

A revision of the genus *Eremaea* (Myrtaceae)

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Abstract

Hnatiuk, Roger J. A revision of the genus *Eremaea* (Myrtaceae). *Nuytsia* 9 (2): 137-222 (1993). *Eremaea* is a genus of shrubs and small trees endemic in south-western Australia. It has an unusual distribution in that 15 of its 16 species occur on or very close to the coastal plain (Irwin and Darling Botanical Districts) and one species extends throughout much of the non-forested areas of the South West Botanical Province. The genus is a significant component of the shrub layer of several vegetation types. Eight new species, 5 subspecies, and 8 varieties are described (*E. asterocarpa* subsp. *asterocarpa*, *E. asterocarpa* subsp. *histoclada*, *E. asterocarpa* subsp. *brachyclada*, *E. atala*, *E. hadra*, *E. beaufortioides* var. *beaufortioides*, *E. beaufortioides* var. *lachnosanthe*, *E. beaufortioides* var. *microphylla*, *E. blackwelliana*, *E. ebracteata* var. *ebracteata*, *E. ebracteata* var. *brachyphylla*, *E. x codonocarpa*, *E. dendroidea*, *E. ectadioclada*, *E. pauciflora* var. *pauciflora*, *E. pauciflora* var. *calyptra*, *E. pauciflora* var. *lonchophylla*, *E. x phoenicea*, *E. violacea* subsp. *violacea* and *E. violacea* subsp. *raphiophylla*). Keys to and descriptions of taxa, and illustrations of most taxa are presented. An index to taxa is given on page 222.

Introduction

Eremaea is a genus of shrubs and small trees in the family Myrtaceae. It occurs only in the south-western corner of Australia. Although it is a significant component of several vegetation types, it has not received any particular attention in taxonomic, ecological, or other botanical studies. At the time of commencement of the present study in 1977, the only published works were a treatment by Bentham (1867) and a series of miscellaneous taxonomic papers (Kuntze 1903, Domin 1923, Gardner & George 1963, Gardner 1964).

In the course of carrying out detailed ecological studies of the vegetation of the kwongan between Coomaloo Creek and Eneabba, north of Perth, the taxonomic richness of this genus was discovered. The study was initially believed to be a simple, small one, but it has revealed a taxonomic, and geographic diversity and complexity not previously known in this genus.

The first named species of *Eremaea*, *E. pauciflora* (Endl.) Druce (as *Metrosideros pauciflora* Endl.), was described in 1837. Over the next 127 years, 11 species (including 3 synonyms) were described, as botanical exploration of the south-west proceeded. The present study recognises 16 species, 5 subspecies and 8 varieties of *Eremaea*.

Eremaea was classified (Briggs & Johnson 1979) as a member of the Leptospermoideae sub-family, Leptospermum alliance and Calothamnus sub-alliance. The capsular fruits, basifixed anthers, slightly fused staminal filaments and small leaves are significant characters in this placement.

Conservation status is detailed in "Conservation Codes for Western Australian Flora" on page 305 of this issue of Nuytsia.

Methods

The general distribution of *Eremaea* was determined from specimens in the Western Australian Herbarium. A field collecting program was designed to allow monthly collections in the area from Perth to a little north of Eneabba. A single trip was made in December to collect from the north of the then known range of the genus to obtain material of *E. ebracteata* which was known to flower at that time. A single spring collecting trip was designed to cover much of the range of *E. pauciflora*.

Following the extensive collecting, specimens were sorted into broad morphological groupings based on characters of the fruits, leaves, and flowers. A selection of specimens was made from each group to represent morphologically complete specimens from throughout the geographic range of each taxon. This resulted in 87 specimens being selected.

Each of the 87 specimens was scored for the 59 characters listed in Table 1. These data were then analysed for patterns of association using the programs in the TAXON package available from CSIRO Division of Computing Research.

These analyses were phenetic and based on a range of morphologic characters. They were carried out specifically to search for patterns in the morphology of *Eremaea* as a means of understanding the complex variation found in the field.

The analyses used were MINSPAN, a minimum spanning tree which links similar pairs of specimens to show relationships in a non hierarchical manner (Figure 1), and MULCLAS to show a hierarchical classification (Figure 2). The similarity index used was the Euclidean metric.

Subsidiary field collections were made to obtain material (fresh flowers, young leaves and seeds) for use in isozyme analyses. The methods and results of this have been reported in Coates & Hnatiuk, 1990. The analyses of the isozyme data were cladistic in contrast to the phenetic analyses of the morphologic data.

Some seed from the first collections were sown at the Western Australian Herbarium and plants placed in that Garden. Unfortunately, most of the plants were lost to an invasion of grasshoppers. However, sufficient plants survived to provide some indication of morphological stability between generations.

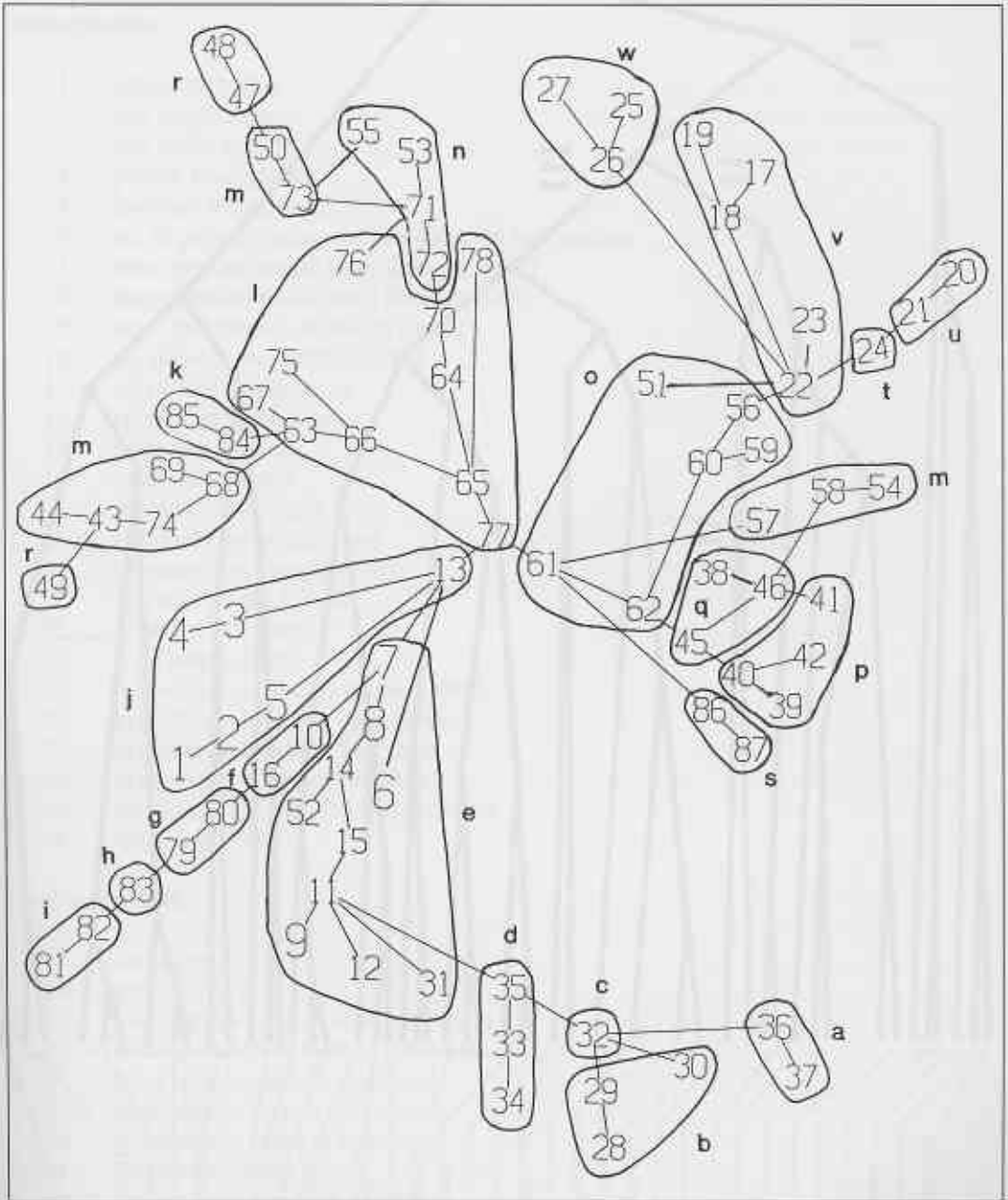


Figure 1. MINSPAN representation of similarities between the 87 *Eremaea* specimens of this study (see methods). Each specimen is linked to the one which is most similar to it. The shape of the illustration is arbitrary. Lower-case letters identify taxa: a: *E. brevifolia*, b: *E. asterocarpa* subsp. *asterocarpa*, c: *E. asterocarpa* subsp. *brachyclada*, d: *E. asterocarpa* subsp. *histoclada*, e: *E. ectadioclada*, f: *E. acutifolia*, g: *E. purpurea*, h: *E. ebracteata* var. *brachyphylla*, i: *E. ebracteata* var. *ebracteata*, j: *E. x codonocarpa*, k: *E. dendroidea*, l: *E. pauciflora* var. *pauciflora*, m: *E. pauciflora* var. *lonchophylla*, n: *E. pauciflora* var. *calyptra*, o: *E. x phoenicea*, p: *E. beaufortioides* var. *beaufortioides*, q: *E. beaufortioides* var. *microphylla*, r: *E. beaufortioides* var. *lachnosanthe*, s: *E. fimbriata*, t: *E. violacea* subsp. *violacea*, u: *E. atala*, v: *E. violacea* subsp. *raphiophylla*, w: *E. hadra*.

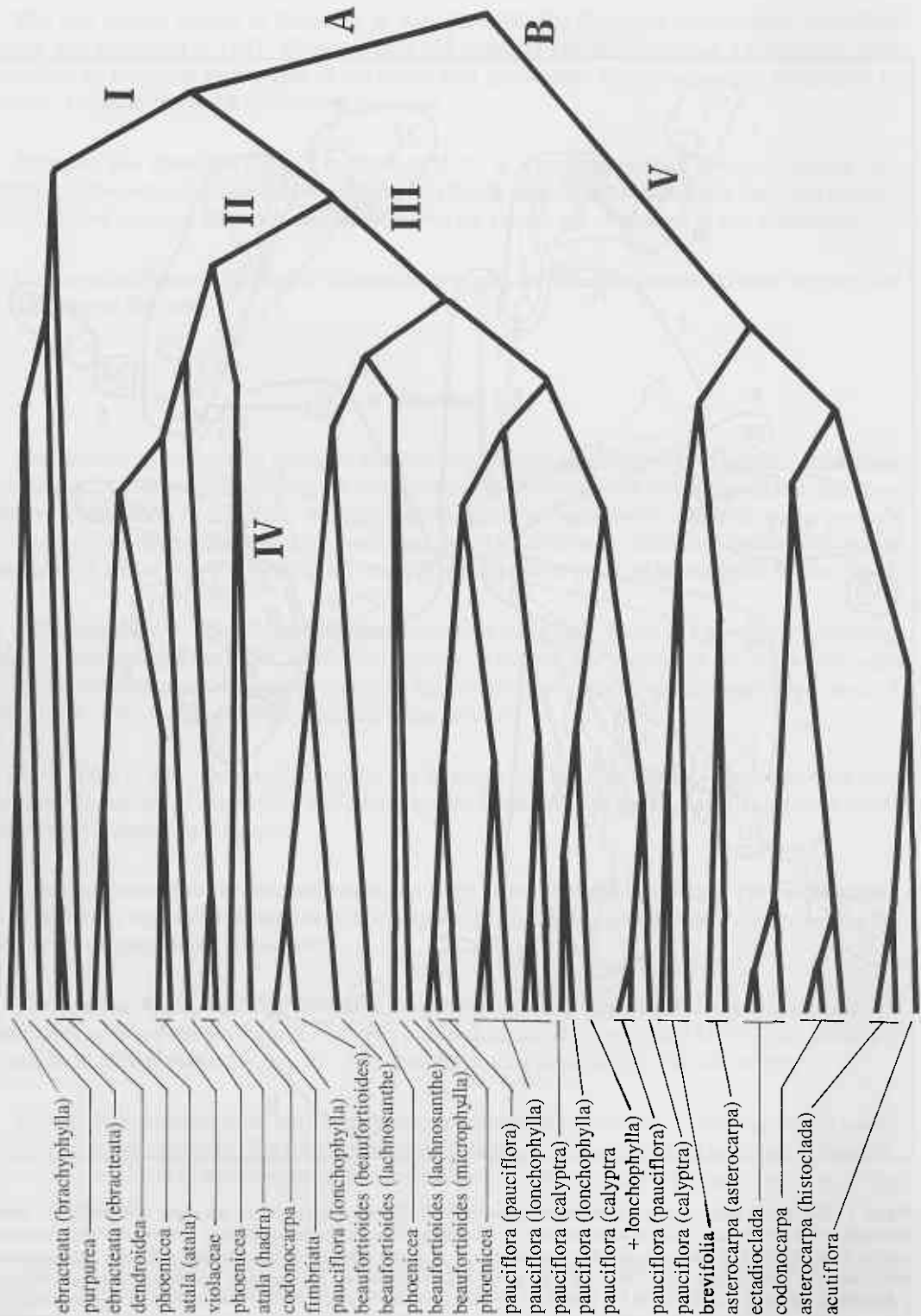


Figure 2. Truncated MULCLAS classification of 87 *Eremaea* specimens using numerical data only. "A" = subg. *Eremaea*; "B" = subg. *Okriocarpa*. "I" = sect. *Ebracteata*"; "II" = sect. *Violaceae*; "III" = sect. *Eremaea*; "IV" = sect. *Fimbriata*; "V" = sect. *Okriocarpa*. The sixth branch from the top is unlabelled and represents an unusual *E. pauciflora*. The specimens of the presumed hybrids, *E. x codonocarpa* and *E. x phoenicea* can be seen to be scattered amongst putative parental taxa.

Table 1. Characters used in the morphological analysis of *Eremaea***Numeric data**

1. plant height (m)
2. leaf length (mm)
3. leaf width (mm)
4. petiole length (mm)
5. leaf-hair length (mm)
6. no. of primary veins visible on abaxial leaf surface
7. bract (perule) length (mm) [longest bract]
8. bract (perule) width (mm) [longest bract]
9. bract (perule) no. at base of flower
10. no. flowers per conflorescence
11. calyx lobe length (mm)
12. calyx lobe width (mm)
13. petal length (mm)
14. petal width (mm)
15. staminal claw length (mm)
16. staminal claw width (mm)
17. filament (free) length (mm)
18. filament no. per bundle
19. stigma width (mm)
20. style length (mm)
21. ovule (incl. ovulodes) no. per loculus
22. hypanthium length in open flower
23. hypanthium length in fruit (mm)
24. hypanthium width in fruit (mm)
25. location of valves relative to fruit rim
26. seed length (mm)

Qualitative data

27. leaf shape
28. leaf-hair type
29. bract (perule) shape (of largest bract)
30. bract (perule): location of indumentum
31. bract (perule) texture [not used]
32. hypanthium: texture at flowering
33. hypanthium: shape at flowering
34. calyx lobe: shape
35. anther dehiscence [not used]
36. branching pattern
37. leaf indumentum density
38. hypanthium: abundance of glands at flowering
39. petal disposition when open [not used]
40. petal colour
41. petal indumentum
42. petal texture

43. petal: abundance of glands
44. calyx lobe: persistence after flowering
45. calyx lobe: texture
46. calyx lobe: abundance of glands [not used]
47. stamen: abundance of glands [not used]
48. filament: presence - absence of swelling
49. anther: type of gland
50. stigma shape
51. style: abundance of indumentum
52. valves at flowering: abundance of indumentum
53. placenta: position [not used]
54. distribution of ovules/ovulodes on placenta
55. hypanthium: texture in fruit
56. hypanthium: shape in fruit
57. calyx lobes: texture in fruit
58. valves: position when open
59. seed surface texture

Numeric data for leaves were based on measurements of 10 randomly selected leaves. Flower measurements were from one flower only (to avoid extensive destruction of herbarium specimens). Fruit measurements were taken from 1-5 fruits as available on a herbarium sheet. Seed measurements were taken from 1-3 seeds as available.

Results

The field collecting revealed a much wider range of morphological diversity in the genus than had been previously known. The observations made of populations in the field showed that individual populations had noticeably less variation than was found between populations. With intimate familiarity of the field situation, it was possible to fairly accurately estimate from where new specimens were collected. In contrast, some populations studied in the isozyme analyses (Coates & Hnatiuk 1990) indicated that there was as much variation within some populations as between some taxa.

Pattern analyses were done to bring together all of the selected morphometric data to see if there was any biologically meaningful pattern to the data. The data were analysed in three ways: all data, numeric data only, and qualitative data only. The results of analyses using the numeric data only grouped most specimens which intuitively belonged together, whereas analyses using only the qualitative data variously grouped or separated many specimens which intuitively either did or did not belong together. For example, of the two specimens which clearly represented the same taxon, *E. fimbriata*, one was placed with an *E. pauciflora* var. *lachnosanthe* specimen and the other with *E. beaufortoides*. These two pairs were separated on either side of the second highest branch of the MULCLAS tree indicating very little "similarity". The all-data set provided intermediate results. Given the clear utility of the numeric-data-only set, this was used in preference to the qualitative-data or all-data sets for the rest of this paper.

The analyses indicated that the genus could be interpreted as having several significant infra-generic groupings (Figure 2). They also highlighted the relationships between the known and the new

taxa as well as focussing attention onto the geographic component of the variation. These aspects had not previously been highlighted as significant within *Eremaea* except for the contrast in distribution of *E. pauciflora* compared to the rest of the species.

The results helped to clarify the complexity surrounding several of the newly discovered rose-, red-, or pink-flowering taxa. These "taxa" (*E. x codonocarpa*, and *E. x phoenicea*) are now interpreted as being of possible hybrid origin because of the mixed relationships which specimens had with several other taxa as well as their noticeably heterogeneous morphological condition across their area of distribution. The hybrid status of *E. x codonocarpa* was confirmed in the isozyme study of Coates & Hnatiuk (1990). The field situation requires further study. Individuals in the field cannot yet be determined as being members of a stabilised hybrid, or members of very recent crosses or back-crosses. All possible combinations could be expected.

E. pauciflora is shown to be a very large species-complex as well as the most widely distributed taxon. Three species have been recognised within the group: *E. beaufortioides*, *E. blackwelliana*, and *E. pauciflora*. The first and last of these have been further subdivided into a number of varieties. The relationships between *E. beaufortioides* and *E. pauciflora* are complex and probably involve a long history of interbreeding, and repeated episodes of isolation and re-uniting. The MINSPAN analysis (Figure 1) shows something of the complexity of relationships within and between these taxa.

Keys to and descriptions of all taxa are presented later in this paper.

Ecology

Eremaea is a small to medium sized shrub that grows in the understorey of open *Banksia* or Eucalypt low woodlands or as one of many species of shrubs which form the kwongan on shallow or deep, yellow or gray sand over lateritic gravels and clays.

Eremaea survives fire either through regeneration from lignotubers or by re-seeding. Populations of some species have a high frequency of lignotubers while others never form them. There is no clear habitat distinction between lignotuberous and non-lignotuberous species. In taxa with both conditions, individual populations tend to be dominated by one or other condition, but this does not clarify the relative roles of genetic *versus* habitat induced lignotuber formation. Further detailed study is needed.

Little detail is known about the root systems of most species. The basic form of the root system appears to be a system of deep tap and sinker roots complemented by a fibrous root system. This is only one of the types of root systems found in these communities (Dodd *et al.* 1984). The root systems of *E. beaufortioides* and *E. violacea* subsp. *raphiophylla* have been observed to extend up to at least 6 m below the surface in open-cut mines near Eneabba (Hnatiuk & Hopkins 1980, & pers. obs.). *E. ebracteata*, *E. brachyphylla* and *E. purpurea* can be assumed to have deep roots to supply water to their growing and flowering activity during the long hot and dry summer season. The flowering and vegetative growth during the mid to late spring and early summer of most of the rest of the species is most likely supported by water supplied by deep roots as surface soil is usually drying out by this time and showers of rain are often too small or non-existent to supply sufficient water.

Pollination has not been studied in detail, but casual observations indicate that a variety of insects as well as birds visit the flowers and could effect pollination. The flowers are brightly coloured as well as scented thus accounting for their attractiveness to these animals. The flowers of Subgenus *Okriocarpa* all have a distinctive musty smell, which contrasts to the sweet or spicy smell of those of Section *Eremaea*. Such a distinction would contribute to reproductive isolation as it could be expected to attract different pollinators.

Phenology

Growth in *Eremaea* is strongly seasonal. The winter period is a time of little or no growth for most species, as is the common condition of most species in the south-west of Australia. With the exception of *E. fimbriata*, the coming of warmer weather in spring (September), marks the beginning of growth. In *E. fimbriata* growth begins in mid-winter, July and August.

There are three flowering patterns amongst the species. In two species, *E. ebracteata* and *E. purpurea*, growth, on mature plants, commences with the production of leaves. Flowers are then produced on this season's stems for as long as moisture and temperature are suitable. In three species (*E. atala*, *E. dendroidea*, and *E. purpurea*) and some populations of two other species (*E. xphoenicea* and *E. violacea* subsp. *raphiophylla*), first growth is the production of flowers which is then followed by new stems and leaves with a continued production of flowers on the new wood. There is variation between these taxa in the relative intensity of the flush of flowering at the start and later in the season. All the other species appear to flower only in the first flush of growth, followed by vegetative growth. This latter pattern of growth results in flowering plants presenting conspicuously massed displays on the upper canopy of each plant. On plants that do not flower, and non-flowering stems of plants with flowers, new shoot production can occur at the same time as flowering on other stems and plants.

Once flowering is complete, fruits mature over approximately the next 12 months. In all species, fruits, with their contained seeds, are held on the stems until the stems die. Then, upon drying, the valves open, releasing the seed in all but *E. fimbriata*. In this species, the orifice of the fruit is very frequently too small for the winged seeds to escape. On death of a stem of *E. fimbriata*, the valves frequently do not open. Seed is effectively released in this species either when the fruit is burned or the outer surface decays. Some populations of *E. pauciflora* also have fruits with very small orifices. In these cases the winged seeds appear to also be small and capable of release when the fruits dry.

There is a broad, though not precise sequence of flowering amongst species. The first to flower is almost always *E. fimbriata*, starting in July or August. *E. ebracteata* and *E. purpurea* are usually the last found in flower. *E. beaufortioides* is a late spring (November, December) flowering species, usually only starting to flower as other species which flower on old wood are nearly finished. All other species tend to flower in September to November.

Many exceptions to this pattern of flowering occur. No precise reasons have been found, but local variations in the occurrence of rainfall and the timing of the warming in any particular place seem to be the most likely reasons for the variations. Detailed observations of temperature and rainfall pattern near Eneabba closely linked rainfall pattern and abundance to growth, flowering and fruiting (my own unpublished observations). In some years, the pattern is clear whereas in other years, it is far from obvious with the exception of the early and late flowering species noted above which still flower at the extremes of the sequence.

The plants are evergreen with leaves typically lasting for 12-18 months: the previous year's leaves falling after the present season's have matured.

Conservation

No taxon of *Eremaea* is currently on the Western Australian list of gazetted rare flora. Field surveys for *E. purpurea* were done by D. Halford for the then Department of Fisheries and Wildlife. He found several more populations than had been previously known and the species was removed from the critical list.

The many new taxa which are recognised by the completion of the present study focus attention on the need for further field survey to determine whether any of them need special consideration as rare taxa. Taxa which should be investigated as a matter of urgency include: *E. acutifolia*, *E. asterocarpa* subsp. *brachyclada*, *E. blackwelliana*, *E. brevifolia*, *E. dendroidea*, *E. ebracteata* var. *brachyphylla*, *E. hadra*, *E. x phoenicea*, and *E. violacea* subsp. *violacea*.

A location which appears to be especially rich in genetic variation in *Eremaea* is on either side of the Brand Highway, 18 km south of Eneabba. This site should be protected and managed so as to protect the high diversity of *Eremaea* found there. The geographic extent of this area needs to be determined. The lateritic tops, and the slopes and extending to the plains to the west of the complex of hills from Mt Benia, to Mt Lesueur, to Mt Peron are also especially rich in diversity of *Eremaea*.

Morphology

Growth form varies from low, spreading shrubs less than 0.5 m high (e.g. *E. ectadioclada*, *E. violacea*) to small trees 4-5 m high (e.g. *E. dendroidea*). Branching patterns vary from low, spreading, arching branches to upward-spreading to erect forms. Basal diameter of stems varies from 2-4 cm to 10 cm or more. Mature stems are covered with a hard, thin, fissured bark.

A secondary pattern in branching is also conspicuous and varies between species. In the most commonly occurring type, ultimate branches are more or less erect or upward spreading. These give rise in the next growth cycle to other branches which are essentially similar in length and disposition to their parent branches. This growth pattern produces a plant with the familiar domed or broom canopy. The second type is found in some of the low growing species (e.g. *E. violacea* subsp. *raphiophylla*). It differs in that the long branches produced in one year themselves give rise to a number of lateral branches that remain relatively short in comparison with their parent branch. These short laterals frequently flower in their second year creating elongated displays of flowers in contrast to the domed displays of the other taxa. These elongated massed flowers are "superconflorescences" in the terminology of Briggs & Johnson (1979). *E. x codonocarpa* displays a mixed branching pattern. It is a putative hybrid between taxa with the two branching types.

Leaves have a disperse arrangement and are relatively crowded along branches. They are rigid in nearly all taxa, but in *E. atala* they are noticeably flexible giving the leafy branches a "soft" feel when touched.

Leaves vary in shape from flattened ovate to obovate to acerose. They vary from about 3 to 20 mm in length. Margins are simple although some are scabrid (e.g. *E. hadra*).

The most frequent condition is a two-layered indumentum on both surfaces of immature leaves. References to leaf indumentum in the species descriptions refers to the condition of very immature leaves. Taxa vary in the rate of disappearance and the amount of indumentum which remains at maturity. The lower layer usually falls earliest and most completely. The density and degree of erectness of hairs vary between populations and can be an enticingly conspicuous characteristic. It has not proven to be a useful taxonomic character even though some early names refer to this character (e.g. *E. pilosa*).

