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SALVIA PLEBEIA R. BR.: TAXONOMY, PHYTOGEOGRAPHY, AUTOGAMY AND MYXOSPERMY

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Abstract

Different attributes of the remarkable *Salvia plebeia* R.Br. (Lamiaceae) are reviewed. Its range is from Iran throughout Asia to Australia. The curious distribution disjunction of c. 4000 km between SE Asia and E Australia and its status, native or introduced, are discussed. The name is here typified with a specimen from Australia. In Asia, *S. plebeia* almost always grows in secondary habitats. In Australia, where it is the only representative (excluding aliens) of the genus, it usually grows in undisturbed habitats. Everywhere, it is remarkably oligomorphic. It has some of the smallest corollas in the genus and our observations showed that it is frequently autogamous, a rare occurrence in *Salvia*. Using innovative SEM technology, the mucilage produced by wetted nutlets was studied. Pollen from four separate areas of its range was examined with light microscopy and SEM. In both these investigations, and the morphological ones, we did not detect significant differences to support recognizing infra-specific taxa the species merits a broad-based molecular analysis.

Introduction

Salvia plebeia is an oddity in a vast almost cosmopolitan genus of over 900 species. With some of the smallest flowers in *Salvia*, a huge distributional range and taxonomically isolated, it was first described from Japan in 1784 by Thunberg as *Ocimum virgatum*, an epithet already existing in the genus. Robert Brown, presumably unaware of Thunberg's species, described it in 1810 from Australia as *Salvia plebeia*. In Asia, it occurs from Iran and Afghanistan to China, Japan and southwards to SE Asia; it is apparently absent from New Guinea and most of Indonesia. Throughout this area, it is a common field weed. In Australia, it usually grows in natural habitats. It has been recently suggested that it is here, in Australia, an introduced species with an Asian provenance (Froissart, 2007). Although *S. plebeia* is dealt with in most of the numerous local Floras where it grows, it has never been critically assessed throughout its total distribution. Also, the name has never been formally typified and its allies and place in the genus never given serious consideration. *S. plebeia* has long been used in folk medicine in Asia; and there are numerous relevant Indian and Chinese references in the literature. Today, these medicinal properties are being more seriously investigated and a sound taxonomy behind this kind of research is most desirable. Another aim of the present paper is to give a new insight into the structure of the mucilage produced by the nutlets on wetting and it also gives a clearer description of pollen morphology.

S. plebeia R. Br., Prodr. Fl. Nov. Holl. 1: 500 (1810)

Salvia brachiata Roxb., Hort. Bengal. 4 (1814) – *nomen*; Roxb., Fl. Indica, ed. Carey & Wallich, 1: 146 (1820); Fl. Indica, ed. Carey 1: 145 (1832).

Lectotype (selected here)**:** A specimen in the Edinburgh herbarium labelled, apparently in Roxburgh's handwriting, as "*Salvia brachiata* R." (E!). *Salvia minutiflora* Bunge, Enum. Pl. China Orient. [Mém. Acad. Sc. St. Petersb. Sav. Étrang. 2] 124 (1832). (microfiche G-DC!; a poor specimen).

Ocimum virgatum Thunb., Fl. Japon. 250 (1784) ["crescit prope Nagasaki]". Type: Thunberg herbarium – microfiche 13795 (UPS!). *Nota*: Although *Ocimum virgatum* is the earliest valid description of the plant known today as *S. plebeia*, when transferred to *Salvia* the epithet is pre-dated by that of the widespread SW Asiatic/European *S. virgata* Jacq. (1770).

***Cf* also Appendix 1**

Type locality (as cited). [Australia] "J. [vicinity of Port Jackson (Sidney) including banks of the estuary named as Hunter's river or Coal River (N Newcastle)] – *v.v.".*

Lectotype selected here: Australia: R. Brown Iter Australiense 1801-1805. New South Wales: banks of Paterson's river between Mt Anna and Mt Elizabeth [32° 39' S and 151° 31' E], Oct. 1804, no 2393 (BM!); isolectotype: Paterson's river, 2393 (E!).

Typification: The first set of Robert Brown's Australian plants is housed at the British Museum (BM) and three specimens there are candidates for lectotypification; all were labelled as "type collection" though none is clearly linked with the original type citation. All are from New South Wales: 1, Hawkesbury, Nepean and Paterson's river; 2, Hawkesbury and Nepean rivers; 3, banks of Paterson's river, between Mt Anna and Mt Elizabeth. The latter two bear the number 2393, given by J. J. Bennett at a much later date than that of the original collection (*cf* Stearn xxvii, 1962). A forth specimen with the same number is at Edinburgh (E) where is the 3rd main set of Brown' specimens; the second set being at Kew. The specimen chosen above as lectotype agrees best with the protologue, it has a date and a more precise locality than the other specimens and we have chosen it even though it is in full fruit and with no flowers.

