also be considered. For many *Pelargonium* species fruitset under cultivated conditions is rare and can probably be ascribed to the absence of a suitable pollinator (Marais 1994). Fruitset in *P. appendiculatum* in the Botanical Garden at Stellenbosch was almost 100%, probably an indication of autogamy, which was confirmed by Meve (1995).

**Geographical distribution and ecology**

*P. appendiculatum* is known from a small distribution area along the Langevlei River near Leipoldtville (Figure 1). During the previous century J.F. Drège collected it at Brakfontein along the Olifantsrivier and during the first half of this century a few collections were made near Clanwilliam. However, since the start of this research project at the University of Stellenbosch in 1975, no collection of this species was made in this area. *P. appendiculatum* is a very robust species and should be obvious in the veld, but it is also known that these plants are heavily grazed by sheep and as this area is extensively cultivated, it is possible that its
distribution has shrunk and is now confined to the Langvlei area. *P. appendiculatum* grows in deep coastal calcareous sands in west coast strandveld in an area with an annual rainfall of 200–300 mm. It flowers from September to October.

Material studied

—3218 (Clanwilliam): Farm Langdam, Graaffwater (AB), Engelbrecht s.n. (STEU); Langvlei (AB), Thunberg s.n. (Sx2, UPS); Ecklon & Zeyher 503 (G. K. L., MEL, MO, P, S, SAM, TCD, Wx2, WU, Z). Along Langvlei near Leipoldtville (AB), *Van der Walt* 1429, 1430 (STEU); De Brug, Clanwilliam (BB), Adamson s.n. (BOL); Bergvalley (-BC), Zeyher 80.10 (PRE); Olifantsrivier, near Brakfontein (BD), Drège s.n. (MELx2).

—Specimen without precise locality: "Habitat in Africa" sub LINN 858.92 (LINN).

References