Leaf tips are pungent to rounded. Oil glands are present in all taxa. There is a small amount of variation in size and disposition of glands, but it has not been taxonomically useful. The most conspicuous variation in arrangement is that in narrow leaves, the glands appear to be in one line on either side of the mid-vein. Where leaf shape is somewhat variable, where broader leaves occur on a plant with otherwise narrow leaves, the broad leaves frequently do not have proportionately more glands, but this is not always so.

The extension-growth of leaves and stems declines rapidly at the end of the growing season resulting in short crowded leaves at the apex. These late-produced leaves also become progressively bract-like with the production of brown, slightly expanded laminae topped by progressively shorter, narrow green tips. In the end, a dormant or resting bud is produced covered with a variable number of bracts ("perules" of Briggs and Johnson 1979). With the commencement of growth in the spring, a reverse sequence is often seen with the first leaves having expanded brown laminae at the base which in progressively newer leaves becomes smaller until "normal" leaves occur. The stems in the region of the dormant bud are often somewhat expanded. This expanded region seems to disappear in branches more than about three years old.

Flowers

The inflorescence of *Eremaea* is a "monad" in the sense of Briggs & Johnson (1979). Specifically, it appears to be a "metaxymonad" i.e. it consists of a conflorescence reduced to a single flower. The basic structure is most easily seen in *E. ebracteata* and *E. purpurea* where the three "bracts" ("metaphylls" of Briggs & Johnson 1979) below each flower are readily visible in young flowers. These metaphylls are small, short, broad and caducous. In other species the metaphylls are difficult to see, but are present. They are reduced to almost filiform structures which are difficult to see because they are covered by the much larger and more numerous "perules".

The conflorescence of *Eremaea* occurs in many species as single flowers at the ends of branches. These are not "terminal" or "anthotelic" structures, rather they are all axillary. In most species the primary axis grows on after flowering. In *E. violacea* subsp. *raphiophylla*, the main axis frequently does not grow on. In these cases the branch is "anauxotelic" in Briggs and Johnson terminology.

In some species, the monads occur in close association with one another to form clusters of up to 7 flowers called "superconflorescences". In *E. violacea* subsp. *raphiophylla*, these first order superconflorescences may be grouped into higher order groups so that whole branches form an aggregation of superconflorescences.

The overwintering bracts (perules) form a conspicuous feature of the flowers of those *Eremaea* taxa which produce flowers as the first growth in the season. They are variable in number and range from about 1 to 40. These bracts include the phyllomes produced at the end of the last growing season, plus new bracts produced or at least developed fully once dormancy is broken. The length of these late-produced bracts varies from relatively short in the outermost (older) to relatively long and broad and finally to very narrow and short. The metaxyphylls, if present, are found distal to (i.e. inside or above) the innermost phyllomes. In many species there are a variable number of minute elongate scales at the very base of the flower. The significance of these is not known. These latter are only seen in dissections of flowers and in neither their number nor shape were found to have any taxonomic value within the genus.

The perules are typically indumented on the exposed abaxial surfaces and occasionally, and very variably, on the distal adaxial surface as well. The outer indumentum of the bracts is of some limited taxonomic value, but in most taxa it is too variable between populations to be of great use. The shape and arrangement of the bracts is also a conspicuous feature of the inflorescence of some taxa, but again it is too variable in relation to other characters to be generally of taxonomic value.

The *hypanthium* is glabrous or variously indumented. This character is useful taxonomically. The shape of the hypanthium at the time of flowering is abruptly constricted at the base, occasionally nearly cylindrical in the mid-region though more commonly it expands more or less rapidly from near the base to the distal rim. This character is not useful taxonomically. The surface of the hypanthium may be smooth, and then often shiny and sometimes sticky too, or it may be dull because of the roughness caused by the swellings at the base of hairs. This character is closely related to the indumentum type and is not used taxonomically because it is difficult to quantify or describe unambiguously. Glands may be more or less conspicuous, but this is not taxonomically useful.

Five *calyx* lobes arise from the rim of the hypanthium. In only one taxon, *E. asterocarpa* subsp. *hystoclada*, does the number and regularity of lobes vary. In this subspecies, the lobe number is often 5 but can vary from 4 to 6. The unusual numbers are most frequently the result of fusion or splitting of adjacent lobes or the complete loss of a lobe. This feature is maintained in garden cultivated plants grown from seed.

The lobes are most often triangular in shape. Following Stearn (pp 318-319, 1978), they are called "broadly triangular" if the length to width ratio is less than or equal to 1.2, "triangular" if the ratio is between 1.5-2.0, and "narrowly triangular" if the ratio is greater than 3.0. The lobes are sometimes cuspidate, usually from in-rolling of the thin margin. The lower edges are sometimes auriculate and may overlap adjacent lobes. The margins are either entire or ragged or fimbriate. They may also be brown rather than the usual green.

The abaxial surface of the calyx lobe is either glabrous or indumented. The type of indumentum is usually similar to that of the hypanthium although the hairs may be shorter or longer. The indumentum appears most frequently to be single layered. When densely indumented it may consist of more than one layer but this character is very difficult to ascertain. The adaxial surface of the lobes may be glabrous or indumented, but because of variability this was not found to be a useful taxonomic character.

The calyx lobes may have more or less conspicuous glands. These have no taxonomic utility. The calyx lobes may either fall completely from the hypanthium at the end of flowering or as the fruits

mature or they may variously become woody in the lower portions only, or completely woody and remain as part of the mature fruit. This character is of great taxonomic significance.

Petals alternate with the calyx lobes. They consist of a narrow limb which arches outwards at anthesis to spread the petals widely. Above the limb, the petal expands rapidly into an almost hemispheric lamina. The central portion of the lamina is thick and contains a variable number of oil glands. It is surrounded by a much thinner zone which is either continuous or variously ragged to finely if unevenly fimbriate. The whole of the lamina is coloured similarly though usually not so brightly as the filaments. The petals fall at the end of flowering.

Stamens are epipetalous in origin and thus appear opposite the petals. The filaments are variously fused at the base to form a short to long claw. When filament numbers are low, the filaments are arranged in a single plane, but when numbers increase the claw becomes thicker with filaments appearing to arise from the back and front of the claw as well as from its distal edge. The claws may be free from each other or they may fuse slightly at the base to form a ring. The degree of fusion is variable on individual plants and within populations and was not found to be taxonomically useful. The free portions of the filaments are either narrow-linear and tapering only shortly at the apex or they show a narrow club-like swelling in the distal portion which then tapers to the apex. The surface of the filaments is either smooth or only slightly undulate or the surface of the cells may become shortly papillose. The filaments fall after anthesis. Either each bundle may fall separately, or in individuals with fused claws, the whole set or groups of bundles may fall as a unit. Filaments are coloured usually with only one colour and this is of considerable taxonomic value. In some populations colour is absent or greatly reduced in varying degrees from portions of the filaments leaving pale or white zones in purple and pink flowered species or pale yellow filaments in orange flowered species. These pale colours are not of general taxonomic value although they may be of horticultural interest.

Anthers are basifixed with two large loculi on either side of a simple connective. Dehiscence is by longitudinal or diagonal slits. Small glands are usually present in the connective and may be found at the base, the middle, or top, but the character is not taxonomically useful as what little variation there is, is not consistent. The base of the integument is sometimes a little swollen and may contain oil glands. The anthers are yellow which varies in intensity from light to dark.

The ovary is three-chambered. The top is closed by three pairs of valves which at flowering may be above, below or at the level of the rim of the hypanthium. The outer surface of the valve is densely indumented with hairs of one length in all but two species (*E. ebracteata* and *E. purpurea*) where there is a conspicuous but sparse upper layer of very much longer hairs. The valves become indurated (woody) in the fruit *q.v.*

The *placenta* is axile and bi-lobed. Ovules are produced over its surface. Their number varies from (7)10-14(23), but generally the larger the ovary the more ovules there are. The ovules are arranged generally with 2 or 4 in the central area and a ring of up to 15 around the periphery. Not all ovules develop into seed. It is not obvious at the time of flowering which ovules will become seed and which chaff.

Seeds are produced at a rate of about 1 to 6 per fruit. They are elongate polygonal structures with longitudinal angles formed by compression from the tightly packed adjacent ovules. Seeds develop wings along the compression lines out of a single layer of elongate cells which resemble a palisade. Infertile ovulodes have no wings. The surfaces of the seeds are glabrous or minutely chaffy, especially

near the junction of seed and wing. The seeds are brown although there is mottling of dark and light patches on some seeds, but this does not have taxonomic significance.

The embryo is essentially straight or slightly arcuate. The variation is minor and is related to the degree of deformation of the seed as it matures. Seeds attached to the central part of the placenta and surrounded on all sides, parallel to the seed axis, by either other seeds or ovulodes, remain straight. Seeds attached to the periphery of the placenta become arcuate as they are pressed, by seeds and ovulodes, against the inner curvature of the ovary wall.

The primary axis of the cotyledons in the seed form a continuation of the straight axis of the radicle. In a more or less obvolute manner, they envelope each other. The pattern of folding is not consistent between seeds on one plant, nor between taxa.

Woody fruits are formed from the enlarged hypanthium. They are of various shapes from cup to barrel shaped. The outer surface is either smooth or rough depending upon whether the epidermis of the hypanthium is retained as the fruit matures, producing a rough texture, or is shed leaving a fairly smooth surface. The rim of the hypanthium may be plain, undulate over the hardened bases of the calyx lobes or distinctively lobed from the indurated calyx. When dry, the valves open and reflex to varying amounts. In deeply included valves, they essentially become erect, in others, they may reflex out and over the rim of the hypanthium. The surface of the valves is ornamented either with two lobes or with several small callosities. The degree of development of the ornamentation varies between taxa. These have some taxonomic value. The smooth-fruited taxa, of subgenus *Eremaea*, have two generally hemispherical smooth lobes at the apex of the valves. The rough-fruited taxa, of subgenus *Okriocarpa*, have two generally triangular lobes covered at the top with several small callosities. Fruits vary in colour from dull pale brown to various shades of golden brown to dark and almost purplish brown. Most characters of the fruit are very significant taxonomically.

Seedlings

Seedlings of most taxa were raised in shade house conditions at the Western Australian Herbarium. There was very little variation between taxa. Larger seeds tended to produce larger cotyledons, but this was not taxonomically useful. All taxa had obvolute cotyledons in the seed which quickly opened out and spread horizontally after germination. Germination was epigeal.

Hybridisation

Natural hybridisation appears to have occurred in many places and at many times in *Eremaea*. Confirmation of this comes from both morphometric analyses reported here, and from isozyme studies (Coates & Hnatiuk 1990).

Hybridisation between taxa of different Sections appears to produce products which are sufficiently stable and different to be recognised taxonomically as is done with *E. x codonocarpa* and *E. x phoenicea*. These taxa are both generally more variable than other species of *Eremaea* but the suite of defining characters appears robust. This is borne out in the isozyme analyses of *E. x codonocarpa*. Hybrids appear to set smaller numbers of fruits and seeds, but seeds are fully viable and produce offspring similar to the maternal parent.

Hybridisation between taxa in the same Section or within a species complex tends to produce minor variants of the parents. Thus for example, *E. beaufortioides* and *E. pauciflora* are extreme variations within Section *Eremaea*, but there are many intergrades found in the wild. Some of these are sufficiently consistent and frequent to be taxonomically recognised, as in the varieties of these two species, but finer grades of intermediates will be found which are difficult to place. At the level of variety in these species, the taxa defined here provide some indication of the major trends in morphological patterns, but care is needed in using them.

Horticulture

The masses of brilliant flowers found on most species of *Eremaea*, coupled with the small shrub growth form of many species, has attracted comment on the great potential for use in gardens. However, the genus is still very seldom seen in nurseries or in gardens. Success has been limited and variable in eastern Australia as well as in Perth. Improper soil conditions together with summer rain have been implicated in the lack of horticultural success to date. There is much room for horticultural research with this genus.

Fresh seed germinates readily, as does seed at least 9 years after collection. Iron chlorosis can occur in young seedlings but is easily corrected with a weak solution of chelated iron. Most species seem able to strike from cuttings though problems have been reported with *E. violacea* subsp. *raphiophylla*. General notes on cultivation can be found in Hubbard 1978, and Elliot and Jones 1984.

Discussion

The richness of the species-rich shrublands of south-western Australia has been known since the days of the early European collectors. The bipolar distribution of richness between the "northern" and "southern" sandplains was commented on by Diels (1906) and further confirmed by Speck (1958). The concentration of certain taxa in shrublands of the deep sand *versus* those on the rocky laterite was elaborated by Hnatiuk & Hopkins (1981) and more recently by Brown (1989).

The variation in morphology and isozymes appears to be very similar in *Eremaea*. The same infra-generic groupings were found in the separate analyses and the same geographic pattern of variation was found in the two studies. The close relationship of some of the taxa to each other was also confirmed.

Testing of seed from a number of taxa showed that they produced new plants that were identical with their parents - there was no obvious segregation in the progeny. The isozyme analyses, however, found greater variability within taxa than between them. Samples were small in each case and further work is needed before firm conclusions can be drawn about genetic and morphologic stability of populations.

Hybridisation, relatively but not very recent, has been strongly indicated for *E. x codonocarpa* and *E. x phoenicea*, and suggested for another, *E. dendroidea*, although perhaps at some more remote time, but many of the taxa are very closely related (*cf.* Coates & Hnatiuk 1990).

The study of *Eremaea* has contributed to our understanding of the species-rich shrublands north of Perth by demonstrating how one genus has developed in the region. *Eremaea* has split into two main evolutionary lines, subgenera *Eremaea* and *Okriocarpa*. The former has evolved four distinctive sections, three of which have several species and lower taxa. Subgenus *Okriocarpa* has four species (Table 2). It is my express intention to indicate that in my judgement all four of these species belong to the same Section. This decision is based on the same kind of assessments as applied to the assignment of species to Sections in subgenus *Eremaea*. The International Code of Botanical Nomenclature (Greuter *et al.* 1988) does not provide for naming this Section of *Okriocarpa* until such time as another Section, not including the type of subgenus *Okriocarpa*, is established. In the light of present knowledge, a second Section is not known to exist, only one section, but several species.

Although the topography of the northern sandplain is noted for its subdued relief, the species often seem to have sorted themselves according to the subtle but significant differences in the landscape. The distinction between the deep sands of the coastal plain and those on the archaean shield show up in section *Violacea* for example. Some speciation in *Eremaea* appears to correlate well with the margin between the archaean shield and the coastal plain, for example, the spatial sequence of some species in section *Eremaea* (*E. dendroidea*, *E. pauciflora* var. *lonchophylla* and *E. blackwelliana*). In subgenus *Okriocarpa*, speciation has produced primarily a north-south alignment of taxa which has *E. brevifolia* in the north followed southwards by *E. acutifolia*, *E. asterocarpa* subsp. *histoclada*, *E. ectadioclada*, *E. asterocarpa* subsp. *asterocarpa*, and *E. asterocarpa* subsp. *brachyclada*.

There are suggestions in the isozymic analyses that these north-south and east-west alignments of taxa developed in a variety of ways. It seems that the oldest taxa of section *Eremaea* and subgenus *Okriocarpa* occur roughly from about the Burma Road reserve to Alexander Morrison National Park, along the western boundary of the archaean shield. From here speciation occurred towards the north, east, south and west. In contrast, however, taxa of sections *Violacea* and *Ebracteata* seem to have proceeded to evolve from the most northerly taxa, *E. violacea* and *E. dendroidea* respectively, to the two other species and one subspecies of section *Violacea* and the two varieties of *E. ebracteata* which themselves are separated along an east-west alignment more than a north-south one.

Geologically and edaphically, the coastal plain is very complex. It is composed of many small subunits. Close study of the distribution of a wider range of species in relation to this detailed geology and the current geomorphology would be rewarding.

Perhaps the most striking distribution pattern in *Eremaea* is the contrast of the high density of taxa in the relatively small Darling-Irwin districts in contrast to the very widespread but single variable species *E. pauciflora* var. *pauciflora* throughout much of the rest of the Southwest Botanical Province. The isozymic analyses suggest that this widespread taxon is perhaps the most recent of section *Eremaea*. If this is so, then it represents recent and rapid spreading into new territory. The lack of speciation within such a widespread area is less puzzling if it is seen as being of recent origin. How recent cannot be said from the data, but the postulated droughts of the Pleistocene era and again as recently as a few thousand years ago must have had a major impact on the distribution of species in the southwest. The last period of major aridity in south-western Australia was only as recent as 18,000 - 16,000 years before the present (Bowler 1976). Perhaps the widespread distribution of *E. pauciflora* var. *pauciflora* dates from a rapid re-invasion of land with a sparse vegetation after more mesic conditions returned. The winged seeds of *Eremaea* may have assisted in dispersal by the wind.

The seeming morphologic uniformity within each population in this widespread distribution suggests that each population could have been founded by one or a few propagules which is consistent with the hypothesis of recent wind dispersal. The isozyme study did not sample the geographic range of *E. pauciflora*, and only one population came from the region of extensive distribution. This population was at Tutanning, and was second only to two populations of *E. fimbriata* in observed heterozygosity (Coates & Hnatiuk 1990). While this hints strongly that the hypothesis of spreading suggested here may be correct, further data are required. Given sufficient time, genetic isolation could be expected to result in many more "species" across this large area.

Further research

Significant questions remaining unresolved concern details of the evolutionary relationships between populations and taxa in section *Eremaea*, in particular, the complex of taxa included in *E. beaufortioides* and *E. pauciflora*. Further field work is needed, but the extensive clearing in the area roughly bounded by Gingin, Jurien, Eneabba and Windsor, as well as throughout the 'wheatbelt' region, may have destroyed many of the important populations.

In need of testing and confirmation are the hypotheses raised here concerning relative ages of taxa and the directions of speciation and geographic spreading.

Eremaea

Eremaea Lindley, Sketch Veg. Swan R. xi (1829).

Non Eremia Don, Ericaceae; *Non Eremaeopsis* Kuntze, *nom. illeg.*

Typus: not specified. *Lectotype* (here chosen): *Eremaea ericifolia* Lindley (= *E. pauciflora* (Endl.) Druce.) (*Lectotype*: CGE; photos CBG, PERTH).

Shrubs or small trees; with or without lignotubers. *Branches* spreading or ascending, sometimes very densely intergrown; indumentum on young branchlets commonly two-layered, inner layer tomentose and glabrescent, the outer pilose may persist. *Overwintering bracts* (perules) numerous, conspicuously surrounding flowers in species that flower on old wood. *Leaves* linear, oblong, ovate, elliptic, or obovate, straight, reflexed or incurved, mucronate or obtuse; indumentum as for perules; longitudinal veins on lower surface none, 1 or many; leaves flat or triquetrous in cross-section. *Flowers* axillary although appearing terminal in species where the flowers are the first growth following winter dormancy; single or in cymes up to about 9; flowers on old or new wood. *Hypanthium* campanulate, glabrous and shiny and occasionally glutinous, or variously indumented and dull. *Calyx* of five triangular lobes, in a few populations 4 or 6 lobes occur and are genetically fixed, with or without thin auriculate lower margins; glabrous or variously indumented; persistent or caducous in part or in total. *Petals* narrow at base, greatly expanded and somewhat hemispheric in upper part, the centre of the upper part thick and glandular, surrounded by a thin margin that is wide at the sides and either wide or narrow at the apex, margin entire or variously ciliate to ragged; wide-spreading; coloured similar to stamens but less intensely. *Filaments* fused into a claw usually of 1/2-1/4 length of stamens forming five groups alternate with petals; groups may be free or slightly and irregularly fused together at their basal edges; free portions of filaments in two or more irregular

rows at top of claw, smooth or papillose, cylindrical or slightly swollen distally, narrowed at apex, brightly coloured violet, pink, rose, or orange, rarely white or pale yellow; anthers basifixed, bilocular with erect or oblique pores, connective with or without small glands at base or apex or in between, occasionally slightly swollen at base or apex, bright yellow. *Ovary* trilocular, placenta axile, bi-lobed, 7-23 ovules per loculus only some of which become seed, the remainder remaining as chaff; densely indumented on exterior apex, rarely sparsely pilose over the dense tomentum. *Style* glabrous or indumented, similar in length to stamens or exceeding them; stigma small, apical. *Fruit* woody, cupulate, urceolate, or globose; outer wall smooth or rough, with or without corky outgrowths; light brown, coppery brown, dark purplish brown or dark grey brown; rim smooth or variously lobed; valves bi-lobed, deeply included, reaching to rim, exerted, or exerted and reflexed, lobes smooth or variously finely mammillate or warty. *Seeds* variously obovoid, longitudinally finely ridged with palisade-like wings along all vertical and the distal, horizontal ridges; sides smooth or slightly chaffy; brown or somewhat mottled; in most cases (except *E. fimbriata*) shed freely when branch to which fruit is attached dries.

Endemic in south-western Australia.

The genus is clearly defined by its basifixed anthers, single axillary flowers, stamens in five bundles, characteristically shaped woody fruits and characteristically shaped and winged seeds. Its closest relatives are *Beaufortia* from which it differs in having generally oblique anther pores, the ovary with more than 2 ovules and the seeds with several wings rather than a single terminal wing. From *Calothamnus* it differs in having flowers arising on old wood at the apex of stems, or on new wood and not in confluences on only one side of the stem, and in having winged seed that are much greater in diameter than in *Calothamnus*. From *Regelia* it differs in having oblique anther pores, flowers generally not in globular clusters, and in the winged seeds. Initial trials in the isozymic study showed differences between *Eremaea* and *Beaufortia* and *Calothamnus* to be too great to be readily useful, but further work could clarify the relationship. At this stage it appears that *Eremaea* is a clearly defined genus, without any suggestion that it needs splitting into segregate genera, and it is well separated from its nearest neighbours.

Key to infrageneric taxa and species

1. Outer surface of fruit smooth (i.e. epidermis all or nearly all shed) although it may appear lumpy from subsurface swellings or have corky outgrowths; valves smooth and having 2 more or less hemispheric lobes ... subg. *Eremaea* 2
1. Outer surface of fruit rough (i.e. epidermis present but disintegrated), flaky; valves 2-lobed with surface of each finely warty or irregularly mammillate subg. *Okriocarpa* 14
2. Fruit valves deeply included 3
2. Fruit valves reaching rim of fruit or only shallowly included 5
2. Fruit valves exerted and enclosed or not by lower part of lobes 10
2. Fruit valves exerted and reflexed 12
3. Filaments pink, or dark pink, fruit urceolate with very narrow orifice 1. *E. fimbriata*
3. Filaments orange, fruit not as above 4
4. Leaves linear or narrowly elliptic 5. *E. pauciflora*
4. Leaves elliptic or ovate 7. *E. beaufortioides*

5. Flowers borne on last season's wood 6
5. Flowers borne on current season's wood 8
6. Filaments orange 7
6. Filaments pink, or dark pink 16. *E. x phoenicea*
7. Flowers terminal on long branches, fruits cylindrical to slightly obconic 9. *E. dendroidea*
7. Flowers terminal on short laterals along long branches, fruits globose 6. *E. blackwelliana*
8. Filaments pink 10. *E. purpurea*
8. Filaments orange 9
9. Fruit rim without lobes, leaves narrowly elliptic to oblong, a small tree when mature 9. *E. dendroidea*
9. Fruit rim undulate, leaves linear, or obovate-elliptic and broadly boat-shaped when dry, shrub to about 1 m when mature 8. *E. ebracteata*
10. Flowers borne on last season's wood 15. *E. x codonocarpa*
10. Flowers borne on current season's wood 11
11. Filaments orange, leaves linear, or obovate-elliptic 8. *E. ebracteata*
11. Filaments pink, or dark pink, leaves narrow, ovate, elliptic to obovate 10. *E. purpurea*
12. Leaves strongly mucronate 13
12. Leaves not mucronate 3. *E. atala*
13. Leaves straight or reflexed in upper part, >1.2 mm wide, longest perules >3 mm long 4. *E. hadra*
13. Leaves sinuate, or up-turned in upper part, <1.2 mm wide, longest perules <3mm long 2. *E. violacea*
14. Leaf veins seen on lower surface 0 or 1 15
14. Leaf veins seen on lower surface 3 17
14. Leaf veins seen on lower surface 5 or more 18
15. Filaments orange, fruiting valves with two densely tomentose, mammillate lobes 16
15. Filaments pink, or dark pink, fruiting valves with two glabrescent, smooth lobes surrounded by fringe of hairs 15. *E. x codonocarpa*
16. Flowers terminal on long branches, longest perules attenuate, tomentose 13. *E. ectadioclada*
16. Flowers terminal on short laterals along long branches, longest perules contracted at apex, mostly glabrous or ciliate 12. *E. acutifolia*
17. Filaments orange, leaves broad and multiveined 14. *E. asterocarpa*
17. Filaments pink, or dark pink, leaves triquetrous, rarely flat, 1- or 3-veined 15. *E. x codonocarpa*
18. Perules ciliate, back glabrous or distally tomentose 14. *E. asterocarpa*
18. Perules villous 11. *E. brevifolia*

Taxonomy

The only previous comprehensive study of *Eremaea* which has been done is that of Bentham (1867). The results of the present study, based on extensive field survey and large numbers of specimens, has shown a much wider range of variation than was known to Bentham. All four methods used in the present study (intuitive, morphometric/phenetic, isozyme distance, and isozyme cladistics) indicate that there are distinct infrageneric groupings in *Eremaea*.

Infrageneric classification

At the highest level, there are two subgenera that can be distinguished:

subg. *Eremaea*: the "smooth, unlobed-fruit group" and

subg. *Okriocarpa*: the "rough, lobed-fruit group".

Subgenus *Eremaea* readily subdivides into four Sections, and subgenus *Okriocarpa* into only one.

Two species recognised in the isozymic and morphologic analyses as unusual are also placed in this structure. *E. purpurea* is clearly part of subgenus *Eremaea* in both the isozymic study and the morphologic study. These two analyses do not agree on placement within the group. One isozymic analysis placed it within section *Pauciflora* while another placed it outside any of the four sections of the subgenus. The morphologic analysis placed it with section *Ebracteata*. For the present time and until further data clarifies the situation, it has been placed in section *Ebracteata* with which it shares the unusual features of sparse long hairs on the top of the ovary, fruits with corky growths which may or may not erupt through the surface of the fruit, and it also flowers late in the season. It flowers on new wood, a feature shared with section *Ebracteata* but also with part of section *Violacea*.