From his diary, both text and maps (Mabberley, 1985; Vallance *et al*., 2001), Brown was on a boat journey up Paterson's river [=Hunter river] on the 18th October 1804; on the 19th he was 2 miles above Mt Anna; on the 20th he reached the base of Mt Elizabeth and returned to Kingston [=Newcastle] on the 23rd. Therefore, the type locality of *S. plebeia* "between Mt Anna [= Comersford Hill] and Mt Elizabeth [= Mt Hudson]" is near to present-day Rosebrook at 32° 39' S; 151° 31' E.

lllustrations: There are numerous illustrations in many different Floras and revisions; most giving a correct impression of its facies and floral/fruiting parts, but none as detailed as that given here in Fig. 1. However, one cited in Index Londonesis: "Rumphius, Herb. Amboin. vii, Auct. t. 21, fig. 2 (1755); fide Merrill, Intrep. Rumph. Herb. Amboin. [457, 1917]" is erroneous. Our studies of Rumphius's original text, in Latin and Dutch, and the unhelpful drawing led us to the conclusion that Rumphius's "*Tschintschau javanense*" probably was a Labiate, but not a *Salvia* and maybe an *Ocimum.*

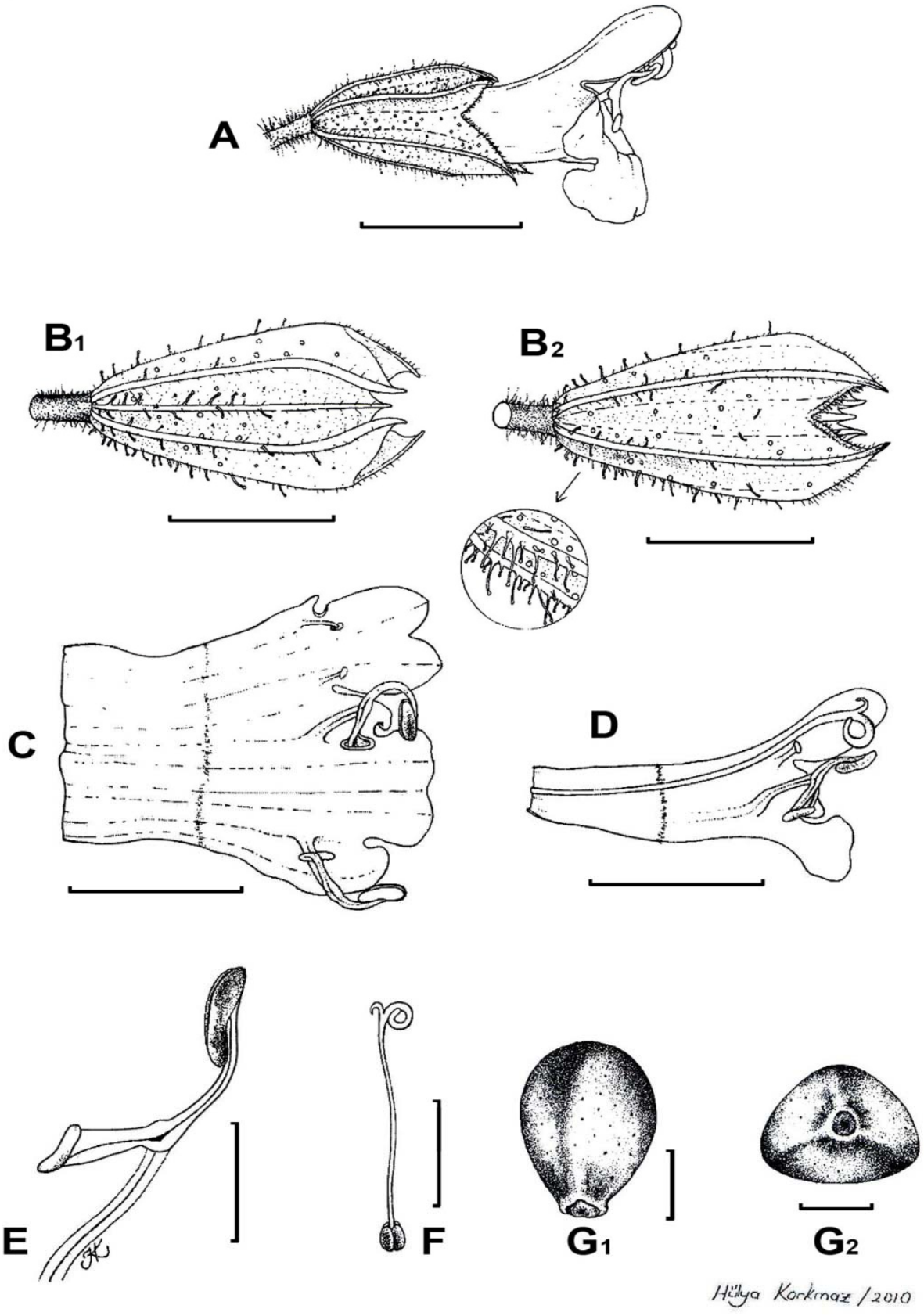

Fig. 1. *Salvia plebeia* R.Br. (Australia, *Bean* 22660). A, flower side view; B, calyx dorsal and C, ventral views with glandular indumentum; D, corolla open showing annulus, staminal position and staminodes; E, internal longitudinal view of flower; E, stamen showing the point of possible articulation; F, ovary, style and un-equally bilobed stigma; G, nutlet side view; H, nutlet basal view. Scale bar: a, c, d, f = 3 mm; b = 2 mm; e = 1 mm; g = 0.5 mm.

Distribution: For an approximate distribution map *cf* Froissart (2007). *Asia*: It is very common in India, China, Japan and uncommon to rare in SE Asia. Iran (southernmost Baluchistan); E. Afghanistan; Pakistan (Peshawar, Chitral, Swat, Sind); Kashmir; throughout most of India (often abundant); Nepal, Bhutan, Sikkim; easternmost Russia (considered adventive in lake Khanka area); Burma/Myanmar; throughout most of China; Taiwan (widespread); Bangladesh (*J. Bot.* 6(1): 107. 1977); Laos, Cambodia*;* Malaysia; Korea (widespread); Japan; Okinawa (Miyako); N. Sumatra; Philippines (Luzon – very rare). It is absent, as far as known, from Sri Lanka, Tibet, Thailand, Fiji, Java, Irian Jaya, New Guinea (a record in *Gard. Bull. Sing*. 24: 162. 1969 is based on a plant cultivated in Lae Bot. Gard.) and surrounding islands.