The other unusual species is *E. fimbriata* which is the most different species in the genus. One isozymic analysis placed it as a sister group to all other *Eremaea* species, while the other analysis placed it within subg. *Eremaea*, but on its own. The morphologic analysis placed it within section *Violacea*, but separate from all other species of the section. While it is clearly a species of *Eremaea* (flowers single, stamens fused into 5 groups, anthers basifixed with oblique slits, seeds with characteristic shape and wings), it does not fit well into any other section. It is here placed in a monospecific section, *Fimbriata*, in subg. *Eremaea*.

The taxa of putatively hybrid origin are not placed within the classification. *E. x codonocarpa* appears to be a stabilised hybrid between subgenera *Eremaea* and *Okriocarpa*, while *E. x phoenicea* appears to be a stabilised hybrid between sections *Pauciflora* and *Violacea*. Hybridisation appears to be continuing and "hybrid swarms" occur.

Intraspecific taxa have been described here for the first time in *Eremaea*. The categories "subspecies" and "variety" have been used. The distinction between these levels was largely based on the following criteria. If the taxa were not geographically isolated, and they were morphologically and isomatically close, then they were classed as varieties. If the taxa were geographically distinct and could be distinguished consistently by a suite of morphological characters, then "subspecies" was

used. In the case of *E. ebracteata*, where geographic separation existed, but only one conspicuous character distinguished the taxa, then "variety" was used.

The classification is summarised in Table 2. Formal descriptions of new infrageneric taxa follow.

Eremaea Lindley subg. **Eremaea**

Shrubs or small trees with leaves linear to elliptic, flowers surrounded by few or numerous perules, stamens conspicuous, violet, pink or orange, anthers yellow, basifixed, opening by longitudinal or oblique slits; fruits woody, smooth outer wall, valves bi-lobed and smooth, seeds with several palisade-like wings.

A subgenus of four sections (*Ebracteata*, *Eremaea*, *Fimbriata*, and *Violacea*) containing 10 species.

Eremaea sect. **Eremaea**

Shrubs, with or without lignotubers; leaves linear, narrowly or broadly elliptic, veins 1-7, rarely 0; flowers with numerous perules; anthers orange; fruits light or coppery brown, valves deeply included or at rim of fruit.

A section of three species and six varieties - *E. beaufortoides* var. *beaufortoides*, *E. beaufortoides* var. *lachnosanthe*, *E. beaufortoides* var. *microphylla*, *E. blackwelliana*, *E. pauciflora* var. *pauciflora*, *E. pauciflora* var. *calyptra*, *E. pauciflora* var. *lonchophylla*.

Eremaea sect. **Ebracteata** R.J. Hnatiuk sect. nov.

Frutices vel arbores parvae, cum vel sine lignotuberibus; folia linearia, oblonga, ovata vel elliptica, venis 1 raro 0 vel 3; flores perulis paucis vel multis; stamina aurantiaca vel rosea; fructus pallide brunneus, cupreus vel cano-brunneus, laevis sed interdum eruptionibus suberosis; valvae fructus lobis 2 laevis labia equantes vel exserta.

Typus: *E. ebracteata* F. Muell.

Shrubs or small trees, with or without lignotubers; leaves linear, oblong, ovate or elliptic, veins 1 rarely 0 or 3; flowers with few or many perules; stamens orange or pink; fruit light brown, coppery or grey brown, smooth but sometimes with corky eruptions; valves with two smooth lobes reaching rim or exserted.

A section of three species and two varieties - *E. dendroidea*, *E. ebracteata* var. *brachyphylla*, *E. ebracteata* var. *ebracteata*, *E. purpurea*.

Eremaea sect. **Fimbriata** R.J. Hnatiuk sect. nov.

Frutices interdum lignotuberibus; folia angusta ovata, venis 0 vel 1; plerumque in Julio florentes; stamina rosea; fructus late urceolatus, orificio angustissimo, atropurpureo-brunneus vel atrocano-brunneus; valvae fructus lobis 2 parvis, profunde inclusae.

Typus: E. fimbriata Lindl.

Shrubs, sometimes lignotuberous; leaves narrowly ovate, veins 1 or rarely 0; flowers typically in July; stamens pink; fruit broadly urceolate with very narrow orifice, dark purple-brown or dark grey-brown, valves with two small lobes, deeply included.

A section of one species - *E. fimbriata*.

Eremaea sect. **Violacea** R.J. Hnatiuk sect. nov.

Frutices erecti vel patentes, sine lignotuberibus; folia linearia ad anguste elliptica, venis 1 vel 3; flores perulis paucis vel multis; stamina violacea, raro alba vel rosea; fructus cupulatus vel globosus, laevis, atropurpureo-brunneus; valvae fructus bilobatae, laeves, exsertae, reflexae.

Typus: E. violacea F. Muell.

Shrubs, erect or spreading, without lignotubers; leaves linear to narrowly elliptic, veins 1 or 3; flowers with few or many perules, stamens violet, rarely white or pink; fruit cupulate or globose, smooth, dark purple-brown, dark grey-brown or light brown, valves bi-lobed and smooth, exerted and reflexed.

A section of three species and two varieties - *E. atala*, *E. hadra*, *E. violacea* subsp. *violacea*, *E. violacea* subsp. *raphiophylla*.

Eremaea subg. **Okriocarpa** R.J. Hnatiuk subg. nov.

Frutices cum vel sine lignotuberis; folia late ovata, spathulata vel anguste ovato-elliptica, venis 1, 3, 5, 7 vel raro pluribus; flores perulis multis circumcinctis; stamina aurantiaca, raro rosea; fructus extus asper pallide brunneus, orificio lato, labio undulato vel lobis prominentibus; valva fructus exsertae sed non reflexae, verrucis parvis numerosis.

Typus: E. asterocarpa R.J. Hnatiuk

Shrubs, with or without lignotubers; leaves broadly ovate, spathulate or narrowly ovate-elliptic, veins 1, 3, 5, 7 or rarely more; flowers surrounded by many perules; stamens orange, rarely pink; fruit with rough light brown exterior, orifice wide, rim undulate or with prominent lobes, valves exerted but not reflexed, with numerous small callosities.

A subgenus containing one section, four species and three subspecies - *E. acutifolia*, *E. asterocarpa* subsp. *asterocarpa*, *E. asterocarpa* subsp. *brachyclada*, *E. asterocarpa* subsp. *histoclada*, *E. brevifolia*, *E. ectadioclada*. (Taxonomically they belong to the same section, even though nomenclaturally this section does not attract a name at present.)

Etymology. The subgeneric names comes from the Greek *okrios* (rough) and *karpa* (fruit), in reference to the roughness of the outer wall of the fruit of each member of this group.

Table 2. Summary classification of the genus *Eremaea*

Group	Species	Infraspecies
1. subg. <i>Eremaea</i> (smooth fruited)		
1.1 sect. <i>Fimbriata</i>	<i>fimbriata</i>	
1.2 sect. <i>Violacea</i>	<i>violacea</i>	subsp. <i>violacea</i> subsp. <i>raphiophylla</i>
	<i>atala</i>	
	<i>hadra</i>	
1.3 sect. <i>Eremaea</i>	<i>pauciflora</i>	var. <i>pauciflora</i> var. <i>calyptra</i> var. <i>lonchophylla</i>
	<i>blackwelliana</i>	
	<i>beaufortioides</i>	var. <i>beaufortioides</i> var. <i>lachnosanthe</i> var. <i>microphylla</i>
1.4 sect. <i>Ebracteata</i>	<i>ebracteata</i>	var. <i>ebracteata</i> var. <i>brachyphylla</i>
	<i>dendroidea</i>	
	<i>purpurea</i>	
2. subg. <i>Okriocarpa</i> (rough fruited)		
(taxonomically all in one section)		
	<i>brevifolia</i>	
	<i>acutifolia</i>	
	<i>ectadioclada</i>	
	<i>asterocarpa</i>	subsp. <i>asterocarpa</i> subsp. <i>histoclada</i> subsp. <i>brachyclada</i>
3. species of putative hybrid origin		
3.1	<i>x codonocarpa</i>	
3.2	<i>x phoenicea</i>	

The most important suite of characters found to be useful in classifying *Eremaea* have been: the surface of the fruits, the lobing of the fruits, the positioning of the valves relative to the rim of the fruit; the number of veins visible on the undersurface of the leaves and leaf shape. Stamen colour can be useful.

Some recent major publications dealing with *Eremaea* have used a number of codes to designate taxa. The current names applying to these codes are given in Table 3.

Table 3. Code names for *Eremaea* taxa used in recent publications with their current names as well as can be determined

Code name and source	Current name
"Flora of the Perth Region"	
Marchant <i>et al.</i> (1987)	
<i>E. sp. A</i>	<i>E. asterocarpa</i> subsp. <i>asterocarpa</i> and <i>E. asterocarpa</i> subsp. <i>brachyclada</i>
"Encyclopaedia of Australian Plants"	
Elliot & Jones (1984)	
<i>E. aff. acutifolia A</i>	<i>E. ectadioclada</i>
<i>E. aff. acutifolia B</i>	<i>E. asterocarpa</i> subsp. <i>histoclada</i>
<i>E. aff. acutifolia C</i>	<i>E. x codonocarpa</i>
<i>E. aff. beaufortioides</i>	<i>E. x phoenicea</i>
<i>E. aff. brevifolia</i>	<i>E. asterocarpa</i> subsp. <i>asterocarpa</i>
<i>E. aff. ebracteata</i>	<i>E. dendroidea</i>
<i>E. aff. pauciflora</i>	<i>E. pauciflora</i> var. <i>lonchophylla</i>
"How to know Western Australian Wildflowers" Part IIIA 2nd ed.	
Blackall & Grieve (1980)	
<i>E. sp. (p.p., not Northampton)</i>	<i>E. asterocarpa</i>
<i>E. sp. var. (p.p. not Mt Lesueur)</i>	<i>E. brevifolia</i>
Coates and Hnatiuk (1990)	
<i>E. aff. pauciflora 1 (AP1)</i>	<i>E. blackwelliana</i>
<i>E. aff. pauciflora 2 (AP2)</i>	<i>E. pauciflora</i> var. <i>lonchophylla</i>
<i>E. aff. pauciflora 3 (AP3)</i>	<i>E. ?beaufortioides</i> var. <i>microphylla</i>
<i>E. aff. pauciflora 4 (AP4)</i>	<i>E. dendroidea</i>
<i>E. aff. ebracteata 1 (EA1)</i>	<i>E. ebracteata</i> var. <i>brachyphylla</i>
<i>E. violacea</i>	<i>E. violacea</i> subsp. <i>raphiophylla</i>
<i>E. aff. violacea 1 (AV1)</i>	<i>E. atala</i>
<i>E. aff. violacea 2 (AV2)</i>	<i>E. hadra</i>
<i>E. aff. brevifolia 1 (AB1)</i>	<i>E. asterocarpa</i> subsp. <i>histoclada</i>
<i>E. aff. brevifolia 2 (AB2)</i>	<i>E. ectadioclada</i>
<i>E. aff. brevifolia 3 (AB3)</i>	<i>E. asterocarpa</i> subsp. <i>asterocarpa</i>
<i>E. aff. brevifolia x violacea (ABV)</i>	<i>E. x codonocarpa</i>

1. *Eremaea fimbriata* Lindley, Sketch Veg. Swan R. xi (1829). (Figure 3)

Typus: not specified; *lectotype* (here chosen) "Swan River, Drummond, 1839" (lectotype: CGE, isolectotype: K; photos CBG, K, PERTH). These specimens appear identical and likely therefore to be from the same gathering and to represent the material used by Lindley in compiling his description. The K specimens have been annotated by Bentham as *Eremaea fimbriata* Lindley.

Eremaea rosea Gardner and George, Journal of the Royal Society of Western Australia 46:134 (1963) is a taxonomic synonym. *Typus*: "Maida Vale, in sand, A.S. George 4161, September 10, 1962." (PERTH).

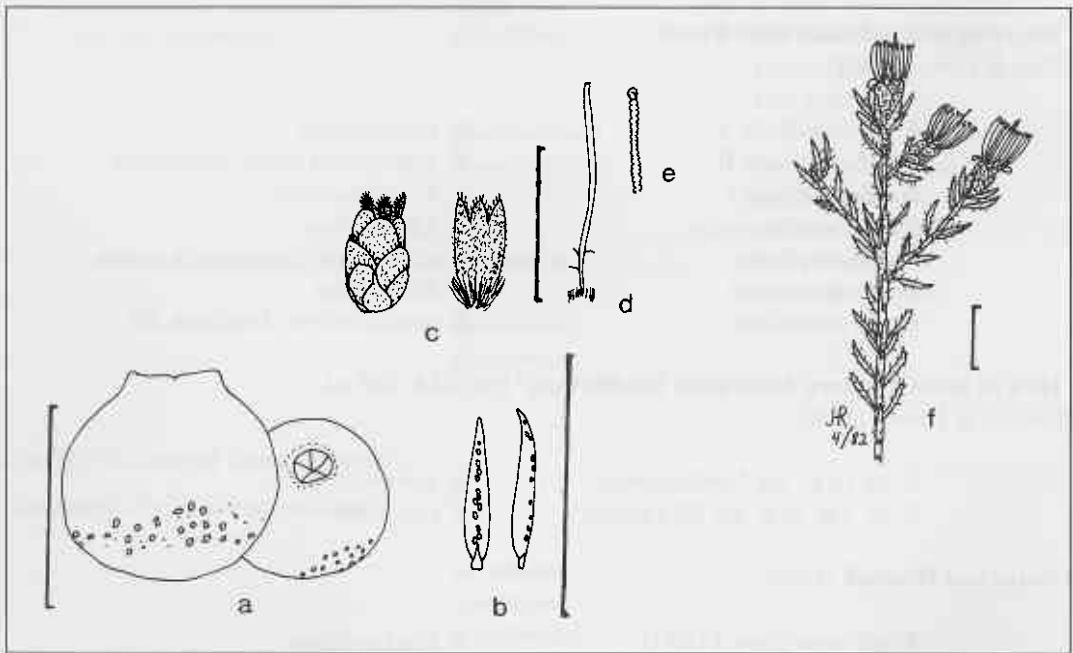


Figure 3. *E. fimbriata*: a: fruits, side view and oblique view of top; b: leaves, side and back views; c: hypanthium and calyx, on left with perules, on right perules removed; d: style and top of ovary; e: stamen; f: habit. 6 km W of Brand Hwy on S-most road to Nambung Natl Pk, R.J. Hnatiuk 780100 (PERTH). All scale bars = 10 mm.

Shrub, 50 cm tall; sometimes lignotuberous. *Branches* spreading to ascending. *Branchlet indumentum* two-layered with sparse pilose outer layer, inner densely tomentose. *Over-wintering bracts* 16-18 per terminal bud; ovate to oblong; 4.5-6.2 mm long, 3.2-4.2 mm wide; indumentum one-layered, tomentose on edges and all over back; smooth. *Leaves* narrowly ovate; acute; 4-8 mm long, 0.5-4 mm wide; 1 vein below or rarely none visible in thick leaves or 3 in wide, rapidly grown leaves; indumentum two-layered, upper pilose (max. length of hairs 1.1 mm), lower densely tomentose; dry leaf cross-section flat, thin (slightly incurved at margins). *Petioles* 0.2-1 mm long. *Flowers* terminal on long branches, (occasionally terminal on short laterals but not as in *E. violacea*) along long branches on last season's wood; 1 per inflorescence. *Hypanthium* campanulate, 4-4.7 mm, 2-3.5 mm wide; indumentum two-layered, upper layer dense villous only on lower half of hypanthium, lower layer dense tomentose all over; smooth, outer surface dull, but wrinkled longitudinally when dry. *Calyx* lobes triangular; 1.5-2 mm long, 1.4-2.5 mm wide; sparsely to densely pubescent with tuft at tip; caducous. *Petals* 2.8-4.6 mm long, 3.5 mm wide; glands sparse; thin-margin narrow at apex and

wide at sides, weakly fringed. *Stamens* 13-18 per bundle; filaments fused in lower quarter; papillose; 7.8-8 mm long; pink, or dark pink; swollen distally; claw 1.5-2.5 mm long, 1.5-2 mm wide. *Ovary* with 12-13 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 9.4-13.5 mm long; glabrous or indumented on lower quarter. *Fruit* urceolate; 8.6-11 mm long 3.5-6.5 mm wide; smooth; dark purplish brown, or dark grey-brown; without lobes, or very slightly undulate; valves deeply included, finely warty at apex. *Seeds* 2.2 mm long; rough; shed when fruit decays or is burnt.

Selected specimens examined. WESTERN AUSTRALIA: 86 mls (138.4 km) NNW of Gingin, T.E.H. Aplin & R. Coveny 3178 (NSW, PERTH); 5 mls (8 km) N of Perth, K. Beamish, NSW146288 (NSW); Junction Gillingarra Rd & Badgingarra Rd, near (NE of) Regans Ford, M. Blackwell, 16 Aug. 1978 (PERTH); Crystal Brook, Old Lesmurdie Road, R. W. Blake 51395 (PERTH); 4.3 km E of Regans Ford, M.L. Clark 202 (MEL, PERTH); Namman Rd & Gillingarra Rd, Regans Ford, R.J. Cranfield 1295 (AD, PERTH); Kalamunda, c. 20 km E of Perth, Jean Galbraith 9 Sept. 1964 (MEL); Maida Vale, A.S. George 4161 (MEL); 6 km W of Brand Hwy on south-most road of Nambung National Park, R.J. Hnatiuk 780101 (PERTH); 20 mls [32 km] SW of Three Springs, K. Newbey 2264 (PERTH); 3.7 km S of Greenhead Coorow Rd and 5.5 km N of Cockleshell Gully, B.L. Rye 77045 (PERTH).

Distribution. Southern Irwin and Darling Districts (Figure 4).

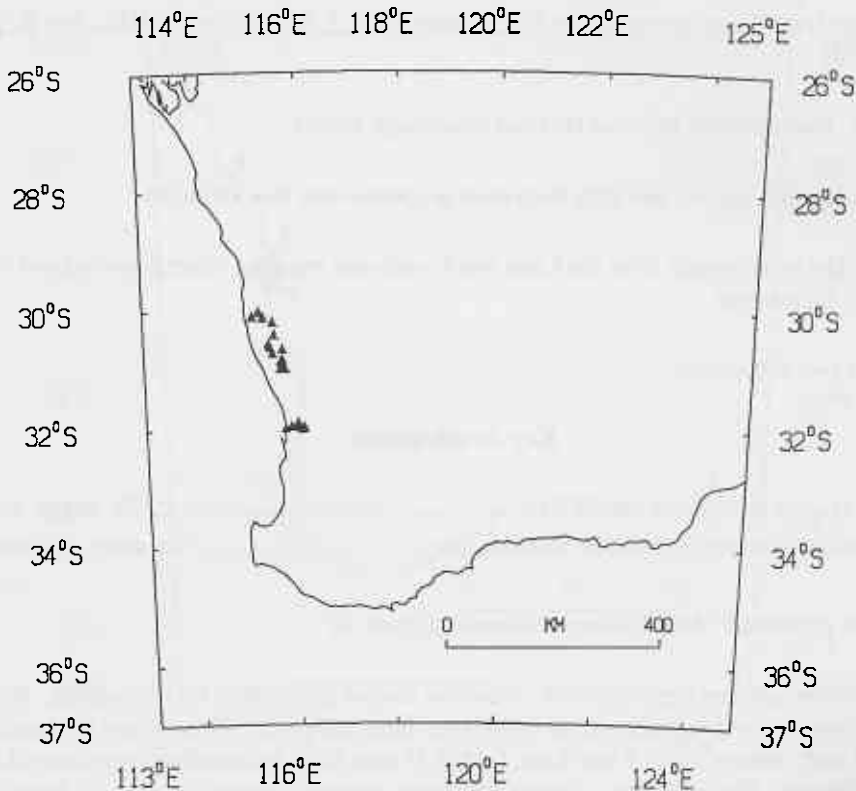


Figure 4. Distribution of *E. fimbriata*.

Habitat. Lateritic uplands to coastal plains; associated vegetation low open heath, or low woodland (of *Banksia* spp. with dense 50 cm tall understorey); soil grey sand over laterite, light brown sand, or lateritic gravel.

Flowering period. July to September.

Notes. *E. fimbriata* is the species most morphologically, ecologically, and isozymatically distinctive within *Eremaea*. Its leaves are narrow, densely arranged, tending to the erect. It flowers in mid-winter before any other species flowers. Its fruits are unique in shape. The orifice of the fruit is generally too small to allow the winged seeds to come out when the fruit dries. This means that seeds are dispersed generally only after the fruits have been burned or otherwise decay. Its distinctness from other species was reinforced in the isozyme studies of Coates and Hnatiuk (1990).

Conservation status. This species is probably not threatened.

Etymology. The name comes from the Latin word *fimbriatus* meaning fringed, and may refer to the often persistent long hairs on the margins of leaves, though the author of the name, Lindley, did not specify this.

2. *Eremaea violacea* F. Muell. Fragm. 11:10 (1878)

Typus: "Upper Irwin's and Arrowsmith's Rivers, Nov. 1877, F. Muell." (holo: MEL; iso: K; photos: CBG, PERTH).

Distribution. Irwin District between Hill and Greenough Rivers.

Habitat. On lateritic gravels and grey deep sand in species-rich low kwongan.

Etymology. The name comes from the Latin word *violaceus* meaning violet coloured and refers to the colour of the stamens.

There are two subspecies.

Key to subspecies

- Leaves flat, at least on top, not needle-like 2a. subsp. *violacea*
 Leaves needle-like, terete or ovoid in cross-section 2b. subsp. *rapiophylla*

2a. *Eremaea violacea* F. Muell. subsp. *violacea* (Figure 71)

Shrub, 100 cm tall; not lignotuberous. *Branches* almost prostrate to very spreading. *Branchlet indumentum* two-layered, sparsely pilose outer layer, inner pubescent. *Over-wintering bracts* 13-39 per terminal bud; oblong, 0.6-0.7 mm long, 0.25-0.35 mm wide; indumentum one-layered, pilose, ciliate or glabrous; finely striate. *Leaves* narrowly obovate, narrowly ovate to linear, acute, mucronate; 7-12 mm long, 0.9-1.1 mm wide; 1 vein below; indumentum two-layered, outer layer pilose; inner tomentose; dry leaf cross-section flat or triangular where the midrib is prominent on the undersurface. *Petioles* 0.9-1 mm long. *Flowers* axillary on current season's wood, but with only a

few new leaves present between perules and flower; fragrance sweet; 1-7 per inflorescence. *Hypanthium* campanulate; 3-4 mm long, 2.5-3.5 mm wide; indumentum two-layered, upper layer densely villous; lower layer densely tomentose all over; outer surface uneven, dull, finely mammillate. *Calyx* lobes triangular; 1.3-3.2 mm long, 2-2.7 mm wide; indumentum sparse or dense, villous to glabrous; caducous, or very rarely persistent. *Petals* 2.3-4.5 mm long; glands absent or sparse; thin-margin wide, weakly fringed. *Stamens* 29-32 per bundle; filaments fused in lower quarter; papillose (especially in upper parts); 7.2-9 mm long; violet; swollen distally; claw 2-2.5 mm long, 0.8-2.3 mm wide. *Ovary* with 10-12 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 4.9-5.1 mm long, glabrous, or rarely indumented on lower quarter. *Fruit* cupulate, or globose; 5-8 mm long, 6-7.5 mm wide; smooth; light brown or coppery brown; without lobes, or rarely with small pointed lobes; valves exerted and reflexed, apex with two prominent irregularly hemispherical lobes. *Seeds* 1.5-2 mm long; rough to smooth; shed freely when fruit is dry.

Selected specimens. WESTERN AUSTRALIA: 17.6 km SW of Arrino, R.J. Hnatiuk 780394 (PERTH); on Casuarinas-Mingenew Road, B. Jack, 13 Sept. 1977 (PERTH); Ajana, D.H. Perry, Sept. 1958 (PERTH).

Distribution. Irwin District between Irwin and Greenough Rivers (Figure 5).

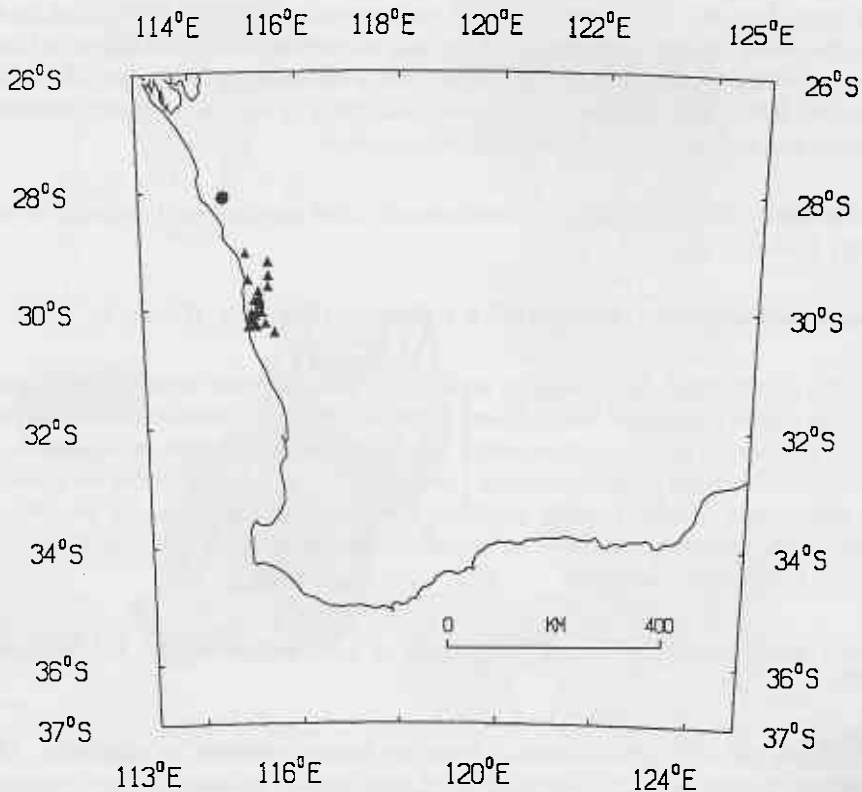


Figure 5. Distribution of *E. violacea* subsp. *violacea* (●) and *E. violacea* subsp. *raphiophylla* (▲)

Habitat. Lateritic and broad uplands; associated vegetation kwongan: open heath, or low closed heath; soil grey sand over red-brown clayey sand, grey sand over laterite, or rarely light brown sand.

Flowering period. September to October.

Notes. *E. violacea* subsp. *violacea* belongs to section *Violacea*. It is distinguished from *E. atala* by its pattern of branching which combines major branches along with numerous short lateral shoots, and narrow, generally incurving leaves (see notes under *E. atala* for further details). From subspecies *raphiophylla* it is distinguished by its leaves that are flattened on top and frequently have a prominent midrib below; flowers are frequently produced on new wood, even though there are usually only a few new leaves between the perules and hypanthium.

The Type and Isotype of *E. violacea* subsp. *violacea* have localities which are all north of the Arrowsmith River and therefore represents indisputably the northern taxon of the section. Until now, the name has been applied to any violet flowered *Eremaea* of which the populations around Eneabba have become the best known. The Eneabba-Mt Lesueur taxon is however distinct from the northern taxon and is now distinguished as subspecies *raphiophylla*.

In the protologue of *E. violacea*, Mueller refers to the great similarity of *E. violacea* to *E. acutifolia*. This similarity is strong between the northern subspecies of *E. violacea*, but less so with south-western subspecies (*raphiophylla*). The similarities of *E. violacea* subsp. *violacea* to *E. acutifolia* are in the flowering often being on very short laterals along long major branches, in the shape and disposition of the leaves, especially as they grow old and deflex, and in the tendency for the fruits to be depressed-ovoid in outline rather than cupulate. These two taxa differ in the colour of the stamens and the ornamentation and degree of reflexing of the fruiting valves.

Conservation status. This subspecies is known from only a few populations. It is classified as Priority Two - Poorly Known Taxa.

2b. *Eremaea violacea* subsp. *raphiophylla* R.J. Hnatiuk subsp. nov. (Figure 6)

Frutex sine lignotubero. Folia anguste obovata, in sectione transversali ovoidea, mucronata, glabra; vena in pagina inferiore 0 vel 1. Flores in ramulis brevibus lateralibus ramorum longorum anni proximi terminales 1-7, per inflorescentia. Hypanthium campanulatum, indumento bistrato, strato supero villosa, infero parce pubescente. Lobi calycis triangulares, glabri vel villosi, caduci. Stamina in parte quarta inferiore connata, papillosa, violacea, raro alba et violacea. Fructus cupulatus ad globosus, laevis, elobatus, atro-violaceo - brunneus; valvae exsertae reflexiae ad apicem lobis 2 prominentibus hemisphericis ornatae.

Typus: 6 km N of Jurien rd on Cockleshell Gully rd; 30°14' S lat., 115°10' E long., R.J. Hnatiuk 780192, 17 Oct. 1978.

Shrub, 50 cm tall; not lignotuberous. *Branches* almost prostrate to ascending. *Branchlet indumentum* two-layered, densely pilose outer layer, inner densely pubescent. *Over-wintering bracts* 13-39 per terminal bud; oblong, 2.1-3.5 mm long, 1.5-2.5 mm wide; indumentum one-layered, pilose, on edges and rarely on upper (distal) back; finely striate. *Leaves* narrowly obovate to linear, acute, pungent, mucronate; 6.1-12.5 mm long, 0.4-1.2 mm wide; 0 or occasionally 1 vein below; incurved; glabrous or indumentum two-layered, outer layer pilose; inner tomentose; dry leaf cross-section

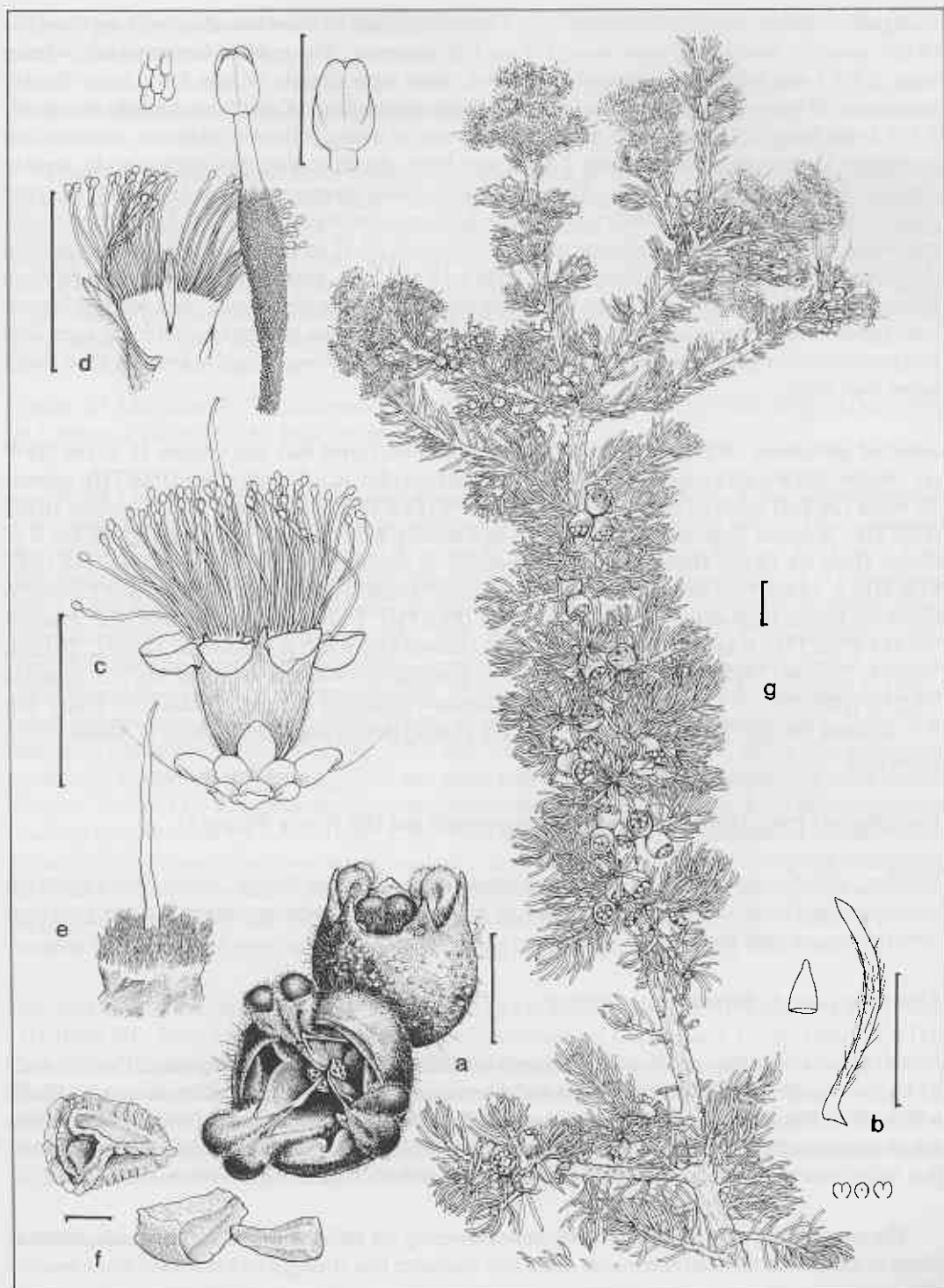


Figure 6. *E. violacea* subsp. *raphiophylla*: a: fruits, upper one is not fully mature; b: leaf with detail of apex (scale bar 5 mm); c: flower (scale bar 5 mm); d: two staminal bundles, detail of stamen and anther (scale bar of details 1 mm); e: style and top of ovary (scale bar 5 mm); f: seed and chaff (scale bar 1 mm); g: habit. 26 km S of Eneabba, R.J. Hnatiuk 780343 (PERTH). Scale bars, not indicated otherwise, 10 mm.

triangular or ovoid. *Petioles* 0.3-1 mm long. *Flowers* terminal on short laterals along long branches of last season's wood; fragrance sweet; 1-7 per inflorescence. *Hypanthium* campanulate; 3-4 mm long, 2.5-3.5 mm wide; indumentum two-layered, upper layer densely villous; lower layer densely tomentose all over; outer surface, uneven, dull, finely mammillate. *Calyx* lobes broadly triangular; 1.3-3.2 mm long, 2-2.7 mm wide; indumentum sparse or dense, villous to glabrous; caducous, or persistent, but not enlarging. *Petals* 2.3-4.5 mm long; glands sparse; thin-margin wide, weakly fringed. *Stamens* 24-32 per bundle; filaments fused in lower quarter; papillose (especially in upper parts); 7.2-9 mm long; violet (rarely whitish or pinkish); swollen distally; claw 2-2.5 mm long, 0.8-2.3 mm wide, joined variously to adjacent claws. *Ovary* with 10-12 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 8-13 mm long, glabrous, or rarely indumented on lower quarter. *Fruit* cupulate, or globose; 5-6 mm long, 6-7.5 mm wide; smooth; dark purplish brown, rarely paler; without lobes, or rarely with small pointed lobes; valves exerted and reflexed, apex with two prominent irregularly hemispherical lobes. *Seeds* 1.5-2 mm long; rough to smooth; shed freely when fruit is dry.

Selected specimens. WESTERN AUSTRALIA: between Jurien Bay and Gingin, *D. Clyne* NSW no. 146264 (NSW); Mt Lesueur, N along Cockleshell Gully Rd, *R.J. Cranfield* 828 (PERTH); approx. 20 miles [34 km] south of Eneabba, *H. Demarz* 749 (PERTH); Badgingarra, *C.A. Gardner* 10257 (PERTH); Western Titanium Leases, 8 km S of Eneabba, *E.A. Griffin* 1173 (PERTH); 19 km E of Green Head on Green Head-Jurien road, foothills of Gairdner Range, *J.A. Halliday* 146 (AD, PERTH); c. 12 km N of Eneabba, *R.J. Hnatiuk* 760247 (PERTH); on roadside, 5 km S of Coomallo Creek on Brand Highway, *R.J. Hnatiuk* 761451 (PERTH); 1 km E of Lake Indoon, *R.J. Hnatiuk* 761418 (PERTH); 6 km N of Jurien Rd on Cockleshell Gully Rd, *R.J. Hnatiuk* 780192, 780193, 780194, 780196, 780198 (PERTH); 10 km S of Eneabba on Western Titanium Rd, *R.J. Hnatiuk* 780216 (PERTH); 7 km E of junction of Coorow-Greenhead Rd and Cockleshell Gully Rd, *R.J. Hnatiuk* 780263, 780264, 780265 (PERTH); 10 mls [16 km] east of Jurien Bay, *K. Newbey* 2351 (PERTH).

Distribution. Irwin District, between the Arrowsmith and Hill Rivers (Figure 5).

Habitat. On the coastal plain and isolated mesa of the Gairdner Range. Associated vegetation kwongan: open heath or low, closed heath; soil: grey sand over red-brown clayey sand, or grey sand over laterite, or light brown sand.

Flowering period. September to October.

Notes. *E. violacea* subsp. *raphiophylla* belongs to section *Violacea*. It is distinguished from *E. atala* by narrow, needle-like, incurved leaves and flowering on last season's short lateral shoots, and habit which is low and spreading. The low habit and narrow leaves also distinguish it from *E. hadra*. From subsp. *violacea* it is distinguished by leaves that are ovoid in transection, not flat on top; by leaves that only incurve, not decurve with age; and flowers that are only on old wood, not new wood.

The populations near Eneabba tend to have flowering on well developed short laterals, whereas those to the east of the Gairdner range show this character less strongly and also have more needle-like leaves than those near Eneabba.

Conservation status. This species seems well protected in several national parks and reserves in the area. The security of sites from gross disturbance as from open-pit mining must be monitored as regeneration appears to be very adversely affected by such disturbance.

Etymology. The name comes from the Greek word *raphis* meaning needle shaped and refers to the shape of the pungent leaves.

3. *Eremaea atala* R. Hnatiuk sp. nov. (Figure 7h-k)

Frutex sine lignotubero. Folia anguste obovata, acuta ad obtusa, sine mucronata, glabra vel indumento bistrato, strato supero piloso, infero piloso; vena in pagina inferiore 1. Flores in ramis longis anni huius axillares, vel in ramis longis terminales, 1-5 per inflorescentia. Hypanthium campanulatum, indumento uni strato supero dense villosa. Lobi calycis anguste triangularibus, dense, pilosi vel tomentosi, caduci. Stamina in parte quarta inferiore connata, papillosa, violacea. Fructus cupulatus ad campanulatus, elobatis, laevis, atro-cinereo-brunneus, pallide brunneus, cupreus vel cano-brunneus, valvis exsertis reflexis ad apicem lobis 2 hemisphaericis ornatis.

Typus : 27.1 km from E (Gunyidi) end of Marchagee Track, 30°09'S lat., 115°46'E long., 5 Dec. 1978, R.J. Hnatiuk 780401 (holo: PERTH; photo: CBG).

Shrub, 120 cm tall; not lignotuberosus. *Branches* very spreading to erect. *Branchlet indumentum* two-layered, upper layer dense to sparse, pilose; lower layer short sparsely pilose. *Over-wintering bracts* 10-12 (bracts below flowers 2-3) ovate to obovate; 1.5-3 mm long, 0.9-1.5 mm wide; indumentum one-layered, ciliate, striate. *Leaves* narrowly obovate; acute to obtuse; 7.3-10 mm long, 0.8-1.5 mm wide; 1 vein below; glabrous or indumentum two-layered, upper layer long pilose, lower layer short pilose; dry leaf cross-section flat, thin. *Petioles* 0.3-0.8 mm long. *Flowers* axillary along long branches of current season's and occasionally terminal to last season's wood; 1-5 per inflorescence (usually 3); fragrance unknown. *Hypanthium* campanulate; 4-4.5 mm long, 2.6-3.2 mm wide; indumentum one-layered, dense, villous all over, uneven, dull, finely mammillate. *Calyx* lobes narrowly triangular; 2.8-3.7 mm long, 1.8-2 mm wide; indumentum dense, pilose and tomentose; caducous. *Petals* 3.2-4.5 mm long, 3.9-5 mm wide; glands abundant; thin-margin wide; very weakly fringed. *Stamens* 19-20 per bundle; filaments fused in lower quarter; papillose; 8-9.5 mm long; violet; swollen distally; claw 1.5-2.5 mm long; 1.3-1.7 mm wide. *Ovary* with 9-10 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 11-13 mm long; indumented on lower quarter to lower half. *Fruit* cupulate to campanulate; 5-5.5 mm long; smooth; light brown, coppery brown or grey-brown; 3.5-4.8 mm wide; without lobes; valves exserted and reflexed, ornamentation of 2 smooth hemispherical lobes at apex. *Seeds* 1.8 mm long; rough; shed freely when fruit is dry.

Selected specimens examined. WESTERNAUSTRALIA: Allanoorka South, S of Geraldton, A.C. Burns 118 (PERTH); 38 mi [60.8 km] W of Coorow, on Greenhead Rd, C. Chapman 15 Jan. 1967 (PERTH); 16 km W of Coorow, H. Demarz D7269 (PERTH); Mingenew, W.V. Fitzgerald NSW146266 (NSW); Public Recreation Reserve on Coorow-Greenhead Road, 4 km E of Brand Hwy, E.A. Griffin 1712 (PERTH); 15 km S of Tathra National Park, E of Eneabba, E.A. Griffin 1806 (PERTH); SE of Alexander Morrison National Park, R. Hnatiuk 780129 (PERTH); 35 km W of Watheroo, near border of South Irwin and Avon District, D.J. Whibley 4954 (AD, PERTH).

Distribution. Irwin District between the Arrowsmith and Hill Rivers (Figure 8).

Habitat. Broad uplands; on the plateaux to the east of the wide coastal plain between Jurien and Eneabba. Associated vegetation kwongan: closed heath, or open heath with emergent *Banksia* and *Xylomelum* species and *Eucalyptus todtiana*; soil light brown sand, or white sand over laterite.

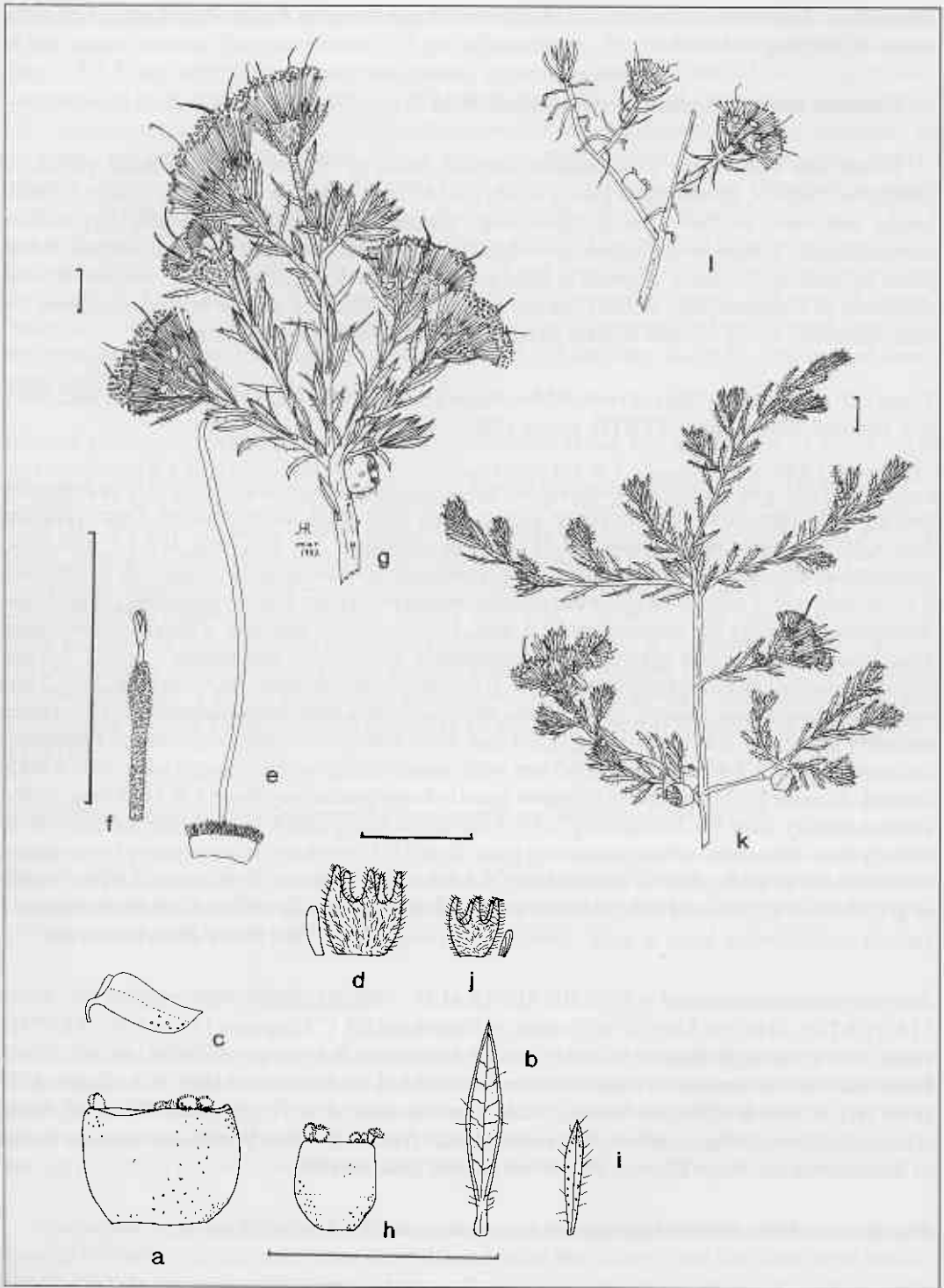


Figure 7. *E. hadra*: a: fruit; b: leaf; c: petal; d: hypanthium and calyx; e: style and top of ovary; f: detail of stamen; g: habit. 7.7 km E of junction of Brand Hwy and Badgingarra Rd, R.J. Hnatiuk 780327 (PERTH). *E. atala*: h: fruit; i: leaf; j: hypanthium and calyx; k: habit. 27 km from E end of Marchagee Track, R.J. Hnatiuk 780401 (survey specimen #21) (PERTH). l: *E. violacea* subsp. *violacea* habit. Allanooka South, S of Geraldton, A.C. Burns 118 (PERTH). All scale bars 10 mm.

Flowering period. November to January.

Notes. *E. atala* is a member of section *Violacea*. It is most closely related to *E. violacea* subsp. *raphiophylla* and *E. hadra*. *E. atala* can be distinguished from *E. hadra* by its narrow, soft leaves, the spreading more delicate branching habit, the generally smaller flowers and fruits, and the flowering which is generally on new wood. The two species may co-exist along their southern boundary of occurrence. *E. atala* can be distinguished from *E. violacea* subsp. *raphiophylla* by the straight, soft, non-pungent leaves, the lack of short side branches which terminate in flowers, and the flowering on new wood. The two taxa are not known to co-occur: *E. atala* is confined to the top of the plateaux and *E. violacea* subsp. *raphiophylla* occurs only on the coastal plain and isolated mesa of the Gairdner Range. *E. atala* is distinguished from *E. violacea* by the upright habit, having non-mucronate leaves which do not have a prominent midrib below, and by leaves which do not strongly reflex with age. The fruits of *E. atala* are most often dark grey-brown whereas those of *E. violacea* are most often light brown.

Conservation status. I recommend that the conservation status of this variety should be Priority Four - Rare Taxa. Although its range is less than 100 km across, it appears to be well represented in Alexander Morrison and Tathra National Parks.

Etymology. The name comes from the Greek word *atalos* meaning tender, delicate, soft and refers to the softness of the leaves in strong contrast to *E. violacea* subsp. *raphiophylla*, *E. violacea* subsp. *violacea* and *E. hadra*.

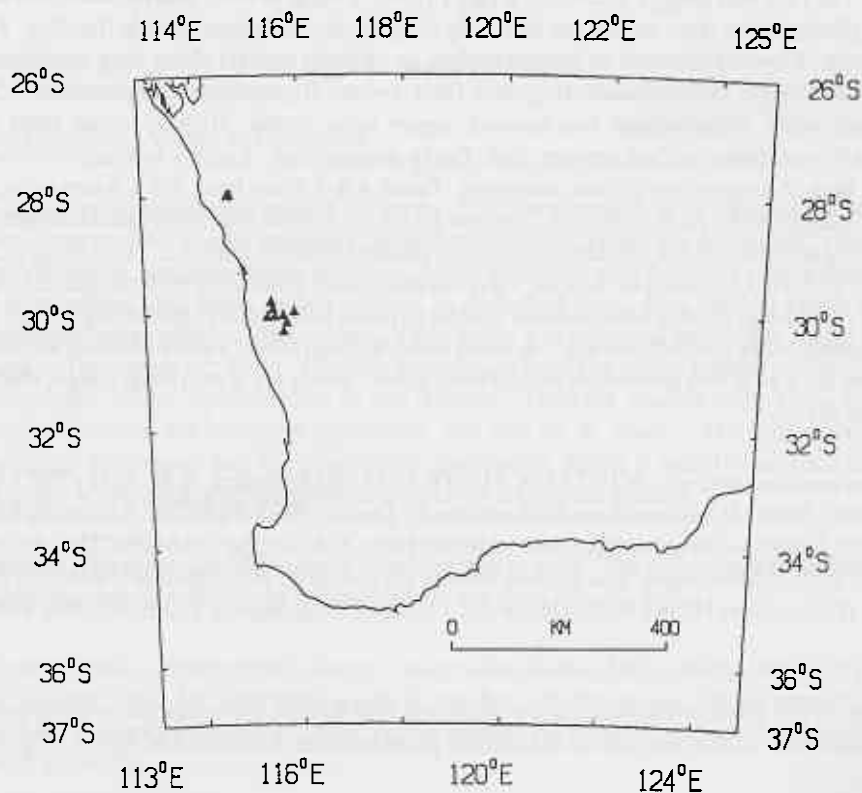


Figure 8. Distribution of *E. atala*.

4. *Eremaea hadra* R. Hnatiuk sp. nov. (Figure 7a-g)

Frutex sine lignotubero. Folia anguste obovata ad anguste elliptica, acuta, muronata, indumento bistrato, strato supero piloso, infero tomentoso, vel breviter strigoso; vena in pagina inferiore 1 vel raro 3. Flores in ramis longis terminales, vel in ramulis brevibus lateralibus ramorum longorum anni proximi terminales, 2-9 per inflorescentia. Hypanthium campanulatum, indumento bistrato, strato supero dense villosa, infero parce pubescente. Lobi calycis anguste triangulares, villosi, caduci. Stamina in parte quarta inferiore connata, papillosa, violacea. Fructus cupulatus ad globosus, laevis, elobatus, atro-violaceo-brunneus, valvis exsertis reflexis ad apicem lobis 2 prominentibus hemisphaericis ornatis.

Typus: 7.7 km E of Junction of Brand Hwy and Badgingarra Road, c. 30°25'S lat., 115°34'E long., 14 Nov. 1978, R.J. Hnatiuk 780327 (holo: PERTH; photo: CBG). (isotypes RJH 780324, RJH 780330).

Illustrations. R.J. Hubbard, Australian Plants 10:16 (1978), as "*Eremaea violacea*"; W.R. Elliot & D.L. Jones, Encyclopaedia of Australian Plants 3:427 as "*Eremaea* aff. *violacea* B".