***Australia*:** Queensland (east in 8 districts as far north as N Kennedy and, marginally, Cook); New South Wales (east, 5 districts north from Bathurst); Victoria (very rare in Snowy River National Park). Almost all these localities are to the east of the Great Dividing Range. With a north to south range of c. 2,000 km, it spans two very different climatic areas, from those with a summer to those with a winter rainfall.

The early collections of the species in Australia were in natural habitats from remote localities far distant from the penal settlements established in the late 1700s. After R. Brown in 1804, Thomas L. Mitchell also collected it during his travels from Port Jackson towards the Gulf of Carpentaria (Mitchell, p. 366, 1848). Although no specimen of Mitchell has been seen, there seems no reason to doubt its determination being the botanical contents in his travel book supplied by G. Bentham and J. Lindley; he also referred to R. Brown. Mitchell's plant was seen, in modern day equivalents, to the north of Mitchell, towards the source of the rivers Maranoa and Merivale near Warrong. This is an area that today is within the Carnarvon National Park. In the 1850s, F. von Müller and his party of explorers also collected the species. They were the first Europeans to traverse the Burdekin river area in northern Queensland.

Habitat: Asia: Almost always collected and recorded from disturbed, usually damp habitats, especially rice and marrow fields; waste ground; edge of ditches and streams; sandy open dry slopes. From near sea level to 2,400 m. Australia: Margins of rain-forest, open areas in forest, roadside; often on limestone; rocky or sandy verges of river, creek-banks; consistently growing in unmodified habitats.

Local names: In almost every Asian country where the species grows, there is a local name, even in countries where it is uncommon such as Sumatra. In India, individual states and regions have different names for it. This abundance of local names may relate to its widespread use in folk medicine.

Morphology: Usually, either an annual or biennial erect aromatic herb, but in some local Floras occasionally described as perennial *S. plebeia* is surprisingly constant, considering its huge range, in its vegetative and floral features. Other than quantitative differences in height and leaf, there is little variation. Only one infra-specific taxon (var. *latifolia* Stibal, Acta Hort. Gothob. 9: 141. 1934) has ever been recognised throughout its total range and that only on its broader leaves. We were unable to detect any significant differences between Asiatic and Australian specimens, although the Australian ones we studied tended to have a more obviously concave upper lip on the fruiting calyx and a more prominent inflorescence indumentums (Fig. 1. B1, B2). Overall, the flowers can be