Shrub, 140 cm tall; not lignotuberous. *Branches* ascending to erect, but becoming spreading in mature plants. *Branchlet indumentum* two-layered with densely or sparsely pilose outer layer; inner densely or sparsely, coarsely tomentose. *Over-wintering bracts* 17-36 per terminal bud; elliptic to oblong; 6.2-7.4 mm long, 2.7-3.5 mm wide; glabrous, or indumentum one-layered tomentose all over back or rarely fimbriate; striate. *Leaves* narrowly obovate to narrowly elliptic, acute, strongly mucronate; 7.6-12.3 mm long, 1.2-2.6 mm wide; 1 rarely 3 veins below; indumentum two-layered, upper layer pilose, lower layer tomentose to shortly strigose; dry leaf cross-section flat, thin. *Petioles* 0.5-1 mm long. *Flowers* terminal on long branches, or on short laterals along long branches of last season's wood; 2-9 per inflorescence; fragrance faint, sweet. *Hypanthium* campanulate; 3.5-5 mm long 3-4 mm wide; indumentum two-layered, upper layer dense, villous; lower layer sparse, pubescent, all over; outer surface uneven, dull, finely mammillate. *Calyx* lobes narrow-triangular; 2.7-5.5 mm long, 2-3 mm wide; villous; caducous. *Petals* 4.4-5.2 mm long, 4.3-5.3 mm wide; glands sparse; thin-margin wide, weakly fringed. *Stamens* 19-25 per bundle; filaments fused in lower quarter or lower half; papillose; 10.5-11.6 mm long; violet; swollen distally; claw 2-2.5 mm long, 2-2.7 mm wide. *Ovary* with 10-13 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 13.5-17 mm long; indumented on lower quarter to lower half. *Fruit* cupulate to globose; 5.6-6.5 mm long; smooth; dark purplish brown; 5-6.8 mm wide; without lobes; valves exserted and reflexed, tips of valves each with two prominent hemispheric lobes. *Seeds* 1.3-2 mm long; rough; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: Badgingarra, A.M. Ashby 762 (AD); 39 miles [62.4 km] West of Coorow on road to Eneabba, H. Demarz 2935 (PERTH); Alexander Morrison National Park, Coorow-Greenhead Rd, east of Brand Hwy, E.A. Griffin 1556 (PERTH); 48 km from E (Gunyidi) end of Marchagee Track, near Dewar Rd junction, R.J. Hnatiuk 780405 (PERTH); Mingenew, H. Steedman NSW146263 (NSW); c. 3 km E of Badgingarra, D.J.E. Whibley 4858 (AD, PERTH).

Distribution. Irwin District between Arrowsmith and Hill Rivers, but confined to the edges of the plateaux which rise to the east, above the coastal plain between Eneabba and Jurien (Figure 9).

Habitat. Edge of escarpments; associated vegetation kwongan: open heath, closed heath, or low closed heath; soil grey sand over laterite, or white sand.

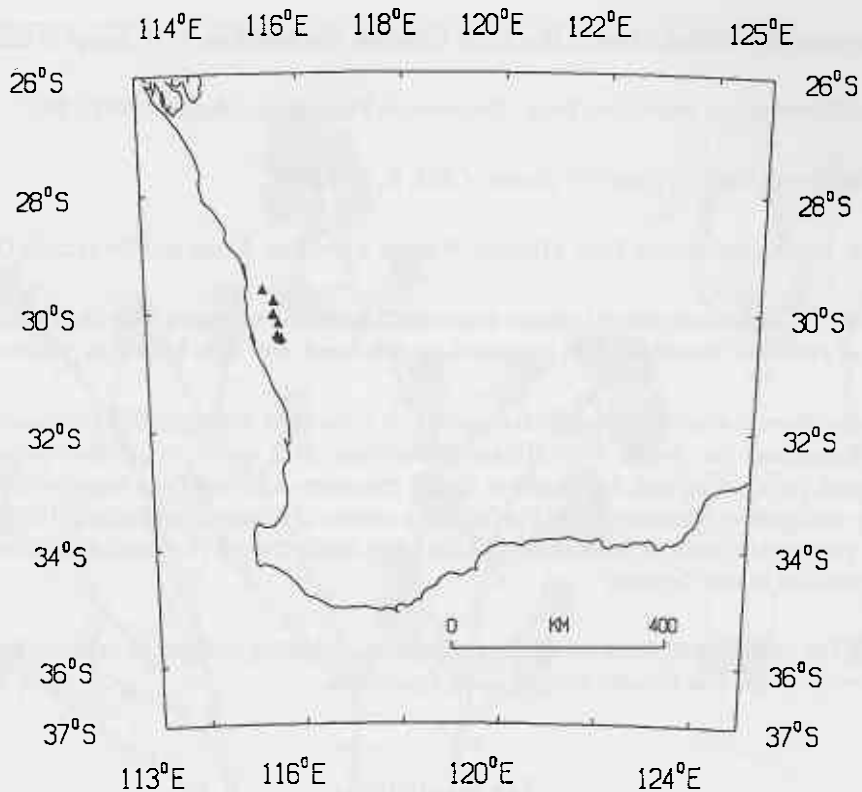


Figure 9. Distribution of *E. hadra*.

Flowering period. October to December.

Notes. *E. hadra* is a member of section *Violacea*. It is characterised by its robust erect growth habit. Its leaves, flowers and fruits are generally larger than its nearest relatives - *E. atala*, *E. violacea* subsp. *raphiophylla* and *E. violacea* subsp. *violacea*. It may hybridise with *E. atala* in some places, but with so few populations, and these mostly near or in disturbed areas, it is hard to know whether the hybridisation is only recent or also ancient. The variety was collected before any major disturbance of the land by Europeans occurred. Whether disturbance from fire, either natural or Aboriginal, could have stimulated recent hybridisation is not known. Isozyme studies only show a very close relationship between the sampled population and that of *E. atala*. The distinctive but small morphological difference, and the geographic distribution which is wholly marginal to its nearest relative make it reasonable to recognise the taxon as a separate species.

Horticulture. The plant is readily grown from cuttings or seed. The large clusters of flowers of deep violet stamens topped with bright yellow anthers are very attractive.

Conservation status. I recommend that the conservation status of this variety should be Priority One - Poorly Known Taxa. Its geographic range is less than 100 km across. Its occurrence in Reserves is not known. It is only known from small populations along the edge of the archaean shield. Further field work is needed.

Etymology. The species name comes from the Greek word *hadros* meaning well-developed, large, strong, and refers to the distinctively robust character of the plant in comparison to its closest relatives.

5. *Eremaea pauciflora* (Endl.) Druce, Bot. Exch. Club Soc. Brt Isles Rep. 1916, Suppl. 2: 622 (1917)

Base name: *Metrosideros pauciflora* Endl.; Enumeratio Plantarum... *Huegel* (1837): 50.

Typus: Swan River (*Hugel.*). (holo: W; photos: CBG, K, PERTH)

Distribution. Irwin, Drummond, Dale, Menzies, Warren, Eyre, Roe, Avon, and Coolgardie Districts.

Habitat. Lateritic uplands to coastal plains; associated vegetation kwongan: low closed heath, low woodland, or open low woodland; soil grey sand, or grey sand over light brown or yellow sand.

Notes. *E. pauciflora* is a member of section *Eremaea*. It is the most widespread of *Eremaea* species. It occurs throughout the South West Botanical Province as a series of isolated populations. Morphological variation is high, but suites of linked characters have not been found which would allow ready recognition of infraspecies. The isozyme studies of Coates and Hnatiuk (1990) did not sample the geographic range of this species. Much more detailed work is needed to understand the nature of variation in this "species".

Etymology. The name comes from the Latin words *paucus* meaning few and *flora* meaning flower. The name refers to the few flowers seen on some specimens.

Key to varieties

1. Leaves narrowly elliptic, leaf veins 1 or 3 5b. var. *lonchophylla*
1. Leaves linear or very narrowly obovate, leaf veins 1
2. Hypanthium covered by large, clasping, spatulate bracts, fruits with orifice nearly as wide as fruit 5c. var. *calyptra*
2. Hypanthium closely covered by usually ovate concavo-convex bracts, fruits with orifice much less than width of fruit 5a. var. *pauciflora*

5a. *Eremaea pauciflora* (Endl.) Druce var. *pauciflora* (Figure 10)

E. ericifolia Lindley, "Swan River, N. Holland, Drummond"; *E. pilosa* Lindley, "N.B. Ward dirt., Swan River District, Comm. I. Mangles 1837".

Shrub, 200 cm tall; with or without lignotubers. *Branches* spreading, forming low mounded shrubs to tall, infundibular large shrubs. *Branchlet indumentum* one-layered, dense, tomentose, glabrescent. *Over-wintering bracts* 12-24 per terminal bud; ovate to obovate; 2-6.7 mm long, 1-4.7 mm wide; indumentum one-layered, finely puberulous and ciliate; on edges to all over back; striate. *Leaves* linear, rarely narrowly elliptic to obovate, obtuse; 2.9-7.9 mm long, 0.6-1.6 mm wide; 0-1 veins below; glabrous, or indumentum one- or two-layered, upper layer dense pilose, lower layer dense tomentose; dry leaf cross-section triangular. *Petioles* 0.6-1.1 mm long. *Flowers* terminal on long branches of last season's wood; 1 rarely 2 per inflorescence; fragrance none or faint, sweet. *Hypanthium* long, campanulate; 2.9-5 mm long, 2.8-3.9 mm wide; glabrous, or indumentum one-two-layered, very dense, velutinous upper layer (at base only sometimes), lower layer tomentose; all over

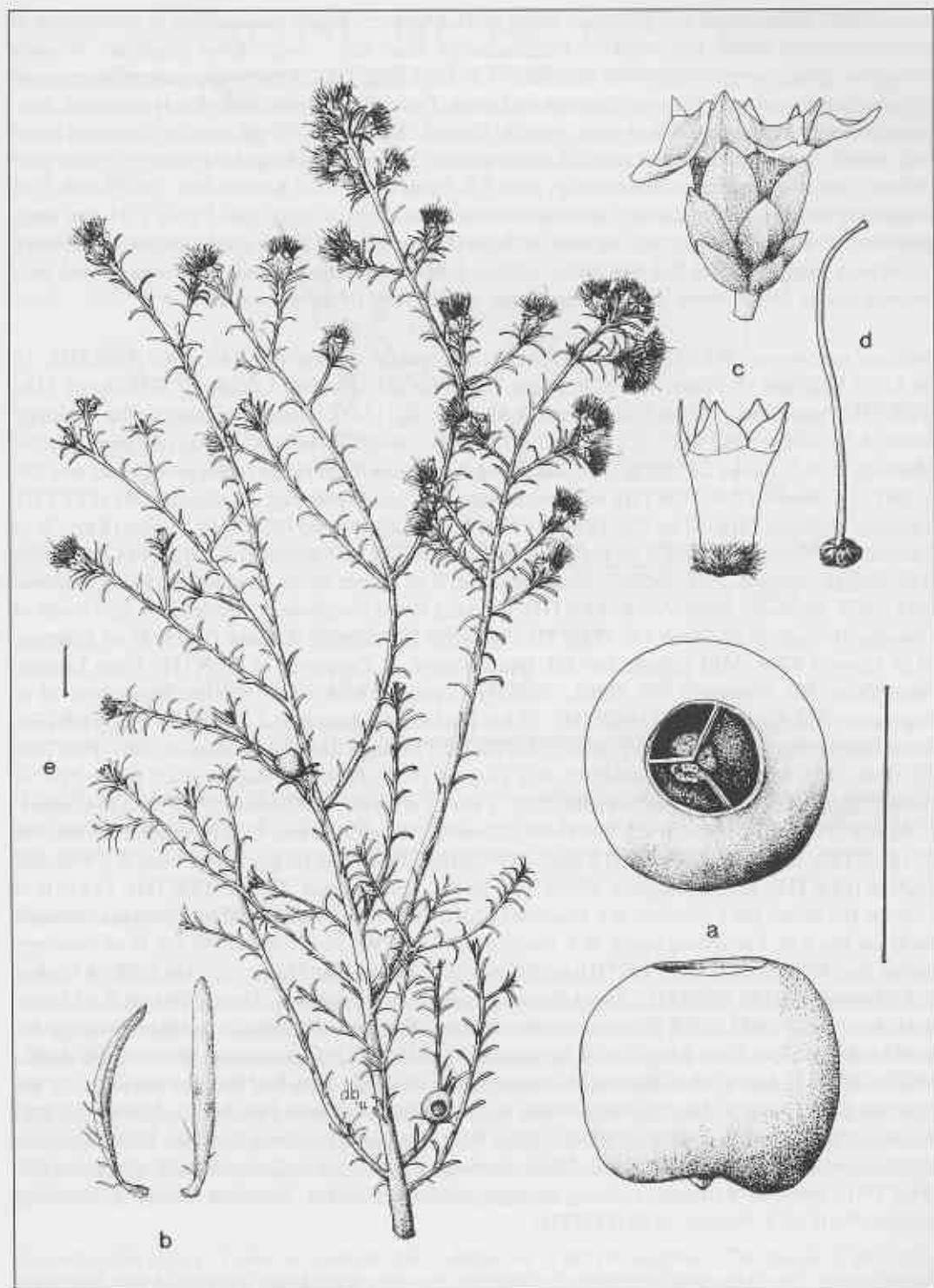


Figure 10. *E. pauciflora* var. *pauciflora*: a: fruits, side and top views; b: leaf, side and ventral views; c: hypanthium: top figure with perules, bottom figure with perules removed; d: style; e: habit. Hillview Terrace and Berwick Street, Victoria Park, R.J. Cranfield 1180 (PERTH). All scale bars 10 mm (left one refers to two habit drawings (e), right one refers to details (a-d)).

or variously indumented and glabrous; outer surface uneven, finely mammillate to tuberculate to smooth, usually shiny, but wrinkled longitudinally when dry. *Calyx* lobes cuspidate, broadly triangular, lower margins somewhat auriculate; 1.3-3 mm long, 1.5-2.5 mm wide; indumentum sparse to dense, pubescent and ciliate, or glabrous; caducous. *Petals* 2.5-5.7 mm long; glands abundant; thin-margin narrow at apex to wide at sides; weakly fringed. *Stamens* 17-32 per bundle; filaments fused only shortly at base to filaments fused in lower quarter; smooth; 4.5-8 mm long; orange (rarely pale yellow); not swollen, or swollen distally; claw 0.5-2 mm long; 1.4-2.8 mm wide. *Ovary* with 7-14 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 7-11 mm long; glabrous. *Fruit* globose but very variable in shape (Figure 12), 6-9.2 mm long; smooth; light brown to coppery brown; orifice 2-3 mm wide; without lobes; valves deeply included, ornamented by 2 inconspicuous apical lobes. *Seed* 1-2 mm long; rough; shed freely when fruit is dry.

Selected specimens. WESTERN AUSTRALIA: Bayswater, *C. Andrews*, Oct. 1907 (PERTH); 17 mi [27.2 km] east of Pingelly, *T.E.H. Aplin* 788 (PERTH); Ruabon-Ludlow, *T.E.H. Aplin* 1184 (PERTH); Armadale, c. 27 km SSE of Perth, *A.M. Ashby* 487 (AD); South of Ongerup on the Toompup Road, *A.M. Ashby* 3092 (AD); Cunderdin, *E.T. Bailey* 126 (PERTH); about 4 mi [6.2 km] north of Muntadgin, *E.T. Bailey* 247 (PERTH); Lake King-Norseman Rd between rabbit proof fence and 100 m tank, *J.S. Beard* 3788 (PERTH); between Goomalling and Meckering *J.S. Beard* 8041 (PERTH); Yanchep National Park, 32 mi [51.2 km] N of Perth, *E.M. Bennett* 65 (PERTH); 5 miles [8 km] N of Yanchep on Moore River Rd, *B.G. Briggs*, 6 Oct. 1969 (NSW); 57 miles [91.2 km] W of Coolgardie, *B.G. Briggs*, 30 Sept. 1960 (NSW); Mogumber Rd, S of Moore River (E of Moore River National Park), *N.T. Burbidge* 8066 (NSW, PERTH); Canning River foreshore, 1.5 miles [2.4 km] south of Canning Bridge, *M.L. Clark* 172 (PERTH); between Harrissmith & Lake Grace, N of Kukerin, *M.G. Corrick* 8748 (MEL); Boundary Rd, Wattle Grove, *R. Coveny* 8073 (PERTH); Palm Terrace, Forestfield, *R.J. Cranfield* 131 (MEL, PERTH); opposite turn-off to Stirling Ranges on rd to Esperance, *R.J. Cranfield* 984 (PERTH); 75 km E of Ravensthorpe, *R.J. Cranfield* 998 (PERTH); Swan District Burswood, *Diels & Pritzel* 258 (PERTH); Tammin Reserve, *H. Demarz* 4667 (PERTH); 22 miles [35.2 km] east of Newdegate, *A.S. George* 1655 (PERTH); Rabbit proof fence, NW of Jerramungup, *A.S. George* 7003 (PERTH); c. 3 km by road SE of Kondut PO on road to Cadoux. *L. Haegi* 1107 (AD); Possum Rd, Tuttanning Reserve, 17 mi [27.2 km] E of Pingelly, *G. Heinsohn* 27 (PERTH); Subiaco, *R. Helms*, 12 Dec. 1897 (MEL, PERTH); 16 km S of Kulin, *R.J. Hnatiuk* 780038 (PERTH); near Boongarra, NE of Two Rocks, *R.J. Hnatiuk* 780150 (PERTH); 17 km E of Coorow Rd-Brand Hwy junction, *R.J. Hnatiuk* 780286 (PERTH); 17 km due NE of Brookton, between Jurakine Rock & Yenyening pools, *R.J. Hnatiuk* 790125, 790126 (PERTH); 80 km W of Southern Cross, *R.J. Hnatiuk* 800092 (PERTH); c. 22 km SW of Round Top Hill, c. 122 km ENE of Hyden, *R.J. Hnatiuk* 800198 (PERTH); Swan River, *Hugel* 11 (V); Jandakot, 15 mi [24 km] S of Perth, *A.M. James* 137 (MEL, PERTH); crossroad c. 6 km SSE of Lake Chidnup, main Ravensthorpe Rd c. 48 km by rd SE of Lake King, *E.N.S. Jackson* 3431 (AD, MEL); Cowcowing, *M. Koch* 995 (MEL, NSW); 3.5 mi [5.6 km] NE of Borden, *K. Newbey* 584 (PERTH); 2 km E of Koorarawaylee, c. 72 km E of Southern Cross, *K. Newbey* 6090 (PERTH); Tone River, *Oldfield* 389 (MEL); 58 mi [92.8 km] W of Coolgardie, *M.E. Phillips* 022849 (AD, CBG); 2 mi [3.2 km] N of Wongan Hills, Research station area, *M.E. Phillips* (AD, CBG, MEL); between Bruce Rock & Quairading, *W. Rogerson* 293 (PERTH); along N-S transect running through middle of Reserve, Jandakot Marsupial Breeding Station, Perth, *A.S. Weston* 7429 (PERTH).

Distribution. This is the most widespread of species. It occurs in the Irwin, Darling, Avon, Roe, Eyre and Coolgardie Districts (Figure 11).

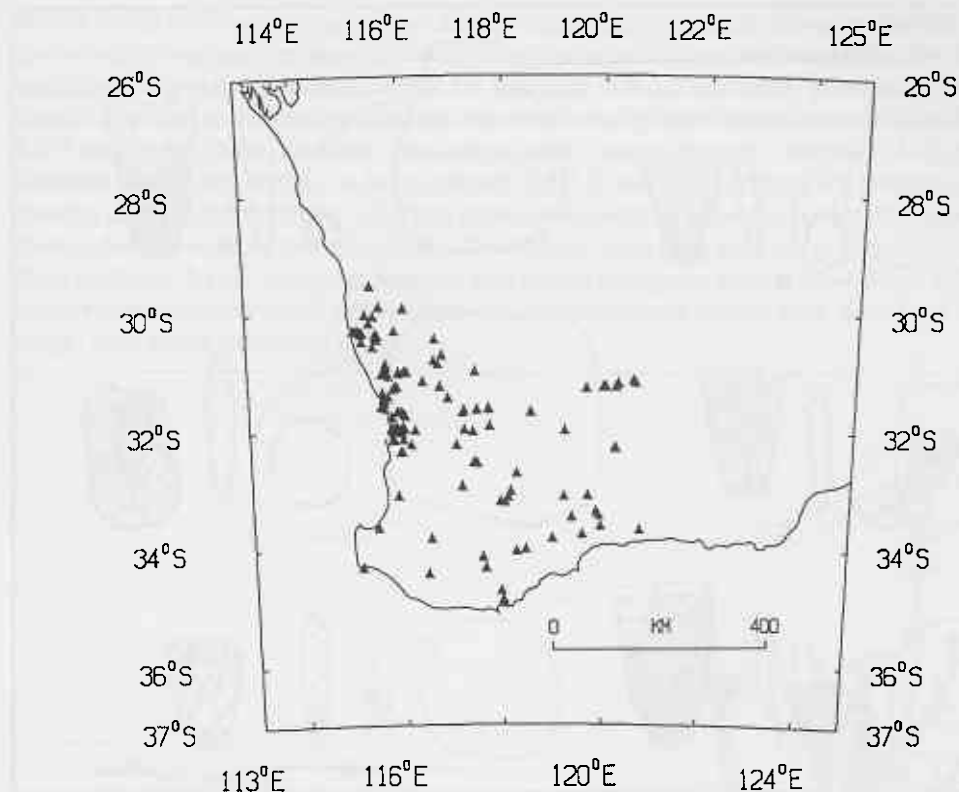


Figure 11. Distribution of *E. pauciflora* var. *pauciflora*.

Habitat. Broad uplands, or from lateritic uplands to coastal plains; associated vegetation kwongan: low open heath, low closed heath, low woodland, or open low woodland (*Banksia* woodland); soil grey sand, grey sand over laterite, sand over laterite, or yellow sand.

Flowering period. July to November.

Notes. *E. pauciflora* var. *pauciflora* is part of section *Eremaea*. It is morphologically variable, but the populations that are recognisable are not sufficiently consistent in the suites of characters to allow recognition of individual taxa, even though some of them are striking. Some of the more prominent variations are in the amount and location of indumentum, the thickness of the leaves (to some extent the thick leaved variants are more common in the south of the range), the presence or absence of lignotubers (lignotuberous plants coincide with low, multi-stemmed, generally less than 1m high plants, whereas non-lignotuberous forms tend to be taller, broom-bush shaped plants); the shape and size of the over-wintering bracts and the degree to which they cover the hypanthium; the size and shape of the fruits and the size of the orifice at the top of the fruit.

Conservation status. Taken as a whole, this subspecies is not endangered. The status of the many population variants is not known.

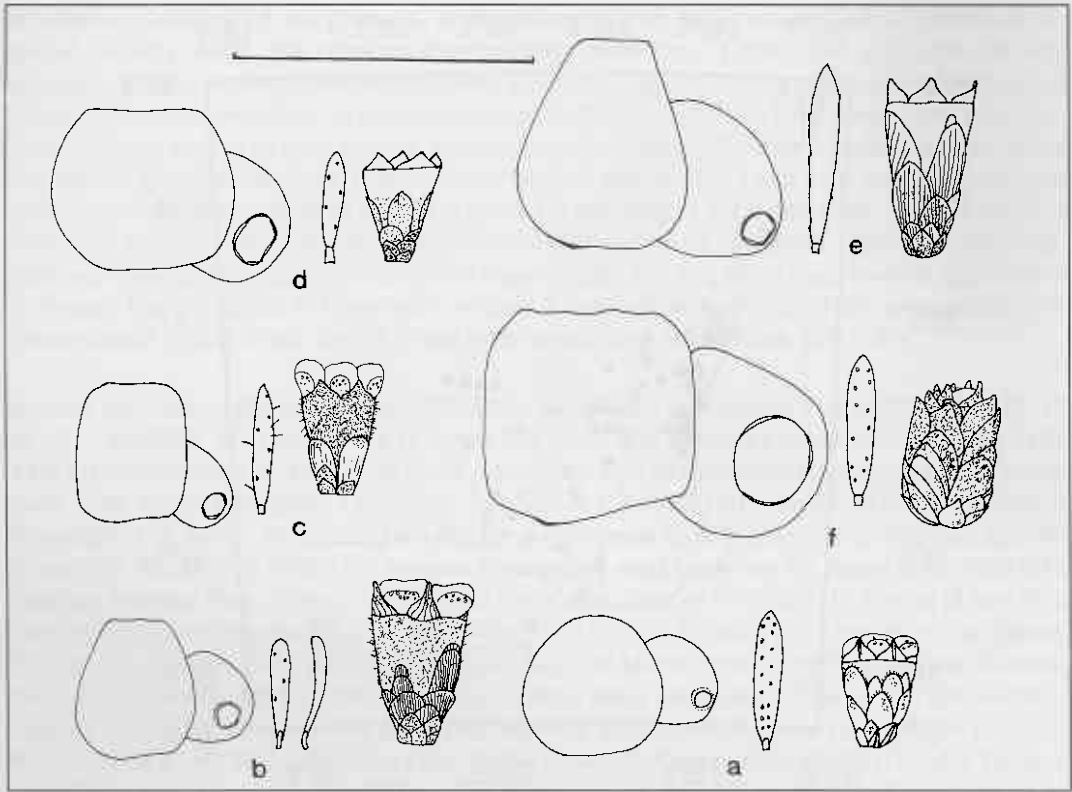


Figure 12. *E. pauciflora* var. *pauciflora*: fruits, leaves and flowers covered with perules; **a**: Round Top Hill, 120 km E of Hyden, R.J. Hnatiuk 800198 (survey specimen # 65). **b**: Mallee Rd, c. 62 km W of Ravensthorpe, R.J. Hnatiuk 800126 (survey specimen # 64) (PERTH). **c**: Neaves Rd, NE of Wanneroo, R.J. Hnatiuk 790193 (survey specimen # 77) (PERTH). **d**: Jarrah Rd, S Perth, R.J. Hnatiuk 771537 (PERTH). **e**: Forrestfield, Perth, R.J. Hnatiuk 780139 (PERTH). *E. pauciflora* var. *calyptra*: **f**: fruits, leaf and flower covered with perules. Munbinea Rd, SE of Jurien, R.J. Hnatiuk 780173 (PERTH). Scale bar 10 mm.

5b. *Eremaea pauciflora* (Endl.) Druce var. *lonchophylla* R.J. Hnatiuk var. nov. (Figures 13, 19f, g, h)

Frutex sine lignotubero. Rami patentes ad erecti (infundibulares). Folia elliptica, angusta, acuta vel obtusa, glabra vel pilosa, vena in pagina inferiore 0 vel 1. Flores in ramis longis anni proximi terminales, 1 vel interdum 3 per inflorescentia, graveolentes dulce odorati. Hypanthium campanulatum, longum, indumento unistrato vel raro bistrato, strato supero denso, velutino, infero denso, tomentoso. Fructus doliiformis, laevis, pallide brunneus ad cupreus, elobatus, valvis profunde inclusis.

Typus: c. 10-20 km E of Tathra National Park, 28 July 1980, R.J. Hnatiuk 800054. (holo: PERTH; photo: CBG) [plus 1 dupl.].

Shrub, 200 cm tall; not lignotuberous. *Branches* spreading to erect (infundibular). *Branchlet indumentum* glabrous or two-layered, sparse, pilose outer layer, inner sparsely puberulous. *Overwintering bracts* 11-21 per terminal bud; ovate to obovate; 2.4-2.9 mm long, 1.9-2.6 mm wide; indumentum one-layered, ciliate, rarely finely puberulous, on edges and occasionally on upper (distal) back; striate. *Leaves* narrowly elliptic, acute or obtuse; 3.1-5.1 mm long, 0.9-3.3 mm wide; 1-3 veins below; glabrous, or pilose; dry leaf cross-section flat, thick. *Petioles* 0.5-1.1 mm long. *Flowers* terminal on long branches of last season's wood; 1 sometimes 3 per inflorescence; fragrance strong, sweet, light or spicy. *Hypanthium* campanulate; 3.2-3.6 mm long, 3-4 mm wide; indumentum

one- or rarely two-layered, upper layer dense, velutinous; lower layer dense, tomentose; all over or sparse to glabrous near rim; smooth, usually shiny, but wrinkled longitudinally when dry. *Calyx* lobes semicircular to obtusely triangular; 0.9-1.4 mm long, 1.8-2.2 mm wide; glabrous or indumentum dense, ciliate and occasionally pubescent; caducous (usually bases remain as an undulate rim). *Petals* 3-4.7 mm long; glands abundant; thin-margin wide, weakly fringed. *Stamens* 24-47 per bundle; filaments fused only shortly at base; smooth; 5.5-7.5 mm long; orange; not swollen, or swollen distally; claw 0.1-0.5 mm long; 1.5-2 mm wide. *Ovary* with 10-12 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 7.5-10.2 mm long; glabrous or variously indumented. *Fruit* doliform; 5.1-6.7 mm long; smooth; light brown to coppery brown; 2.6-4.2 mm wide; without lobes; valves deeply included, ornamented with 2 inconspicuous lobes at apex. *Seed* 1.4-1.6 mm long; rough; shed freely when fruit is dry.

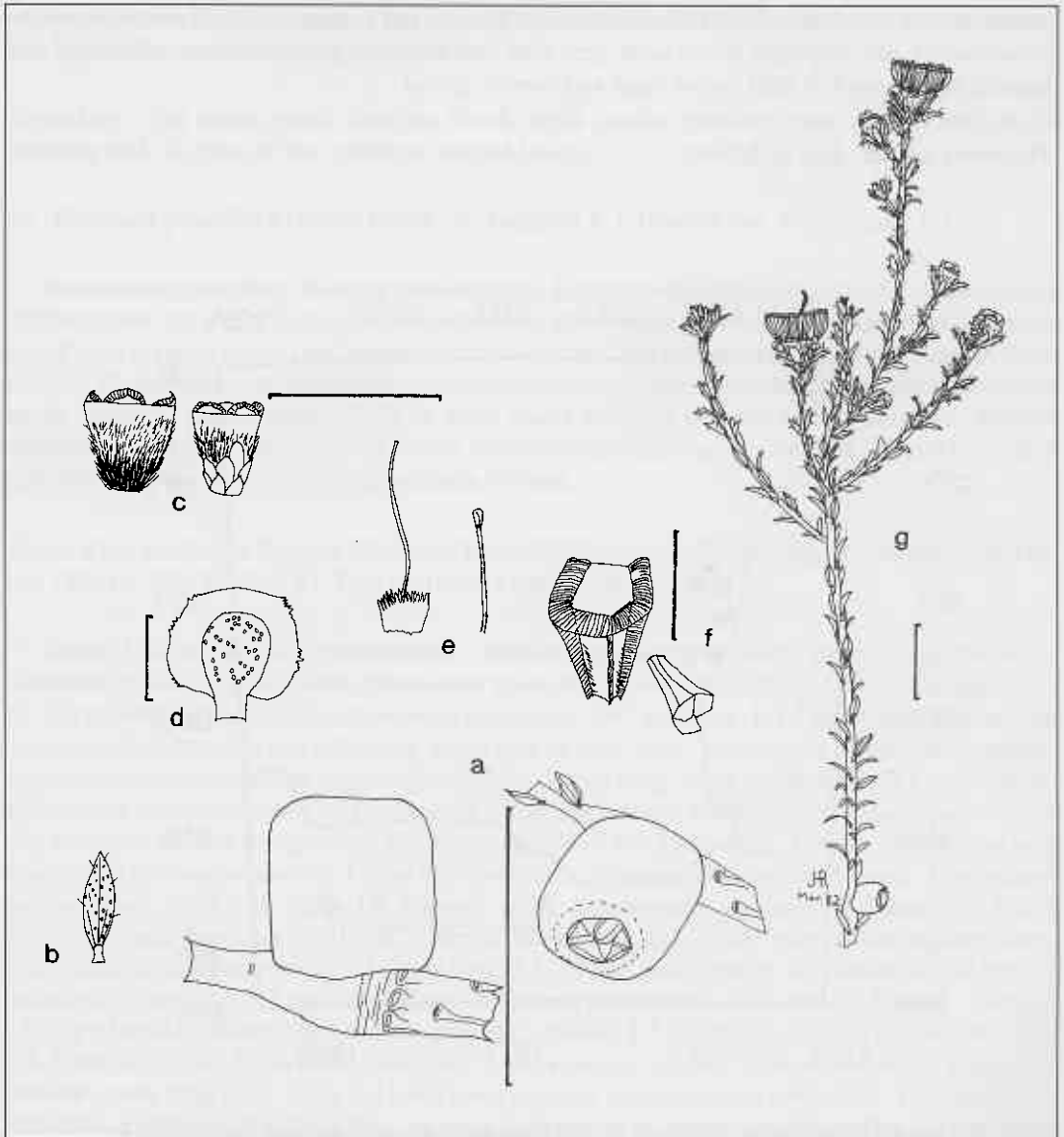


Figure 13. *E. pauciflora* var. *lonchophylla*: a: fruits, side view and oblique of top; b: leaf; c: hypanthium and calyx, left without perules, right with perules; d: petal (scale bar 2.5 mm); e: style and top of ovary; f: seed and chaff (scale bar 2 mm); g: habit. 16 km from Yarra Yarra Lakes towards Tathra Natl Pk, R.J. Hnatiuk 800054 (survey specimen # 54) (PERTH). All scale bars, not indicated otherwise, 10 mm.

Selected specimens examined. WESTERN AUSTRALIA: west of Coorow, *W.E. Blackall* 3956 (PERTH); west of Three Springs, *W.E. Blackall*, Sept. 1940 (PERTH); 25 km (by road) W of Winchester, *C. Chapman*, 23 March 1979 (PERTH); Alexander Morrison National Park, Coorow-Greenhead Rd, *E.A. Griffin* 1559 (PERTH); 23 km S of Eneabba on Brand Hwy, *R.J. Hnatiuk* 780238 (PERTH); 1 km E of Brand Hwy on Coorow Rd, *R.J. Hnatiuk* 780271 (PERTH); 8 km S of New Badgingarra, *R.J. Hnatiuk* 780315 (PERTH); 15 km due W of Coorow, *S.D. Hopper* 1552 (PERTH); cultivated in Kings Park, chromosome count voucher, *B.L. Rye* 76036 (PERTH).

Distribution. On the eastern plateaux of the Irwin District (Figure 14).

Habitat. Broad uplands; associated vegetation kwongan: closed heath, low open heath, high shrubland, low woodland, or open low woodland (of *Banksia* and *Xylomelum* species with dense shrub understorey); soil deep light brown sand, grey sand over laterite, light brown sand, white sand over laterite, yellow sand or light brown loam and lateritic gravel.

Flowering period. July to January.

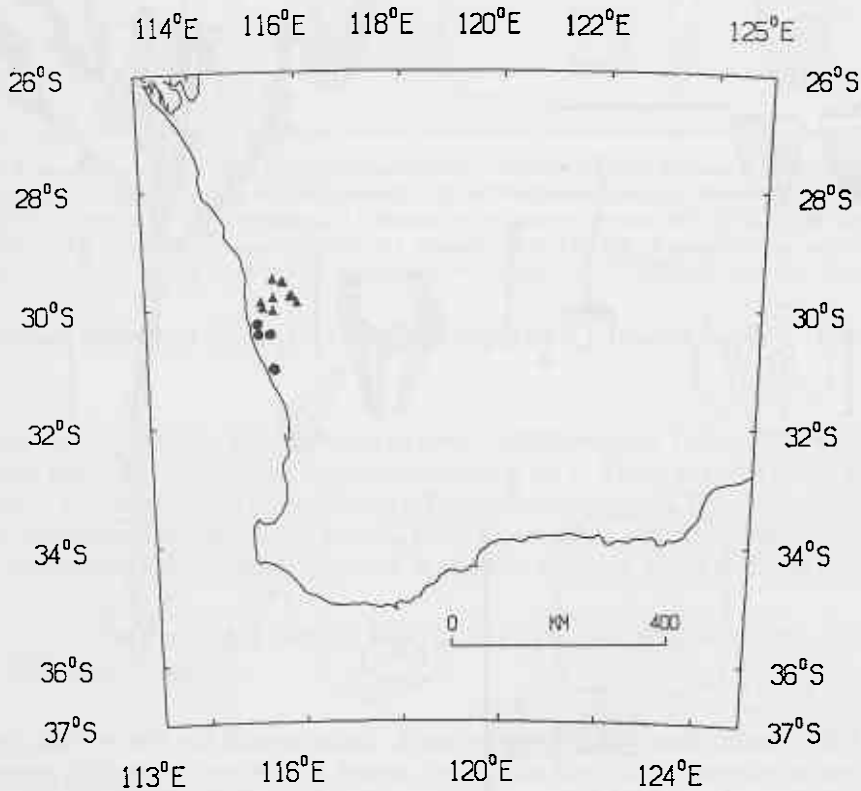


Figure 14. Distribution of *E. pauciflora* var. *lonchophylla* (▲) and *E. pauciflora* var. *calyptra* (●)

Notes. *E. pauciflora* var. *lonchophylla* differs from variety *pauciflora* in the broad thick leaves, the usual presence of 1-3 leaf veins. The variety *lonchophylla* co-occurs with *E. beaufortioides* var. *lachnosanthe*. Morphological intermediates between them can be found.

The major area of occurrence is on the lateritic upland which contains Tathra and Alexander Morrison National Parks. These populations have thick leaves with often obtuse apices. To the south, towards Badgingarra, populations with narrower, thinner, more pointed, and often more crowded leaves occur. To the west near Eneabba, a complex set of populations occurs, generally with narrower, thinner leaves. These variants are visually distinctive. More study of them is required.

Conservation status. I recommend that the conservation status of this variety should be Priority Two - Poorly Known Taxa. Its range is less than 100 km across and its field condition is poorly known. It is known from only scattered populations.

Etymology. The name comes from the Greek words *loncho* meaning spear or lance and *phylla* meaning leaf. It refers to the spearhead shaped leaves.

5c. *Eremaea pauciflora* (Endl.) Druce var. *calyptra* R.J. Hnatiuk var. nov. (Figure 12f)

Frutex sine lignotubero. Rami patentes ad erecti. Folia obovata ad linearia, angusta, obtusa, glabra vel indumento uni- vel bistrato, strato supero piloso, infero parce puberuloso, vena in pagina inferiore 0-1. Flores in ramis longis anni proximi terminales, 1 vel 2 per inflorescentia, non vel leviter et dulce odorati. Hypanthium campanulatum, longum, velutinum, indumento unistrato, interdum tantum ad basin. Stamina per fasciculo 17-32, in parte quarta inferiore connata, laevia, aurantia. Fructus doliiformis, turbinatus vel globosus, laevis, pallide brunneus ad cupreus, orificio 2-3 mm lato, labro undulato lobis parvis acutis, valvis profunde inclusis.

Typus: 8 km S of Jurien Road on Munbinea Road, 30°22' S lat., 115°13' E long, R.J. Hnatiuk 780180, iso: 780181, 780182, 780183, 780185. (holo: PERTH; photo: CBG).

Shrub, 150 cm tall; not lignotuberous. *Branches* spreading to erect. *Branchlet* glabrous, or indumentum two-layered, dense, pilose outer layer; inner dense, tomentose. *Over-wintering bracts* 12-24 per terminal bud; spatulate or ovate to obovate; 2-6.7 mm long, 1-4.7 mm wide; indumentum one-layered, tomentose and ciliate, on edges and all over back, or on upper (distal) back; striate. *Leaves* narrowly obovate to linear; obtuse; 2.9-7.9 mm long, 0.6-1.6 mm wide; 0-1 vein below; glabrous, or indumentum one- or two-layered, pilose upper layer, lower layer very sparse puberulous; dry leaf cross-section triangular, or flat, thick. *Petioles* 0.6-1.1 mm long. *Flowers* terminal on long branches of last season's wood; 1-2 per conflorescence; fragrance none to faintly sweet. *Hypanthium* campanulate; 2.9-5 mm long, 1.6-3.9 mm wide; indumentum one-layered, densely to thinly velutinous; near base only to all over; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* lobes broadly triangular; 1.3-3 mm long, 1.5-2.5 mm wide; sparse; velutinous; apical portion caducous. *Petals* 2.5-5.7 mm long; glands abundant; thin-margin wide, weakly fringed. *Stamens* 17-32 per bundle; filaments fused in lower quarter; smooth; 4.5-8 mm long; orange; not swollen; claw 0.5-2 mm long, 1.4-2.8 mm wide. *Ovary* with 7-14 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 7-11 mm long; sparsely indumented on lower half. *Fruit* doliform, turbinate, or globose; 6-9.2 mm long; smooth; light brown to coppery brown; orifice 2-3 mm wide; rim undulate with small pointed lobes; valves deeply included, ornamented with none or 2 inconspicuous apical lobes. *Seed* 1-2 mm long; rough.

Selected specimens examined. WESTERN AUSTRALIA: Reserve on Hill River 10 km east of Jurien, E.A. Griffin 1796 (PERTH); c. 8 km E of Jurien Bay, R.J. Hnatiuk 780126 (PERTH); Orange Springs Rd, c. 6 km NE of Cowalla Rd, R.J. Hnatiuk 780159, 780160 (PERTH); 12 km S of Jurien Rd on Munbinea Rd, R.J. Hnatiuk 780173, 780174, 780176 (PERTH); 8 km S of Jurien Rd on Munbinea Rd, R.J. Hnatiuk 780180, 780181, 780182, 780183, 780184 (PERTH).

Distribution. Irwin District between Jurien and the Brand Highway (Figure 14).

Habitat. Lateritic uplands to coastal plains; associated vegetation kwongan: low closed heath, low woodland, or open low woodland; soil grey sand, or grey sand over light brown sand.

Flowering period. October.

Notes. *E. pauciflora* var. *calyptra* is distinguished from other varieties of *E. pauciflora* primarily by its stocky or robust branching, somewhat coarser leaves, the development of large, spatulate, clasping over-wintering bracts (perules) which conspicuously cover the hypanthium, and fruits with a conspicuously wide orifice and undulate rim.

Some of the key characters of the taxon appear to integrate with other taxa. Towards the south, the bracteose character is found on plants with linear leaves, gracile branches, and fruits with a narrow orifice and would otherwise fit well within var. *pauciflora*. Towards the northeast, near Eneabba, plants with fruits with wide orifices occur with leaves that resemble those of var. *lonchophylla*. These plants with some intermediate characters are for the time being placed in var. *pauciflora* and var. *lonchophylla* respectively.

Further detailed study may indicate that varietal recognition is not warranted or it may indicate that other varieties should also be segregated. The "*pauciflora*" complex is widespread, diverse and complex. The full details of its variation patterns have not been determined in this study.

Conservation status. I recommend that the conservation status of this variety should be Priority Two - Poorly Known Taxa. The variety occurs over a range of less than 100 km. It occurs in several small, but often dense populations. Its occurrence on reserves has not been determined.

Etymology. The name comes from the Greek word *kalyptra* meaning to cover or conceal in reference to the prominence of the large, clasping over-wintering bracts (perules) which conceal the hypanthium.

6. *Eremaea blackwelliana* R.J. Hnatiuk sp. nov. (Figure 15)

Frutex. Folia linearia, acuta, indumento unistrato, piloso; vena in pagina inferiore 1. Flores in ramulis brevibus lateralibus ramorum longorum anni proximi terminales, 1 per inflorescentia. Hypanthium campanulatum, laevis, plerumque nitens, in dimidio infero dense villosa. Lobi calycis late triangulares, cuspidati, ad basin aliquantum auriculati, glabri, caduci. Stamina in parte quarta inferiore connata, papillosa, aurantiaca. Fructus cupulatus, elobatus, laevis, pallide brunneus ad cupreus, valvis vadose inclusis, ad apicem lobis 2 hemisphaericis laevis ornatis.

Typus: Darling District, 11.4 km from Toodyay along road to Clackline, 31°39'S, 116°28'E, 30 Oct. 1990, R.W. Purdy 3893 (holo: CBG; iso: PERTH).

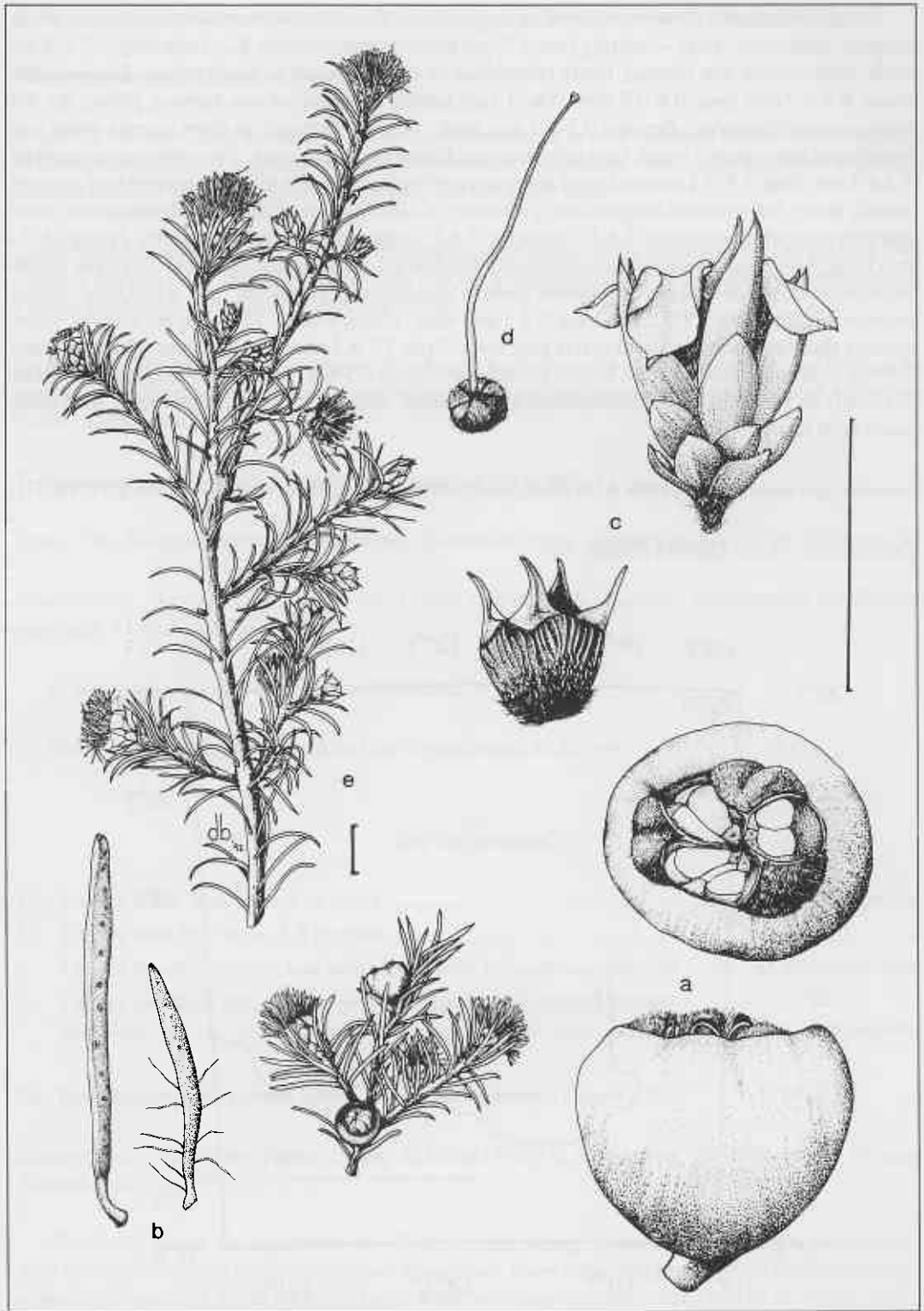


Figure 15. *E. blackwelliana*: a: fruits; b: leaves; c: hypanthium and calyx with and without perules; d: style and top of ovary; e: habit. Clackline, D. Coates CL1 23/10/86 (PERTH). Scale bars all 10 mm (left hand one refers to the two habit drawings (e) and the right one to the detailed drawings (a-d)).

Shrub, 300 cm tall. *Branches* ascending to spreading. *Branchlet indumentum* one-layered, dense, strigose, tomentose. *Over-wintering bracts* 25 per terminal bud, obovate, 8.2-9 mm long, 5.7-6.3 mm wide; indumentum one-layered, finely puberulous on edges; smooth to finely striate. *Leaves* linear, acute; 8.8-9.7 mm long, 0.6-0.9 mm wide; 1 vein below; indumentum one-layered, pilose; dry leaf cross-section triangular. *Petioles* 0.5-1.2 mm long. *Flowers* terminal on short laterals along long branches of last season's wood; 1 per inflorescence; fragrance not recorded. *Hypanthium* campanulate; 3.3-4.1 mm long, 4.4-5.4 mm wide; indumentum one-layered, densely villous, on lower half; smooth, usually shiny, but wrinkled longitudinally when dry. *Calyx* lobes cuspidate, broadly triangular, lower margins somewhat auriculate, 1.5-1.7 mm long, 1.5-1.7 mm wide; glabrous; caducous. *Petals* 2.8-3.4 mm long, 3.3-3.9 mm wide; glands abundant; thin-margin wide; entire. *Stamens* 20-26 per bundle in two rows on top of each claw; filaments fused in lower quarter; papillose; 7.3-8.9 mm long; orange; swollen distally; claw 1.8-2.2 mm long, 0.8-1 mm wide. *Ovary* with 16-17 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 7.7-8.5 mm long; glabrous. *Fruit* cupulate; 7.5-8.1 mm long; smooth; light brown to coppery brown; 5.5-6.2 mm wide; without lobes; valves shallowly included, 2 smooth hemispheric lobes at apex. *Seeds* 1.2-1.7 mm long; rough; shed freely when fruit is dry.

Selected specimens. WESTERN AUSTRALIA: Clackline Nature Reserve, D.J. Coates CL9 (PERTH).

Distribution. Avon District (Figure 16).

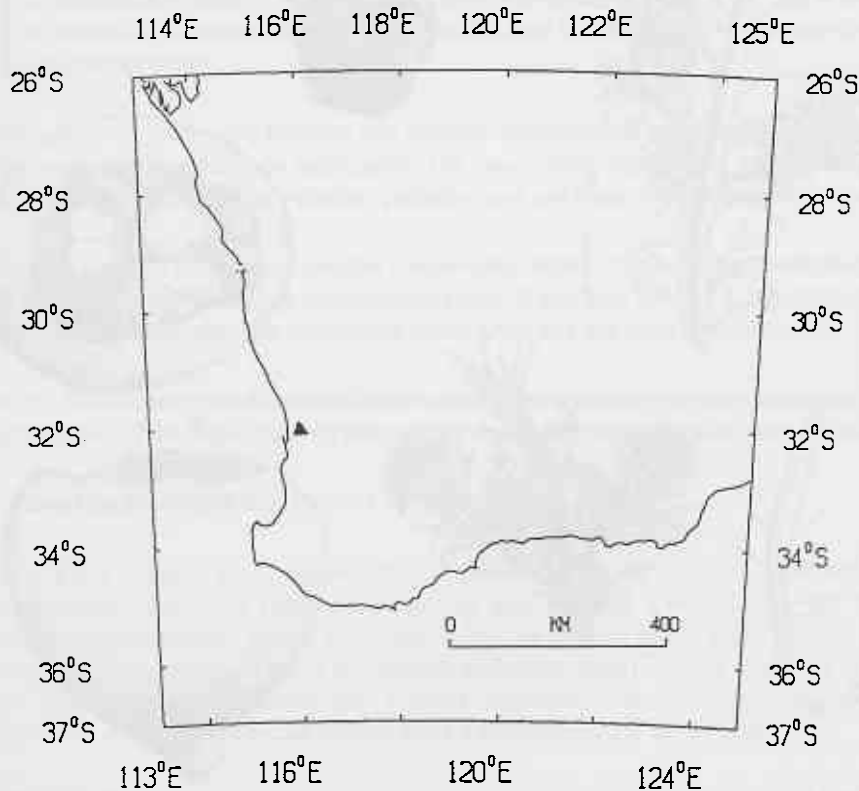


Figure 16. Distribution of *E. blackwelliana*.

Habitat. Broad uplands; associated vegetation open low Marri woodland; soil grey sand.

Flowering period. October to November.

Notes. *E. blackwelliana* is a member of section *Eremaea*. It is very localised on the western margin of the Avon District. It is distinguished by its glabrous hypanthium, valves only shallowly included, flowers on short shoots along long branches, and tall shrub habit.

Conservation status. I recommend that the conservation status of this species should be Priority Two - Poorly Known Taxa. Its range is less than 100 km across and is known from only two collections. Further field work is needed to assess its status.