appreciably smaller than the dimensions given in most Flora descriptions. The smallest measured had calyx 1mm long in flower and a corolla 2 mm long. Flower colour varies in field notes: pale blue, pink, white, light purple, mauve, violet. Indumentum, calyx form and size in flower (1-3mm long) and fruit (3.5-5mm long), corolla form and size (2-5mm long) and staminal features are quite constant. The corolla tube is ± straight, annulate, not squamulate within, and the galea is ± straight (Fig. 1. C, D). The stamens, fully included under the corolla upper lip (Fig. 1. D), have one small fertile theca, a short connective and project was to assess whether variable pressure SEM could be used and add new information about it. The variable pressure SEM technique used here was innovative and the other theca reduced to ± oblong sterile tissue loosely attached to the other sterile theca (Fig. 1, E). It was not possible to determine whether or not there was an articulation at the junction of the connective and filament, although the impression was that there was no articulation, but observation of living material is needed. The style does not or scarcely projects beyond the upper lobe of the corolla (Fig. 1. A, D); the bilobed stigma has remarkably dissimilar arms, a feature rather uncommon in the genus, the anterior arm prominently more strongly developed than the posterior one (Fig. 1. D, F). There is little variation in nutlet size, 0.7-1 x 0.6-0.7 mm, and surface texture (Fig. 1. G1, G2). The nutlets are strongly mucilaginous on wetting (Fig. 2). The combination of all the characters listed above is certainly very unusual in the genus. A full description of the species in cultivation is given by Froissart (2008) where there is also a coloured photograph.

Uses: There are many references to the use of the species in folk medicine throughout its subtropical and tropical ranges in Asia: seeds used to treat gonorrhoea; promote sexual power and cure seminal weakness; as diuretic, vermifuge and astringent; for toothache. In parts of India, the mucilaginous seeds are employed to anoint hair to keep it glossy. One field-note on a Chinese specimen (at E) has "... *champs à rize ou la mange quand elle sort de terre*". Its uses and various chemical constituents are reported (Council of Scientific and Industrial Research, 1972, 2004) and further research to support its traditional medicinal uses has started Jiang & Wang, 2006). The species is occasionally also under cultivation (Froissart, 2008).

Autogamy: Autogamy in *Salvia*, a genus universally strikingly adapted to cross-pollination by insects and birds (*cf* Huck, 1992), is apparently unusual. But in *S. plebeia* a few floral features indicative of an autogamous species are present: (1) remarkably few of the many herbarium specimens investigated bore flowers, the great majority being in fruit, i.e., flowers must be very short-lived and pollinated quickly; (2) the corollas are very small, frequently not significantly longer than the calyces with the anthers enclosed under the corolla upper lip, i.e., very few pollination vectors could act in such small space. (3) The large stigma arm, also enclosed within the galea, was frequently covered with much pollen, i.e., pollination seems to be efficient; (4) nutlet production per plant is remarkably high, i.e., reproduction is very successful; the very small thecae have a low number of pollen grains to the 4 nutlets in a flower this implying a low pollen to ovule ratio (P/O), the Cruden's index (1977). The lowest P/O values (1) indicate the highest efficient pollen transfer rates, as in cleistogamous flowers.