Etymology. The name honours Marion Blackwell, keen observer of native plants in the bush and a landscape designer who for many years has promoted the aesthetic and practical use of Australian plants in landscaping.

7. *Eremaea beaufortioides* Benth. Fl. Austral. 3:182 (1867)

Typus: "W. Australia. Between Moore and Murchison Rivers, Drummond 6th coll. n.79" (holo: K).

Illustrations. Australian Plants 16 no. 125:40 (1990); C.A. Gardner, Wildflowers of Western Australia, 11 edn. (1973).

E. beaufortioides is part of section *Eremaea*.

Three varieties are recognised and can be separated as follows.

Key to varieties

- 1. Leaves thick, leaf veins 3 or fewer 8c. var. *microphylla*
- 1. Leaves thin, leaf veins 3-5 or more 2
- 2. Leaves broadly elliptic, leaf veins 5 or more, hypanthium glabrous ... 7a. var. *beaufortioides*
- 2. Leaves narrowly elliptic, leaf veins 3, hypanthium densely pilose
or villous 7c. var. *lachnosanthe*

7a. *Eremaea beaufortioides* Benth. var. *beaufortioides* (Figure 17)

Illustrations. Australian Plants 16 no. 125:40 (1990); C.A. Gardner, Wildflowers of Western Australia, 11 edn. (1973).

Shrub, 2.2 m tall; not lignotuberosus. *Branches* spreading. *Branchlet indumentum* two-layered; with dense, pilose outer layer; inner dense, tomentose. *Over-wintering bracts* 18-38 per terminal bud; ovate to obovate; c. 3.2 mm long, c. 2.6 mm wide; indumentum one-layered, ciliate on edges; striate. *Leaves* broadly ovate to elliptic, acute or obtuse; 4.5-5.6 mm long, 2.5-3.3 mm wide; 3-7 veins below; glabrous or pilose on margins; dry leaf cross-section flat, thin. *Petioles* 0.5-0.7 mm long. *Flowers*

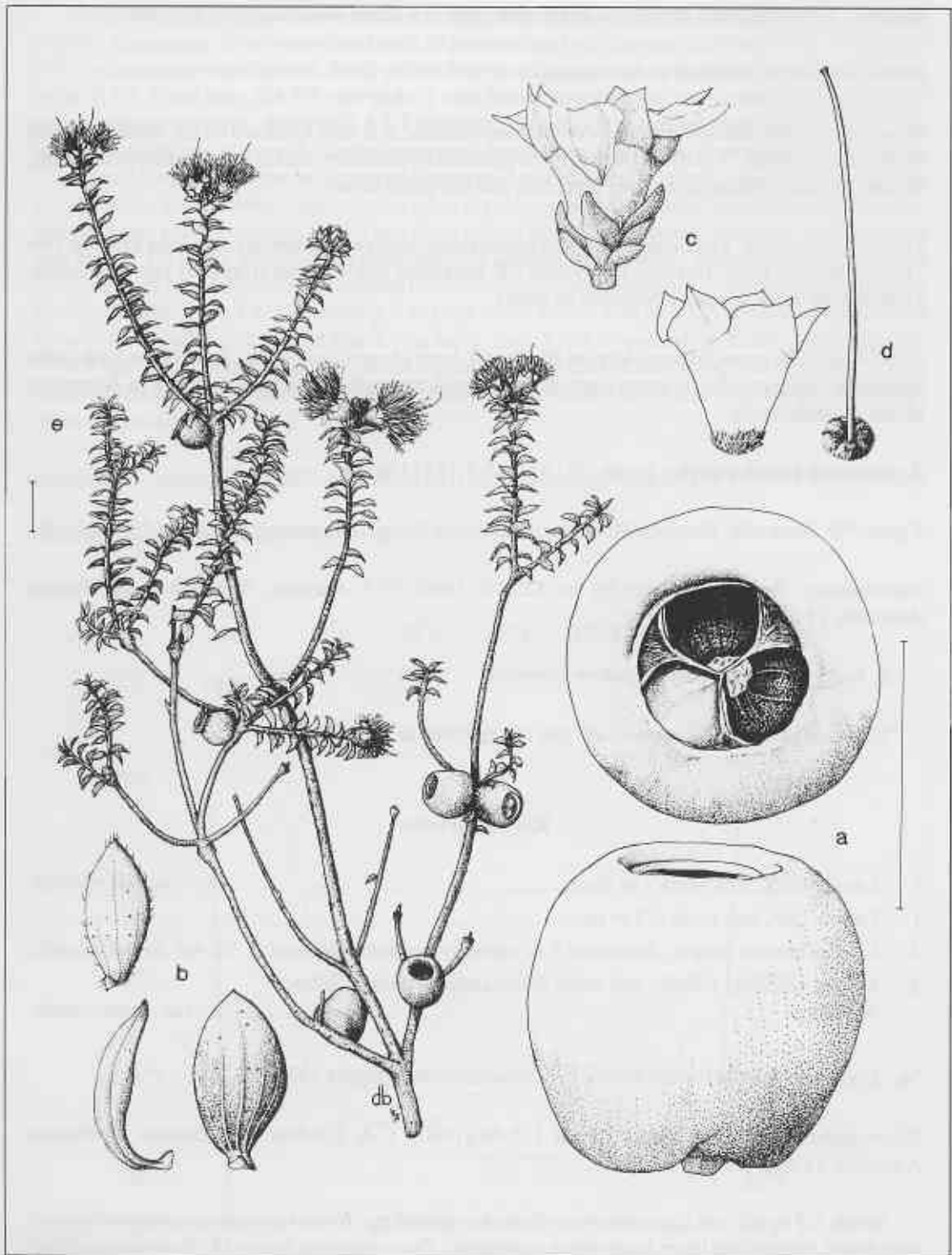


Figure 17. *E. beaufortioides* var. *beaufortioides*: a: fruits: slightly oblique and top views; b: leaves, side and ventral views; c: hypanthium, upper drawing with perules and petals, lower drawing with perules and petals removed; d: style; e: habit. 5 km west of Lake Indoon, E.A. Griffin 1278 (PERTH). All scale bars 10 mm (left one refers to habit (e); right one refers to details (a-d)).

terminal on long branches of last season's wood; 1-6 per confluence; fragrance sweet. *Hypanthium* long; campanulate; 4.5-7 mm long, 3.6-5.2 mm wide; glabrous or rarely indumentum one-layered sparse tomentose near base only; smooth, usually shiny, but wrinkled longitudinally when dry. *Calyx* lobes broadly triangular, or cuspidate (very variable); 2.3 mm long, 3 mm wide; glabrous to ciliate; caducous, or rarely persistent in some populations near Eneabba. *Petals* 3.7 mm long; glands abundant; thin-margin wide; weakly fringed. *Stamens* c. 34 per bundle; filaments fused in lower quarter, bundles frequently fused into a ring; smooth; 7.5 mm long; orange; not swollen, or swollen distally (not consistent within flowers); claws c. 1 mm long, c. 2.6 mm wide. *Ovary* with c. 15 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* c. 10.8 mm long; glabrous. *Fruit* doliform; 8-11 mm long, 3-6 mm wide; smooth; light brown to coppery brown; without lobes, or slightly undulate, rarely with prominent points; valves deeply included; with 2 small inconspicuous apical lobes. *Seeds* 2.1 mm long; smooth to slightly rough; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: c. 12 km south of Eneabba, *C. Chapman*, 27 Nov. 1977 (PERTH); 5 km west of Lake Indoon, *E.A. Griffin* 1278 (PERTH); 20 mi [32 km] S of Casuarinas, *R.J. Hnatiuk* 760290 (PERTH); 8 km S of Jurien rd on Munbinea rd, *R.J. Hnatiuk* 780187 (PERTH); west of Dandaragan, *K. Richards* (PERTH); cultivated at Kings Park, voucher for chromosome count, *B.L. Rye* 76019 (PERTH).

Distribution. Irwin District (Figure 18).

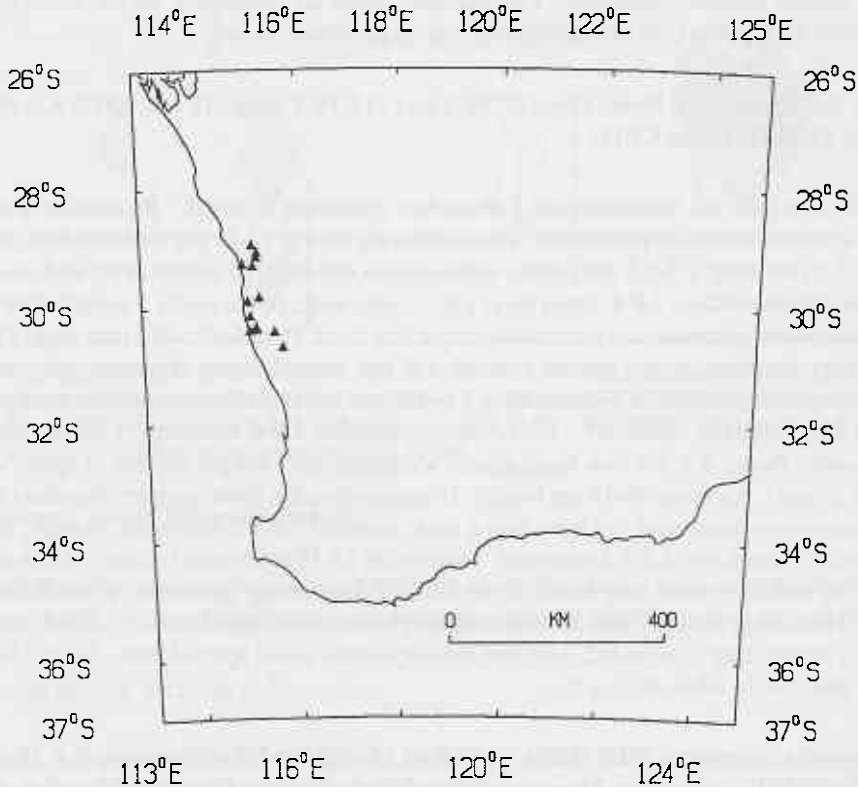


Figure 18. Distribution of *E. beaufortioides* var. *beaufortioides*.

Habitat. Lateritic uplands to coastal plains, and broad uplands (in NE part of range); associated vegetation open heath, closed heath, low open heath, or open low woodland; soil deep light brown sand, grey sand, grey sand over laterite, grey sand over orange sand and massive limestone, or limestone derived soil.

Flowering period. September to December.

Notes. *E. beaufortoides* is part of section *Eremaea*. It is distinguished by its strongly reflexed, multi-veined leaves, its virtually glabrous hypanthium that is frequently very glossy and usually only about half or less is covered by the over-wintering bracts. Its large, conspicuous, bright orange flowers make it very attractive to horticulture.

Etymology. The name alludes to a similarity with the genus *Beaufortia*. G. Bentham, the author of the name, did not specify the similarity he saw.

7b. *Eremaea beaufortoides* Benth. var. *microphylla* R.J. Hnatiuk var. nov. (Figure 19)

Frutex sine lignotubero. Rami patentes ad erecti. Folia elliptica, obtusa, glabra; vena in pagina abaxiali (0)-3 vel raro 5 sed interdum obscura. Flores in ramis longis anni proximi terminales, 1 vel 2 per inflorescentia. Hypanthium campanulatum, longum, glabra, laevia, plerumque nitentia sed in sicco longitudinaliter rugosa. Stamina per fasciculo 38-48, in parte quarta inferiore connata, et fasciculis in annulo connatis, aurantiis. Fructus doliiiformis ad turbinatus, laevis, labro elobato, pallide brunneus ad cupreus (vel rufo-brunneus), valvis profunde inclusis.

Typus: 18 km S of Eneabba on Brand Hwy, 29°56'S lat., 115°16'E long., 18 Oct. 1978, R.J. Hnatiuk 780234 (holo: PERTH; photo: CBG).

Shrub, 200 cm tall; not lignotuberos. *Branches* spreading to erect. *Branchlets* glabrous, occasionally sparsely villous or tomentose. *Over-wintering bracts* 17-23 per terminal bud; ovate to obovate; 3.5-5.5 mm long 2.7-3.2 mm wide; indumentum one-layered ciliate at tip and on edges; striate. *Leaves* elliptic obtuse; 2.9-4.3 mm long, 1.4-2.2 mm wide; 0-3 or rarely 5 veins below which may be difficult to see; glabrous; dry leaf cross-section flat, thick. *Petioles* 0.5-0.9 mm long. *Flowers* terminal on long branches of last season's wood; 1-2 per inflorescence; fragrance not recorded. *Hypanthium* long; campanulate; 4.5-6 mm long, 3.6-4.2 mm wide; glabrous; smooth, usually shiny, but wrinkled longitudinally when dry. *Calyx* lobes cuspidate; 5.3-6 mm long, 1.8-2.8 mm wide; sparse; caducous. *Petals* 4.8-5.7 mm long; glands abundant; thin-margin narrow at apex, wide at sides, weakly fringed. *Stamens* 38-48 per bundle; filaments fused in lower quarter, bundles of fused filaments, themselves fused near the base into a ring; smooth; 7.5-9.5 mm long; orange; swollen distally; claw 0.5-1 mm long; 2.2-3.2 mm wide. *Ovary* with 14-18 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 12.5-13.5 mm long; glabrous. *Fruit* doliform to turbinate; 8-11 mm long; smooth; light brown to coppery brown (to reddish brown); 2.8-6.1 mm wide; without lobes; valves deeply included, with two inconspicuous small apical lobes. *Seeds* 1.9-2 mm long; rough; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: 15 km SE of Eneabba, R.J. Cranfield, 20 Oct. 1979 (PERTH); Alexander Morrison National Park, Coorow-Greenhead Rd, E.A. Griffin 1560 (PERTH); 12 km N of Eneabba, R.J. Hnatiuk 760254 (PERTH); 18 km S of Eneabba on Brand Hwy, R.J. Hnatiuk 780231 (PERTH).

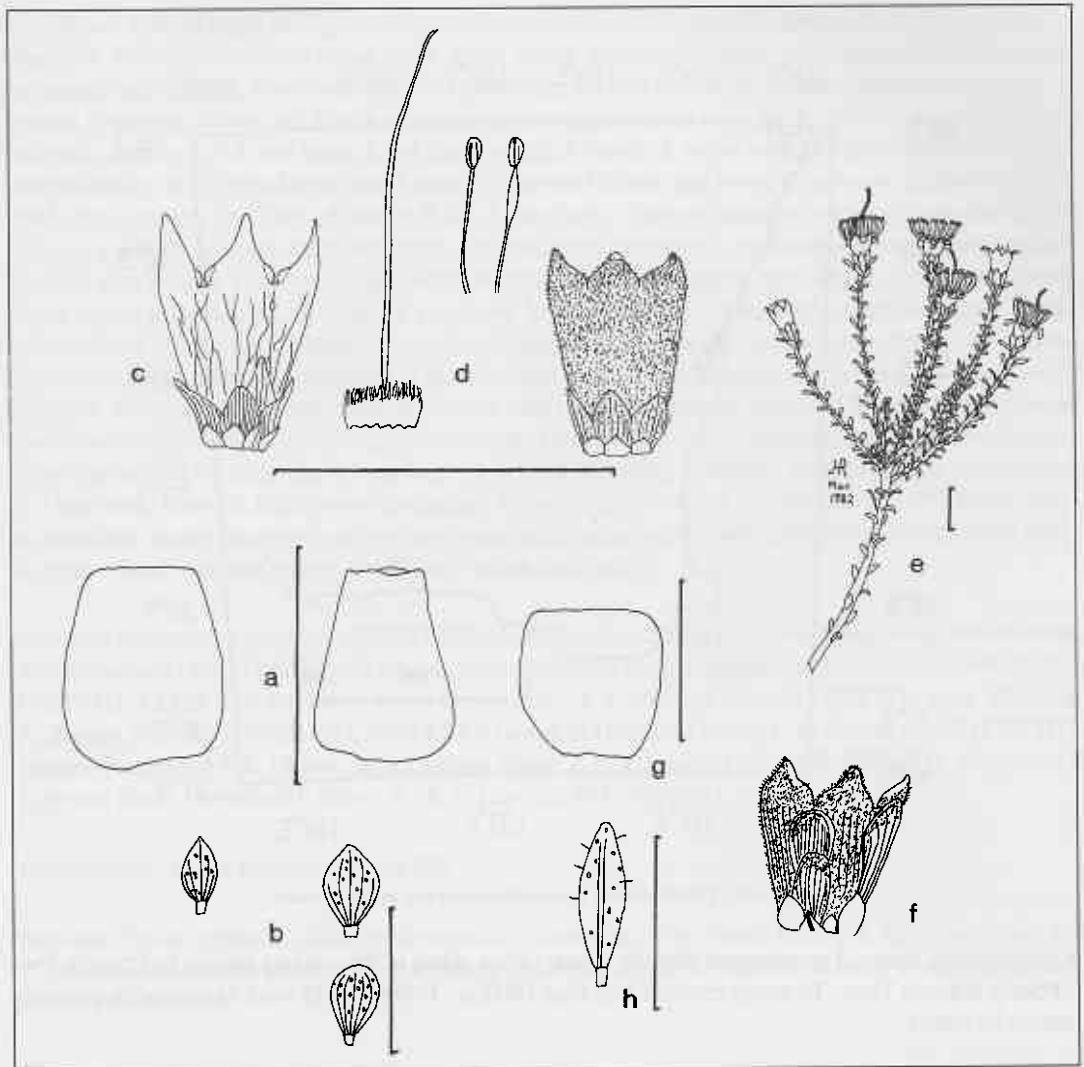


Figure 19. *E. beaufortioides* var. *microphylla*: a: fruits; b: leaves (scale bar 5 mm); c: hypanthium, calyx and perules; d: style and top of ovary, stamens; e: habit. 26 km SW of Three Springs, R.J. Hnatiuk 810017 (PERTH). *E. pauciflora* var. *lonchophylla*: f: hypanthium, calyx and perules; g: fruit; h: leaf (scale bar 5 mm). 23 km S of Eneabba [survey specimen # 73], R.J. Hnatiuk 780238 (PERTH). Scale bars, not otherwise indicated, 10 mm.

Distribution. Irwin District (Figure 20).

Habitat. Broad uplands, or from lateritic uplands to coastal plains; associated vegetation kwongan: low open heath, or low closed heath; soil deep grey sand, or lateritic gravel and sand.

Flowering period. October to November.

Notes. *E. beaufortioides* var. *microphylla* is sympatric with the southern part of the range of var. *beaufortioides*. From var. *beaufortioides* it is distinguished by its small, thick leaves that generally have only 3 veins, are less pointed and less reflexed. The leaves are frequently so thick that the veins are difficult to see.

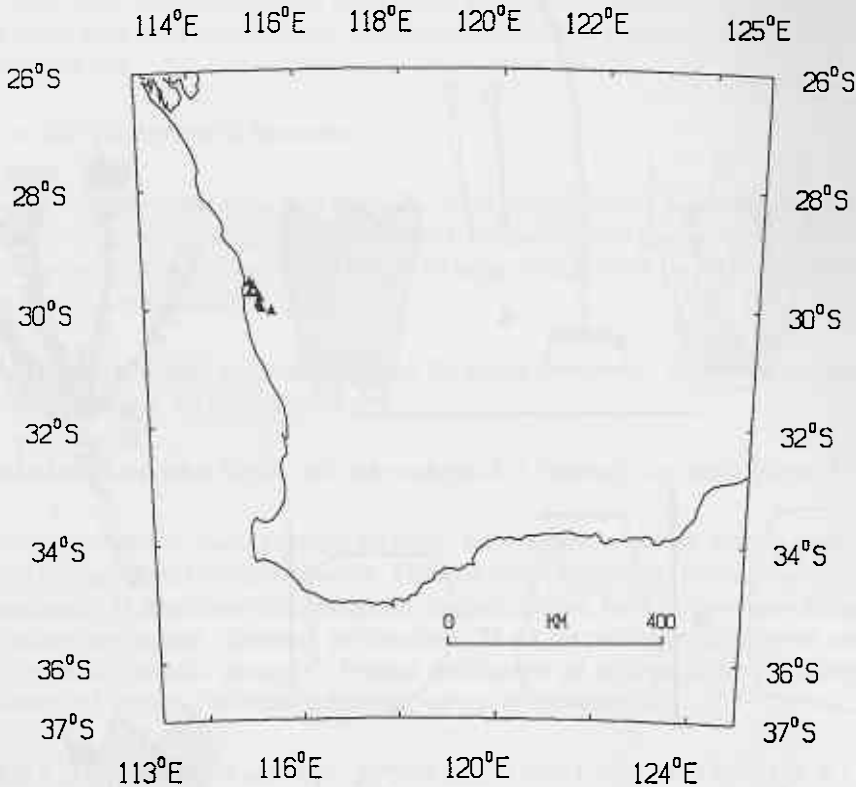


Figure 20. Distribution of *E. beaufortioides* var. *beaufortioides*.

Conservation status. I recommend that the conservation status of this variety should be Priority Two - Poorly Known Taxa. Its range extends less than 100 km. Further field work is needed to properly assess its status.

Etymology. The varietal name comes from the Greek words *mikros*, small and *phylla*, leaf in reference to the smaller leaves in comparison with the type variety.

7c. *Eremaea beaufortioides* var. *lachnosanthe* R.J. Hnatiuk

Frutex sine lignotubero. Folia elliptica, lata vel angusta, acuta vel obtusa, fimbriata; vena in pagina inferiore 3 vel 5. Flores in ramis longis anni proximi terminales, 1-5 per inflorescentia. Hypanthium campanulatum, longum, indumento bistrato, strato supero denso, velutino, infero denso, puberulo, dimidio supero raro glabro. Lobi calycis late triangulares, dense puberuli ad velutini vel glabri, caduci. Stamina in parte quarto inferiore connata, aurantia. Fructus urceolatus ad doliiformis, pallide brunneus ad cupreus vel cano-brunneus, elobatus vel labro undulato, valvis profunde inclusis.

Typus: On roadside, Brand Hwy just south of Lake Indoon Rd, R.J. Hnatiuk 800208 (holo: PERTH; iso: CBG).

Shrub, 150 cm high; not lignotuberous. *Branches* spreading to erect. *Branchlet indumentum* two-layered, with dense, pilose outer layer, inner dense pubescent. *Over-wintering bracts* 16-26 per terminal bud; elliptic to obovate; 2.4-5.3 mm long, 1.8-3.9 mm wide; indumentum one-layered, or rarely glabrous, ciliate and finely puberulous; on edges and all over back; striate. *Leaves* broadly elliptic, obtuse; 4-5.2 mm long, 2.4-4.2 mm wide; 5, rarely 3, veins below; indumentum fimbriate, occasionally two-layered with upper sparse pilose and ciliate and lower tomentose, glabrescent; dry leaf cross-section flat, thin. *Petioles* 0.4-1.2 mm long. *Flowers* terminal on long branches of last season's wood; 1-5 per confluence; fragrance not recorded. *Hypanthium* long campanulate; 5.4-7.2 mm long, 3.9-6.6 mm wide; indumentum two-layered, upper layer dense, velutinous; lower layer dense puberulous; all over, or rarely on lower half only; outer surface uneven, dull, finely mammillate. *Calyx* lobes broadly triangular; 2 mm long, 3 mm wide; indumentum dense, puberulous to velutinous, or glabrous; caducous. *Petals* 3.5 mm long; glands abundant; thin-margin wide, weakly fringed. *Stamens* c. 43 per bundle; filaments fused in lower quarter; smooth; 5.5 mm long; orange; swollen distally; claw 2.5 mm long, 2.5 mm wide. *Ovary* with 13-15 ovules per loculus; valves densely short-pubescent without sparse long hairs; style 11.9 mm long; glabrous. *Fruit* urceolate to doliform; 9.7 mm long; smooth; light brown to coppery brown, or grey brown; 3.5-5.2 mm wide; without lobes, or undulate (rarely strongly); valves deeply included, ornamented with 2 smooth inconspicuous lobes at apex. *Seeds* surface rough; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: 20 km E of Jurien Bay along Jurien Road, R.J. Cranfield 1206 (PERTH); 22 km S of Junction Brand Hwy & Jurien Bay Rd, R.J. Hnatiuk 761372 (PERTH); 15 km S of Eneabba, along Brand Hwy, R.J. Hnatiuk 761447 (PERTH); near Morawa, A. Kiese, Nov. 1936 (PERTH); 3 mi [4.8 km] south of Diamond Springs, K. Newbey 2350 (PERTH); Jurien-Greenhead Rd, 19 km east of Green Head, A.E. Orchard 4228 (AD, PERTH); McQueen's Caravan Park, Arrowsmith River, E. & S. Pignatti 584 (PERTH).

Distribution. Irwin District (Figure 21).

Habitat. Broad uplands, associated vegetation kwongan: low closed heath, or high shrubland (of *E. todtiana* with dense understorey); soil deep light brown sand, brown coarse sand, or white sand over nodular sandstone.

Flowering period. September to November.

Notes. *E. beaufortioides* var. *lachnosanthe* is distinguished from var. *beaufortioides* primarily by its indumented hypanthium, but also by its narrowly elliptic rather than broadly elliptic leaves with fewer veins on the undersurface. It is also closely related to *E. pauciflora* and specimens with intermediate morphology can be found. More detailed studies of its status are needed.

Conservation status. I recommend that the conservation status of this variety should be Priority Two - Poorly Known Taxa. Its range is less than 100 km. It is known only from several scattered populations, mostly on road verges. Further field assessment is needed.

Etymology. The name comes from the Greek words *lachnos*, woolly and *anthos*, flower and refers to the conspicuously indumented hypanthium.