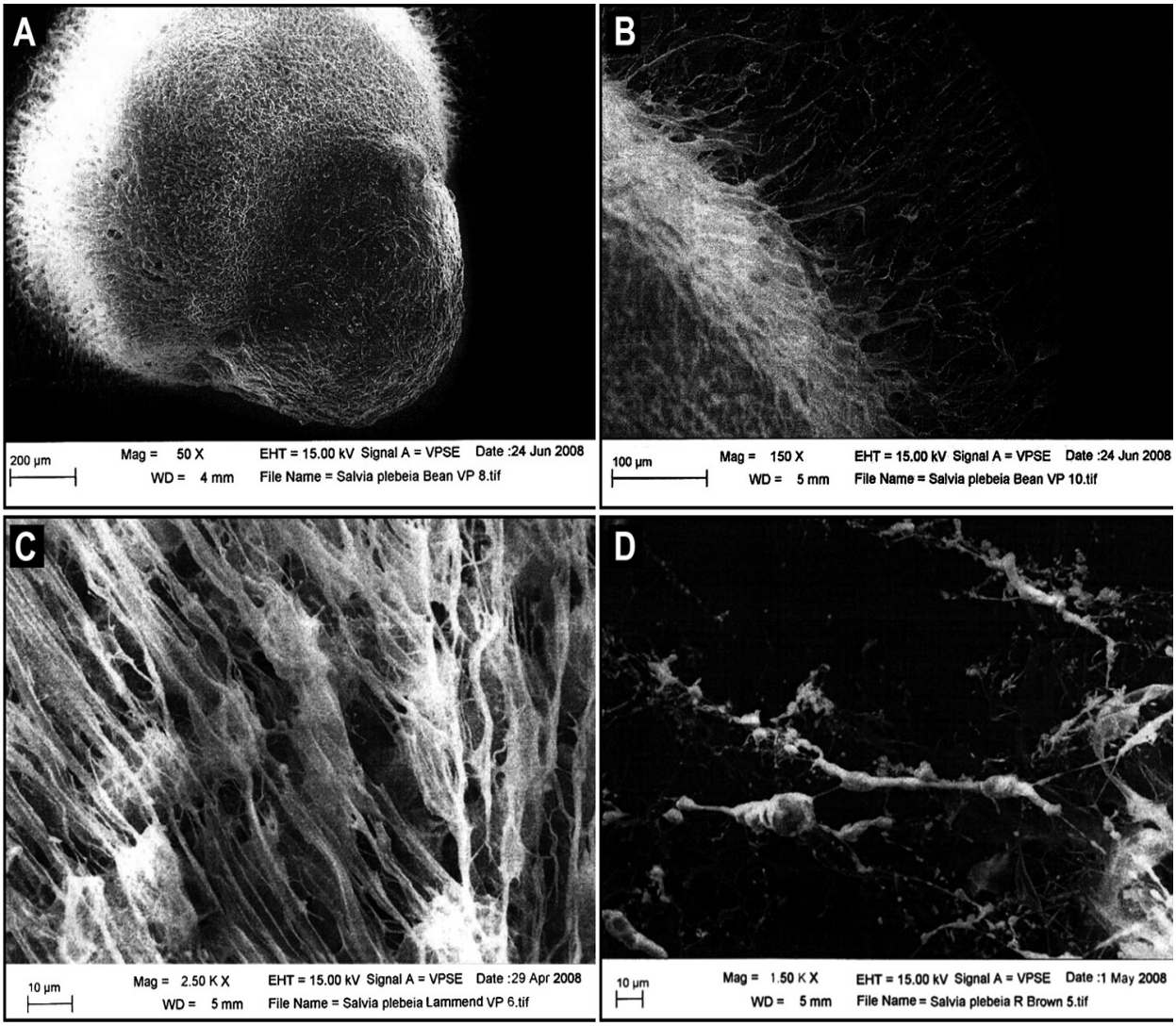

Fig 2. *Salvia plebeia* R.Br., nutlet mucilage observed under variable pressure scanning electron microscope. A (*Bean* 3727), Upon wetting the left hand-side of the nutlet developed thick strands of mucilage from the base; B (*Bean* 3727), The edge of the mucilage as it expands; C (*Lamond* 828), Flat strands of mucilage and occasional irregularly cylindrical strands; D (*Lamond* 828), Irregularly cylindrical strands of mucilage and some flat strands

Some very polymorphic species such as the Euro-Mediterranean *S. verbenaca L.* can have cleistagamous, male-sterile and self-fertile flowers. We are unaware of comparable autogamous examples among the Asiatic salvias. However, some S American and southern African species are autogamous (Wester, *in litt*.).

Nutlet mucilage: The mucilage of wetted nutlets of 20 Afghanistan species was earlier studied (Hedge, 1970; *cf* also Grubert, 1974). The results showed that there were significant differences in the structure of the mucilage produced and that this was a character of some taxonomic value in the genus. The morphologically more distinct species tended to have the more distinctive mucilage. *S. plebeia*, one of the species then studied, came into the latter category. In the present investigation, *S. plebeia* nutlets were sampled from widely different areas of its distribution. Light microscopy was again used, but a further aim of the project was to assess whether variable pressure SEM could be used and add new information about it. The variable pressure SEM technique used here

was innovative and did not produce the artefacts caused by the high vacuum SEM on drying and coating such delicate material. It did facilitate the observation of the fine structure of the mucilage strands both on the periphery of the nutlet and within the extended meshwork.

Materials and Methods

Plant material is cited in Appendix 2

High Vacuum: Nutlets were mounted on aluminium stubs using sticky carbon disks and submerged under a droplet of distilled water. After 5 minutes the nutlets were air dried. They were sputter coated with platinum using an Emitech K575X sputter coater for 2 minutes. The samples were then scanned using a LEO Supra 55VP SEM under high vacuum at 5kV at a working distance of 11 mm. Observations were recorded as 3mB.tif image files. 'Non-wetted' nutlets were also scanned as a control.

Variable Pressure: Nutlets were stub mounted and submerged as before. Excess water was removed with velin tissue before the samples were frozen on a Deben peltier coolstage to -25^{o} C. The nutlets were then scanned in Variable Pressure Mode at 50 Pascals using 15 kV at a working distance of 5 mm. Observations were recorded as 3mB.tif image files.

Results

High Vacuum: A halo of flat, filamentous structures was seen radiating from the nutlet with a dense 'collar' of filamentous material surrounding or partially surrounding the nutlet itself. No evidence of such features was seen in the 'non-wetted' samples.

Variable Pressure: All samples developed thick strands of mucilage from the base. The strands radiated outwards to form a thin meshwork surrounding the nutlet seemingly anchoring it to its substrate. The phenomenon was observed to varying degrees between samples. Upon wetting, the first Australian nutlet failed to react to water but the subsequent samples produced exudation from below (Fig. 2. A, C, D). There was a fine structure of mucilage strands of two types (flat and irregularly cylindrical) both around the periphery of the nutlet (Fig. 2. B) and within the extended meshwork (Fig. 2. C, D). The sample from Pakistan immediately exuded substantial mucilage all over its surface and surroundings. The Japanese nutlet exuded mucilage from below only after submergence for 5 minutes. The first Chinese sample failed to react but the second nutlet was almost immediately covered in mucilage after apparently swelling under the electron beam. A third nutlet produced very little mucilage from below.

Discussion and conclusions (1): The reaction of nutlets is very variable depending perhaps upon the maturity and age of the sample. Mucilage can still be produced by nutlets that are c. 200 years old. (2) High vacuum SEM can be used to demonstrate the presence of mucilage although the combination of drying and sputter coating leads to artefacts, e.g., the thickened collar around the nutlet is probably a function of the coating process whereby platinum coats the surface with a dense structure. (3) Variable pressure SEM facilitates the observation of the mucilage revealing a much finer structure than shown in the illustrations in Hedge (1970). It is also a technique which has several benefits over high vacuum SEM when looking at delicate material as it does not produce artefacts caused by drying and coating.

Pollen: *S. plebeia* was part of an early comparative palynological investigation involving 56 species in the genus (Henderson *et al*. 1968) and was then included in a large, otherwise heterogeneous group, with *S aegyptiaca* and other unrelated Old and New World species. The present investigation revealed no unique features in the pollen of *S. plebeia* (for plant material cf Appendix 2). Although pollen ornamentation in *Salvia* has some taxonomic value (Moon *et al*. 2008; Hassan *et al*. 2009), significant differences between taxa have not been found so far and major conclusions on relationships from palynology are not to be expected. Nevertheless, we noted the reticulate-perforate exine of *S. aegyptiaca* (Hassan *et al*. 2009), different from the bireticulate we found in *S. plebeia*. The grains are prolate (Fig. 3. A) and prolate-spheroidal (Fig. 3. B) in shape, hexacolpate, usually heterocolpate, and sexine ornamentation is bireticulate with little variation (Fig. 3. C, D); the polar axis (P) varied between 31.19-36.29 μm and the equatorial axis (E) varied between 22.58-31.67 μm; the P/E ratio varied between 1.04-1.38.

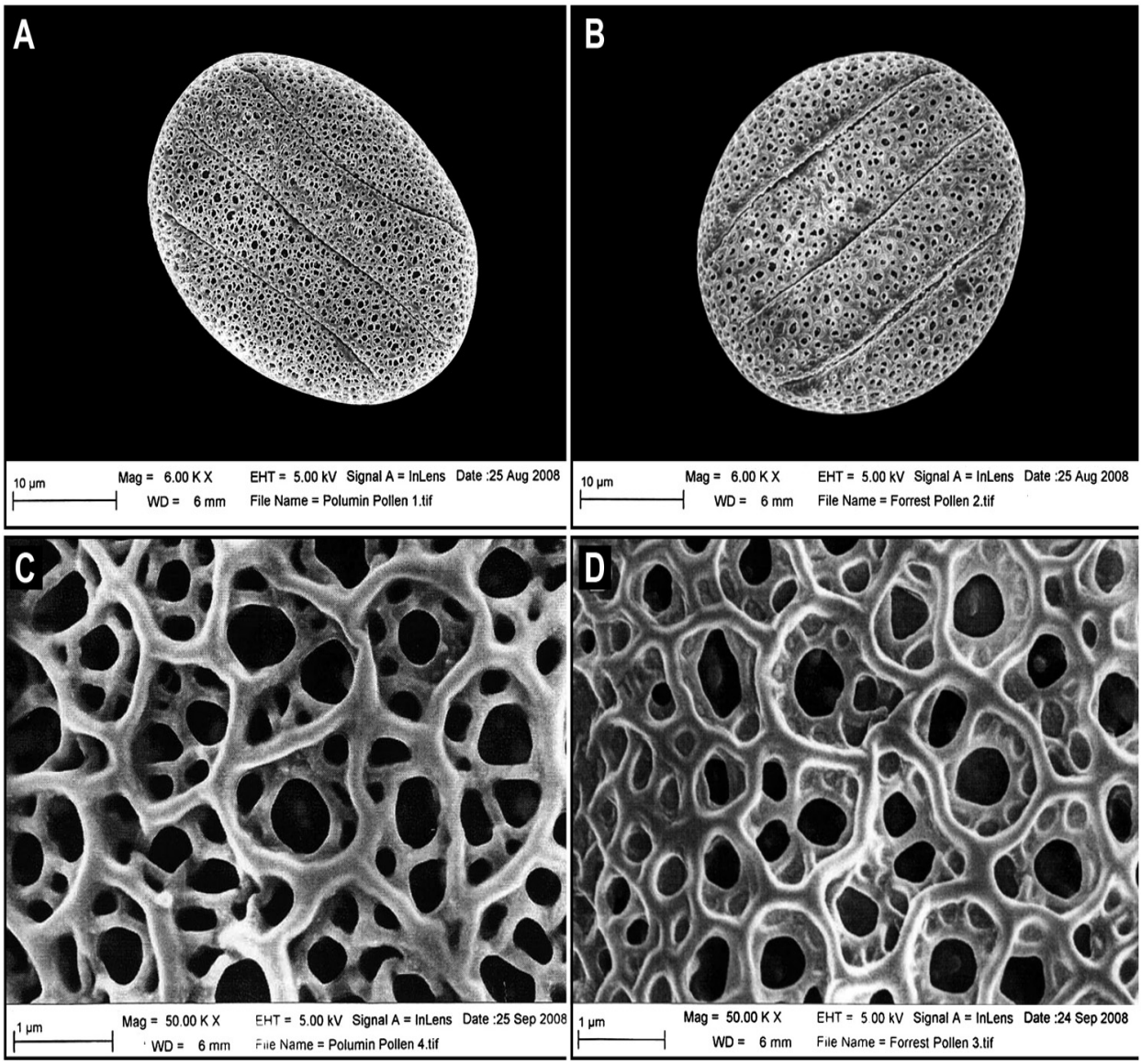

Fig. 3. *Salvia plebeia* R.Br., scanning electron micrographs of pollen grains. A (*Polunin et al.* 674), Prolate hexacolpate pollen grain; B (*Forrest* 4542), Prolate-spheroidal hexacolpate pollen grain; C (*Polunin et al.* 674) and D (*Forrest* 4542), Sexine bireticulate ornamentation.

Placement in the genus and relatives: The first attempt at an infra-generic classification of *Salvia* was that of Bentham (1833a, Jul. & 1833b, Aug.). In this August publication, intended as the precursor for the account in his monographic *Labiatarum* (1833a), but appearing a month after it, Bentham placed S. *plebeia* in his monotypic sect. *Notiosphace*, the name deriving from the Greek "*notio*", south, and "*sphace*", sage. In the *Labiatarum*, Bentham added to this section, but with a question mark, the desertic dwarf shrubby N African/SW Asiatic *S. aegyptiaca* L. In the *Prodromus*, Bentham (1848) added to the section, in addition to a number of species clearly allied to *S. aegyptiaca*, the east Asiatic *S. japonica* Thunb., *S. chinensis* Benth. and *S. fortunei* Benth. (=*S. japonica* var. *japonica*). Briquet (1897) in his global synopsis of the genus retained *S. plebeia* in sect. *Notiosphace,* but excluded the east Asiatic taxa. There are so many differences between *S. plebeia* and *S. japonica* and its allies (Stibal, 1935) in habit, calyx, corolla and stamen characters that they are surely unrelated. Briquet's over a century-old infra-generic treatment was the last attempt at a global classification of *Salvia* and today most recent Floras and relevant publications do not recognise infra-generic taxa. Staminal structure in the genus is a very important character and many of the infra-generic groupings are, or have been, based on its various forms (Baikova, 2004; Walker & Sytsma, 2007). That of *S. plebeia* is the same as in many Euro-asiatic species, but this does not provide any real clues as to a possible relative, other than it has no connection with Africa, Madagascar or the New World. Likewise, cytology does not help in assessing affinities, being 2n=16 common throughout the genus and occurring in otherwise unrelated species. Pollen characters, at least based on light microscopy (Henderson *et al*., 1968), are also unhelpful with little or no correlation with morphology and phytogeography.

Our conclusion is that *S. plebeia* is a very isolated species and, despite our researches, we still have no clear evidence on its allies. However, this is not unusual at least among the several hundred Old World *Salvia* species where there are many examples of easily recognised monotypic or oligotypic "species-groups" (Hedge, 1974), but they, unlike *S. plebeia,* have generally quite limited ranges.

Conclusions

This investigation provides a much clearer picture of the overall distribution of *S. plebeia* and confirms its small morphological variation. However, it is still not possible to be definitive as to whether *S. plebeia* is or is not native throughout its vast range; nor is it possible to pinpoint relatives, although its affinities should be with Asiatic taxa, neither African nor the New World. Despite suggestions that it is an introduced species in Australia in the late 1700s, all the evidence we have points to it being a native and, intriguingly, the only representative there of a huge genus with an almost cosmopolitan range. However, the possibility that it has an Asian origin and arrived to Australia in the very distant past by some means, such as man and his migrations, cannot be excluded (*cf* Froissart 2007). Conversely, maybe heretically, the migration could have gone the other way. In fact, it is in Asia that the species is almost always in man-affected habitats, which raises the possibility of long-range dispersal from Australia, e.g., migrating birds coming in contact with mucilaginous nutlets. Another scenario is that the species is, indeed, native everywhere and had once a continuous distribution interrupted probably by climatic changes in past millennia. The fact that it is such a taxonomically isolated species with a wide distribution suggests that it may be a very ancient species.

We endeavoured to find other taxa with comparable distribution in, e.g., *Anisomeles* (Lamiaceae), *Chlorophyton* (Asparagaceae), *Lysimachia* (Primulaceae), *Lythrum* (*Lythraceae*) and *Samolus* (Primulaceae), but with no success. However, Tony Bean drew our attention to *Hemisteptia* (*Saussurea*) *lyrata* (Bunge) Bunge (Asteraceae). This annual has a distribution remarkably similar to the sage: Nepal, India, Burma, China, Korea and then, apparently disjunctly, in Queensland and New South Wales. Interestingly, it was collected by Robert Brown in the early 1800s near the Paterson River where he also collected *Salvia plebeia*!

Although we have added much to our knowledge of the species, the follow-on would be the molecular approach. But only a molecular assessment of the Old World genus would answer to both its cryptic taxonomic and biogeographical positions. This would be, *inter alia*, a small contribution to understand the intricate origins of the Australian flora.

Appendix 1: Names or synonyms previously considered under *S. plebeia*

Salvia parviflora Roxb., Hort. Bengal. 4 (1814) – *nomen.* No specimens with this name and author have been traced. Therefore, its identity is impossible to determine. In *Hortus Bengalensis*, Roxburgh recognised *S. brachiata*, a synonym of *S. plebeia*, which implies that he considered *"S. parviflora"* different from it. In Roxburgh's *Flora Indica* of 1820 *S. parviflora* is not listed. Bentham (1833) equated it with *S. plebeia* but the reason is not clear.

Ocimum fastigiatum Heyne *ex* Roth, Nov. Pl. Sp. Ind. Orient. 277. 1821. In The International Plant Names Index (2008), the author is cited as Roth only but "H" is printed after the epithet in the species index and in the description Roth is indicated as being the author of the name.

The protologue gives a full species description that includes "*sub hoc nomine dedit Veneratiss. Benj. Heyne, qui in India orientali legit... Calyx labium superius … integerrimum; inferius quadrifidum … Stamina didynama … duo longiora…"*. These characters are not of *Salvia*, but always of *Ocimum*. However, two specimens with the label *O. fastigiatum*, one at B-WILLD (microfiche no. 11059!) the other at E, do not concur with this original description and are, in fact, *S. plebeia*! The specimen in the Willdenow herbarium is labelled "*Ocimum fastigiatum nobis,* May 1779, hab. in India, Klein Ind., Kuttanallur". The label on the Edinburgh specimen has "*Ocimum fastigiatum Nob. ab amic.* Heyne, Marz 15, 95. Herb Klein and Wall. L. n. 2149 K. To date, we have not traced any actual specimen that corresponds with the original description of *O. fastigiatum* nor have we been able to ascertain the currently recognised species of *Ocimum* – if any. But certainly the name *Ocimum fastigiatum* should not be given as a synonym of *Salvia plebeia.* Sprengel transferred *Ocimum fastigiatum* to the independent, no-longer accepted, genus *Lumitizera* as *L. fastigiata* (Roth) Spreng.

Although the apparent confusion of an *Ocimum* with a *Salvia* may seem surprising, some species of *Ocimum* have quite a marked general similarity with *S. plebeia.*

Appendix 2: Plant material

Nutlets of *S. plebeia* were sampled from herbarium specimens: Australia: Queensland, N. Kennedy, x. 1991, *Bean* 3727 (BRI). China: Shantung, Ching Shan, vii.

1930, *Chiao* 2809 (E). Japan: Musashi, Toda, 1908, *Herb. Yokohama nu.* (E). Pakistan: Sind, Karachi to Dadu, v. 1965, *Lamond* 828 (E).

Pollen grains of *S. plebeia* were sampled from herbarium specimens: Australia: Queensland, N. Kennedy, x. 1991, *Bean* 3727 (BRI). China: Kiangsu, Silitsin, d' *Argy s.n.* (E). Japan: Mino, 24.v.1880, *Bisset* 2250 (E); W Yunann, eastern flank of the Tali Range, 25^0 40' N, half shrubby plant, 6-1\2 in, flowers purple-blue, dry stony situations, margins of thickets, 7-9,000 ft, vii-viii. 1906, *Forrest* 4542 (E). Nepal: Lawamjula, weed of cultivated ground and gravelly runs by streamside, flowers pale violet, 3,000 ft, 28.iii.1952, *Polunin, Sykes & Williams* 674 (E). Pakistan: W Pakistan, Swat, Khawazakhiela to Shangla, roadside slopes, edges of cultivated fields, 1300 m, 2.vi.1965, *Lamond* 1705 (E).

Acknowledgements

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