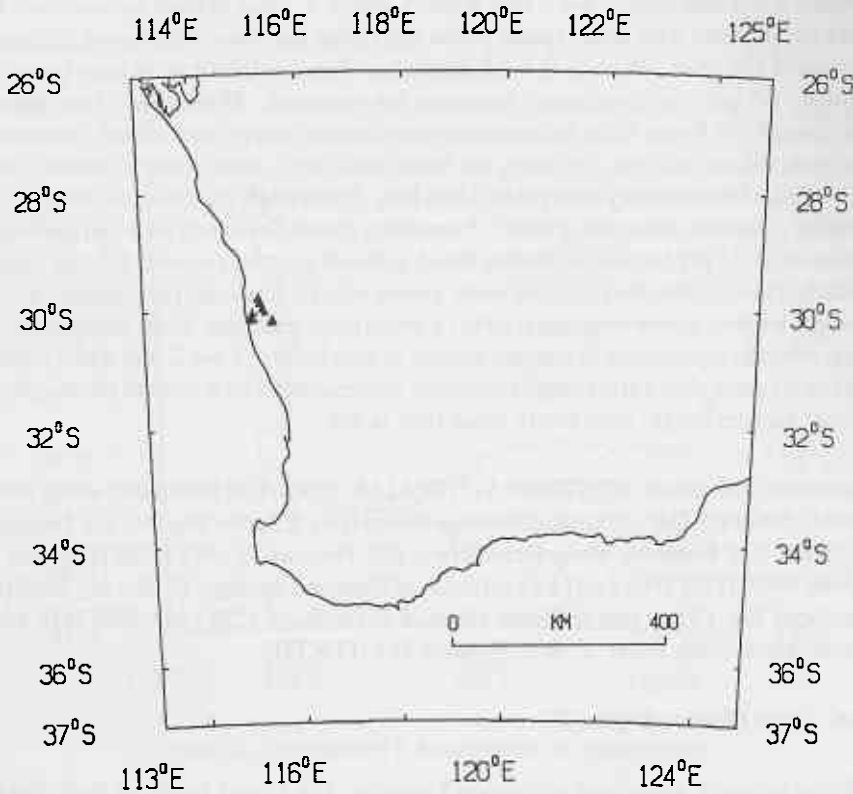


Figure 21. Distribution of *E. beaufortoides* var. *lachnosanthe*.

8. *Eremaea ebracteata* F. Muell. Fragm. 2:29 (1860)

Typus: "Ad fluvium Murchison. A. Oldfield" (holo: MEL; iso: K; photos: CBG, PERTH).

Shrub; leaves linear or elliptic; flowers produced on new wood thus surrounding perules absent and only 3 small caducous bracts evident; stamens orange; fruits frequently with corky outgrowths.

A species with two varieties.

Key to varieties

- 1. Leaves linear 8a. var. *ebracteata*
- 1. Leaves elliptic or obovate 8b. var. *brachyphylla*

8a. *Eremaea ebracteata* F. Muell. var. *ebracteata* Fragm. 2:29 (1860). (Figure 22a-f)

Shrub, 100 cm tall. *Branches* spreading to erect. *Branchlet indumentum* two-layered; with dense, pilose outer layer; inner dense tomentose. *Over-wintering bracts* 3 per terminal bud, very small and falling early; ovate; 1-2.7 mm long, 0.8-2.2 mm wide; indumentum one-layered, ciliate; smooth. *Leaves* linear to oblong, obtuse; 4.5-8.2 mm long, 0.5-1 mm wide; 1 vein below; indumentum one-layered becoming glabrous, outer layer pilose; dry leaf cross-section triangular. *Petioles* 0.2-0.9 mm long. *Flowers* terminal on long branches of current season's wood; 1-3 per inflorescence; fragrance sweet. *Hypanthium* long campanulate; 3.5-4 mm long 3.5-4.1 mm wide; indumentum one- or two-layered, upper layer dense velutinous, lower layer dense puberulous; all over; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* lobes semicircular, broadly triangular, slightly cuspidate and auriculate with adjacent lobes overlapping; 2 mm long 2.5-3.5 mm wide; indumentum dense pubescent (continuation of underlayer of hypanthium), ciliate, and puberulous; apical portion caducous. *Petals* 6.5-6.7 mm long; glands abundant; thin-margin narrow; weakly fringed. *Stamens* c. 60 per bundle; filaments fused in lower quarter to half; smooth; 10-11.6 mm long; orange; not swollen; claw 2-3.5 mm long, 2.8-3 mm wide. *Ovary* with 7-9 ovules per loculus; valves densely short-pubescent with sparse long hairs. *Style* 14-15.5 mm long; glabrous. *Fruit* campanulate to globose; rough, lumpy or mammillate especially in lower parts, or corky often with very conspicuous protrusions; light brown to coppery brown; 5.8-9.5 mm wide, 5.8-7.9 mm long; strongly undulate rim; valves reaching rim of fruit, or occasionally exerted and backed by lower part of calyx lobes, ornamentation of 2 small finely warty lobes at apex. *Seeds* 1.7-2.1 mm long; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: 2.5 mls [4 km] on road to Loop, Kalbarri National Park, *K.M. Allan* 204 (PERTH); Murchison House Station, *J.S. Beard* 6883 (PERTH); East Yuna Flora Reserve, NE of Geraldton, *A.C. Burns* 127 (PERTH); 26 mi [41.6 km] S of Red Bluff, Ogilvie West Rd, *D. Butcher* 1183 (MEL, PERTH); 410 mile peg, Carnarvon Rd, *H. Demarz* D5537 (PERTH); Western Australia, *J. Drummond* 78 (6th collection), 1854 (MEL, NSW); Northampton, *Jean Galbraith* 541 (MEL).

Distribution. Northern Irwin District (Figure 23).

Habitat. Open heath, low open heath, low woodland, or open low woodland; soil yellow sand, or light brown sandy loam.

Flowering period. November to December.

Notes. *E. ebracteata* var. *ebracteata* is a member of section *Ebracteata*. From the other species in the group, *E. dendroidea*, it can be distinguished by its linear leaves, exerted fruit valves, and its fruits tending to become very corky with age. It is not a rare species and is well represented within Kalbarri National Park.

Conservation status. This variety is rated as not threatened. It is fairly widespread and well represented in Kalbarri National Park. The status of outlying populations at the extremes of its range is not known.

Etymology. The name comes from the Latin prefix "e-" meaning without or lacking and *bracteate* having bracts, thus referring the contrast of this species with most others where the flowers are



Figure 22. *E. ebracteata* var. *ebracteata*: a: fruits; b: leaves; c: hypanthium and calyx; d: style and top of ovary; e: seed and chaff (ovulode); f: habit. Kalbarri Rd, 21 km W of NW Coastal Hwy, R.J. Hnatiuk 780362 (PERTH). *E. ebracteata* var. *brachyphylla*: g: leaf. Balla Wheat Bin, N of Yuna, R.J. Hnatiuk 780388 (survey specimen # 82) (PERTH). Scale bars 10 mm.

surrounded by numerous over-wintering bracts (perules). The flowers do have 3 small bracts, but these fall very soon, thus are not often noticed.

8b. *Eremaea ebracteata* F. Muell. var. *brachyphylla* R.J. Hnatiuk var. nov. (Figure 22g)

Frutex. Rami patentes. Folia elliptica, lata, obtusa, glabra vel pilosa indumento unistrato; vena in pagina inferiore 1, raro 3. Flores in ramis longis anni huius terminales, 1 vel raro 2 per inflorescentia. Hypanthium campanulatum, longum, indumento unistrato velutinum, vel raro etiam strato altero infero sparso. Stamina per fasciculo 43-50, in parte quarto inferiore connata, aurantia. Fructus campanulatus ad globosus, rugosus, irregulariter pustulatus, vel mammillatus praecipue ad basin, vel suberosus, pallide brunneus ad cupreus, labro undulato, valvis labro aequantibus vel exsertis lobis 2 terminalibus parvis subtiliter rugosis ornatis.

Typus: Near The Casuarinas, on roadside, *R.J. Hnatiuk* 810022; iso: 810021, 810019 (holo: PERTH; photo: CBG).

Shrub, 50 cm tall. *Branches* spreading. *Branchlet indumentum* one- or rarely two-layered, with dense pilose outer layer of often curved or contorted hairs; inner sparse, tomentose. *Over-wintering bracts* 2-4 per terminal bud, very small and falling early; oblong to ovate; 1.4-2.3 mm long, 0.8-1.4 mm wide; indumentum one-layered; ciliate; smooth. *Leaves* broadly elliptic or obovate, cymbiform when dry, obtuse; 2.5-3.1 mm long, 1.3-1.7 mm wide; 1 or rarely 3 veins below; glabrous, or indumentum one-layered, pilose; dry leaf cross-section flat, thick. *Petioles* 0.2-0.4 mm long. *Flowers* terminal on long branches of current season's wood; 1 or rarely 2 per inflorescence; fragrance not recorded. *Hypanthium* long, campanulate; 3.4-4 mm long, 3.1-3.9 mm wide; indumentum one-layered, rarely with sparse underlayer, upper layer dense, velutinous, lower layer tomentose; all over; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* lobes broadly triangular, and slightly cuspidate; 1.1-2.1 mm long, 2-2.8 mm wide; indumentum glabrous or sparse to dense, pubescent, ciliate; apical portion caducous. *Petals* 5.4 mm long; glands abundant; thin-margin narrow at apex to wide at sides, weakly fringed. *Stamens* c. 40-45 per bundle; filaments fused in lower quarter; smooth; 7 mm long; orange; not swollen; claw 2.3 mm long 2.2 mm wide. *Ovary* with 7-9 ovules per loculus; valves densely short-pubescent with sparse long hairs; style 10.5 mm long; glabrous. *Fruit* campanulate to globose, shape variable depending on degree of development of corky tissue; 7.3-8.4 mm long, 5.7-7.5 mm wide; rough, lumpy or mammillate especially in lower parts, or corky; light brown to coppery brown; rim undulate; valves reaching rim of fruit, or exerted and backed by lower part of lobes, ornamentation 2 small finely warty lobes at apex. *Seeds* 1.9-2.1 mm long; smooth; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: On Eneabba-Mingenew Rd just round corner S of Arrino West Rd, Three Springs Shire, *J. Coleby-Williams* 267 (PERTH); Valentine Rd, 19.2 km S of junction with Nabawa Rd (SE of Yuna), *R.J. Hnatiuk* 780389 (PERTH); 2.2 km S of Casuarina, *R.J. Hnatiuk* 780390 (PERTH); 32.9 km S of Casuarina *R.J. Hnatiuk* 780391 (PERTH).

Distribution. Irwin District (Figure 23).

Habitat. Low woodland with dense shrub understorey; soil deep light brown sandy loam.

Flowering period. November to December.

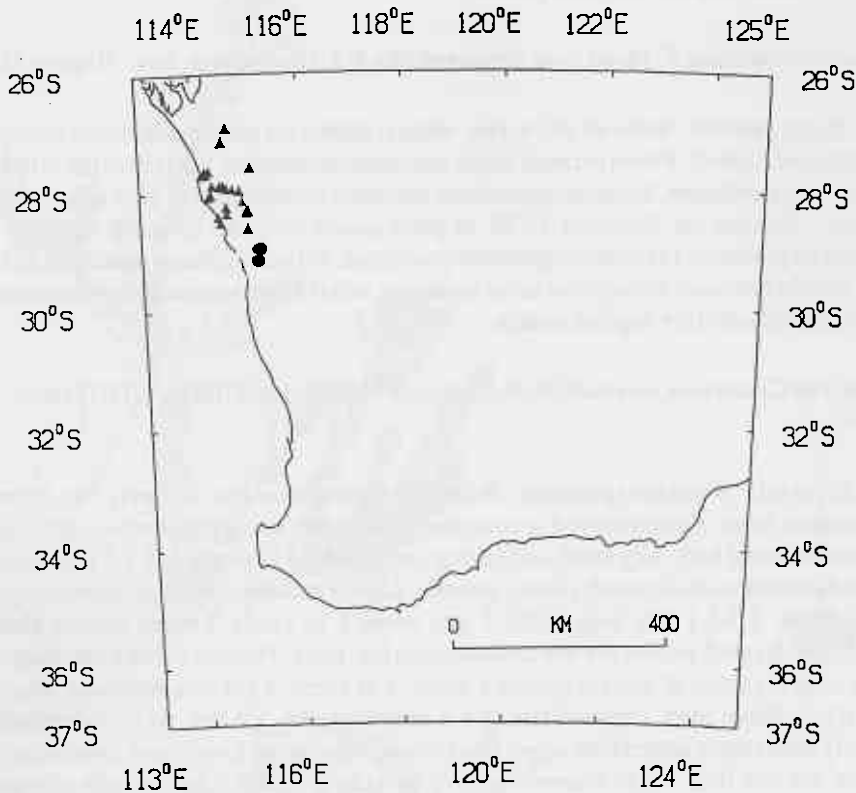


Figure 23. Distribution of *E. ebracteata* var. *ebracteata* (▲) and *E. ebracteata* var. *brachyphylla* (●)

Notes. *E. ebracteata* var. *brachyphylla* is closely related to *E. ebracteata* var. *ebracteata* from which it differs in the small elliptic leaves. Most populations of var. *brachyphylla* have branchlets with only one layer of indumentum, but some with a sparse underlayer occur. It is known from only a few populations, all of which are to the south east of the known range of var. *ebracteata*.

Conservation status. I recommend that the conservation status of this variety should be Priority One - Poorly Known Taxa. It has a range of less than 100 km across. It has only been collected on roadsides in areas extensively cleared for agriculture. Its status needs urgent confirmation from field study.

Etymology. The variety name is derived from the Greek words *brachys*, short and *phylla*, leaf in reference to the shortness of the leaves in contrast to those of subsp. *ebracteata*.

9. *Eremaea dendroidea* R.J. Hnatiuk sp. nov. (Figure 24)

Arbor parva sine lignotubero. Rami ascendentes ad erecti, deinde patentes. Folia oblonga, ovata vel elliptica, angusta, obtusa, glabra; vena in pagina abaxiali 0 vel 1. Flores in ramis anni proximi vel huius terminales, 1 vel 2 per inflorescentia. Hypanthium campanulatum, vadosum, dense ad sparse tomentosum indumento unistrato ad labrum sparso. Lobi calycis semiorbiculati, ciliati, indumento

sparsa, caduci. Stamina per fasciculo 46-49, in parte quarto inferiore connata, laevia, aurantia. Fructus cupulatus, labro elobato, laevis, cano-brunneus, sine lobis, valvis labrum aequantibus.

Typus: "Cooloomia Nature Reserve c. 13 km W of Cooloomia homestead" S.D. Hopper 1348, 18 Sept. 1979. (holo: PERTH; photo: CBG).

Small tree, 350 cm tall; not lignotuberous. Branches ascending to erect, then spreading. *Branchlet indumentum* two-layered with dense, pilose outer layer; inner dense tomentose. *Over-wintering bracts* 4-25 per terminal bud; ovate; 1.1-2.5 mm long, 0.7-1.8 mm wide; indumentum one-layered, ciliate; smooth. *Leaves* narrowly oblong, narrowly ovate to narrowly elliptic; obtuse; 2.8-5.2 mm long, 0.7-2.2 mm wide; 0-1 vein below; glabrous; dry leaf cross-section flat, thick. *Petioles* 0.3-0.7 mm long. *Flowers* terminal on long branches of last season's or current season's wood; 1-2 per confluence; fragrance not recorded. *Hypanthium* shallow, campanulate; 3-3.2 mm long; indumentum one-layered, dense to sparse, tomentose all over, becoming sparse near rim; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* lobes semicircular to very broadly triangular; 0.4-1.5 mm long, 1.8-3.5 mm wide; indumentum sparse, ciliate; caducous. *Petals* 3-4.4 mm long; 4-4.5 mm wide; glands abundant; thin-margin narrow at apex to wide at sides, very weakly fringed. *Stamens* 46-49 per bundle; filaments fused in lower quarter to half; smooth; 4.5-7 mm long; orange; not swollen; claw 2-2.2 mm long, 1.8-2.2 mm wide. *Ovary* with 10-14 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 9 mm long, glabrous. *Fruit* cupulate, 5-8.6 mm long; smooth; grey brown; 4.2-4.9 mm wide; without lobes; valves reaching rim of fruit; tips of valves with 2 lobes. Seed 1.3-1.7 mm long; rough; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: 413 mile peg [661 km], North-West Coastal Hwy, A.M. Ashby 4855 (AD); No. 8 Tank, Carnarvon Rd, C.A. Gardner 12292 (PERTH); 5.2 km east of Ajana on NW Coastal Hwy, R.J. Hnatiuk 780382 (PERTH); Cooloomia Nature Reserve, c. 17 km WSW of Cooloomia Hmstd, S.D. Hopper 1379 (PERTH); c. 20 km SW Hamelin Pool Homestead, c. 5 km W of crossing to Tamala, J.Z. Weber 5045 (AD).

Distribution. Northern Irwin District (Figure 25).

Habitat. Lateritic uplands to coastal plains; associated vegetation low woodland; soil deep yellow sand.

Flowering period. September.

Notes. *E. dendroidea* is the most northern *Eremaea* and is a member of section *Ebracteata*. It is distinguished by its small tree habit, its leaves which are thick, the tendency to flower on both old and new wood, and the location of the fruit valves at the rim of the fruit when dried. The shape of the fruit is also characteristic. The closest relatives appear from isozyme analyses to be *E. ebracteata* (Coates and Hnatiuk 1990). The isozyme study suggested that it might have its origins in ancient hybridisation between *E. pauciflora* and *E. ebracteata*.

Conservation status. I recommend that the conservation status of this species should be Priority Three - Poorly Known Taxa. Its geographic range is greater than 100 km across, but its degree of protection is not known.

Etymology. The name is derived from the Greek word *dendroid*, tree-like in reference to the growth form which contrasts with most other species.

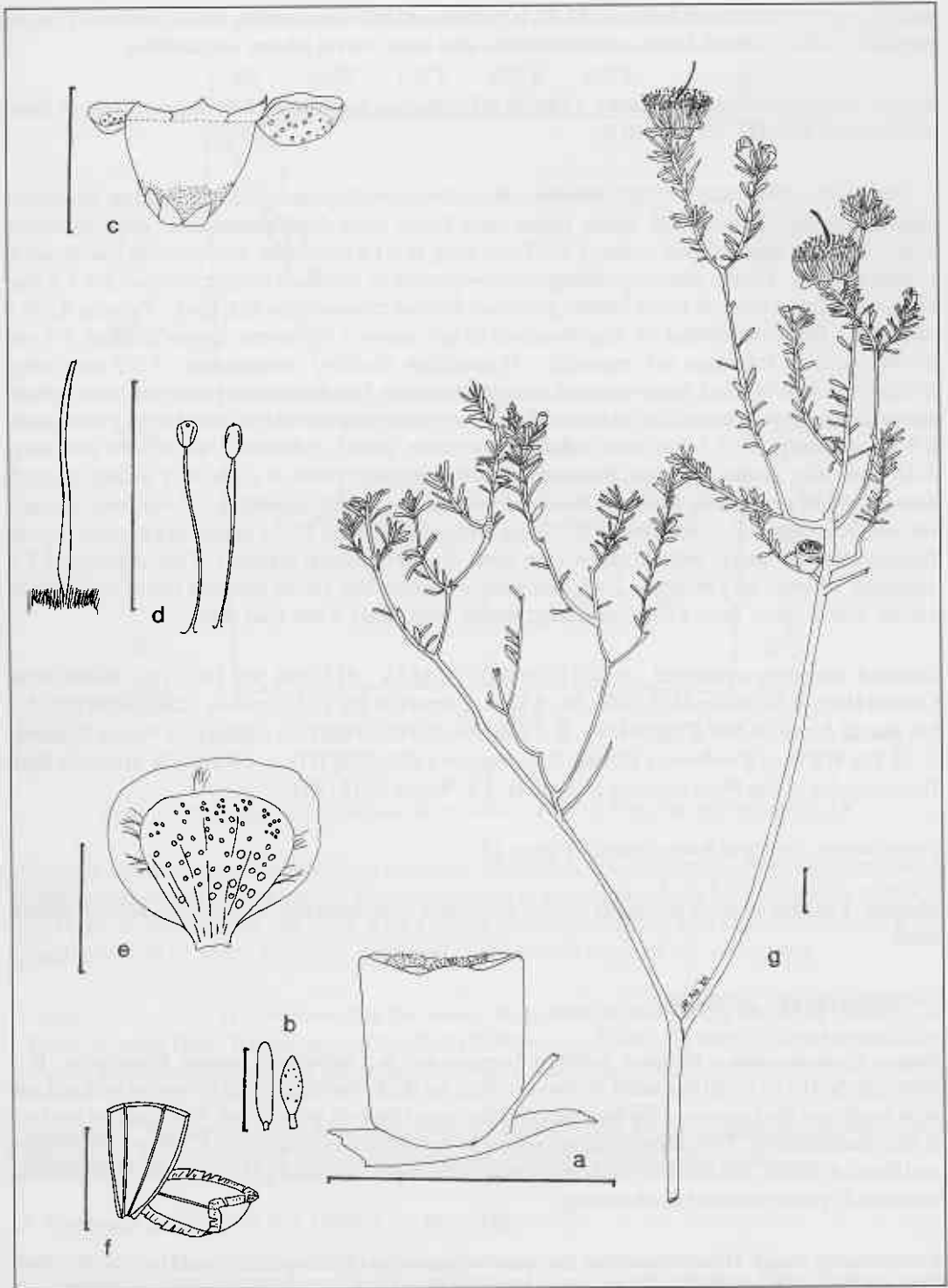
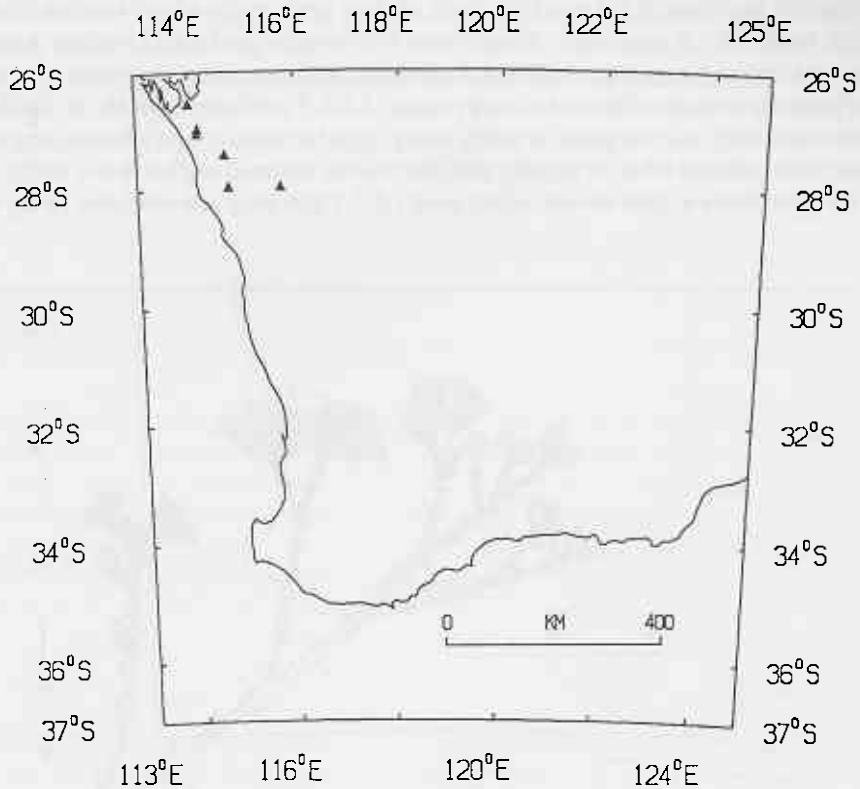


Figure 24. *E. dendroidea*: a: fruit; b: leaves (scale bar 5 mm); c: hypanthium, calyx and perules; d: style, top of ovary and stamens; e: petal (scale bar 2.5 mm); f: seed and chaff (ovulodes); g: habit. 5.2 km E of Ajana, R.J. Hnatiuk 780382 (PERTH). Scale bar, not otherwise marked, 10 mm.

Figure 25. Distribution of *E. dendroidea*.

10. *Eremaea purpurea* C. Gardner, Journ. Roy. Soc. W. Austral. 47: 61 (1964). (Figure 26)

Typus. "Hab. in distr. Darling prope Culalla, in arenosis humidis, fl. m Decem." C.A. Gardner s.n. (holo: PERTH).

Shrub, 110 cm tall; not lignotuberous. *Branches* ascending to erect. *Branchlet indumentum* two-layered, dense, pilose outer layer (hairs bent and contorted); inner dense, tomentose. *Over-wintering bracts* 7-20 per terminal bud (bracts below flowers = 3, broadly ovate, ciliate and with varying but small amount of hair on mid-back); ovate; 2.2-2.4 mm long, 2-2.2 mm wide; indumentum one-layered, ciliate, or pubescent, on edges and occasionally on upper (distal) back; smooth, or occasionally striate. *Leaves* narrowly elliptic to ovate, acute, or obtuse; 2-4.5 mm long, 0.8-1.3 mm wide; 0-1 vein below; indumentum one-layered, hairs primarily on edges and upper surface, outer layer pilose; dry leaf cross-section flat, thick; petioles 0.2-0.4 mm long. *Flowers* terminal on long branches of both last season's wood and current season's wood; (1)-2-(3) per confluence; fragrance faint, fresh. *Hypanthium* campanulate; 2.6-3.2 mm long, 2.7-3.3 mm wide; indumentum two-layered, dense, velutinous upper layer; lower layer dense, tomentose; all over (densest at base); outer surface uneven, dull, finely mammillate. *Calyx* lobes broadly triangular, and slightly cuspidate, edges brown and membranous; 2-2.2 mm long, 2.5-2.8 mm wide; indumentum sparse to dense, pubescent, ciliate, and glabrous near tip; caducous. *Petals* 4.2-4.5 mm long; glands abundant; thin-margin narrow at apex and wide on sides, weakly fringed. *Stamens* 14-33 per bundle; filaments fused

in lower quarter; papillose; 6.2-7 mm long; pink, or dark pink, rarely white; swollen distally; claw 0.8-1.3 mm long, 1.7-1.8 mm wide. *Ovary* with 9-11 ovules per loculus; valves densely short-pubescent with sparse long hairs. *Style* 8-8.2 mm long; glabrous. *Fruit* cupulate or campanulate, becoming irregular with development of corky tissue; 5.4-6.5 mm long; smooth, or rough, lumpy or mammillate especially in lower parts, or rarely corky; light brown to coppery brown, or grey-brown; 4.2-6.2 mm wide; without lobes, or slightly undulate; valves exerted and backed or not by lower part of lobes, with two lobes at apex of each valve; seed 1.5-1.7 mm long; smooth; shed freely when fruit is dry.

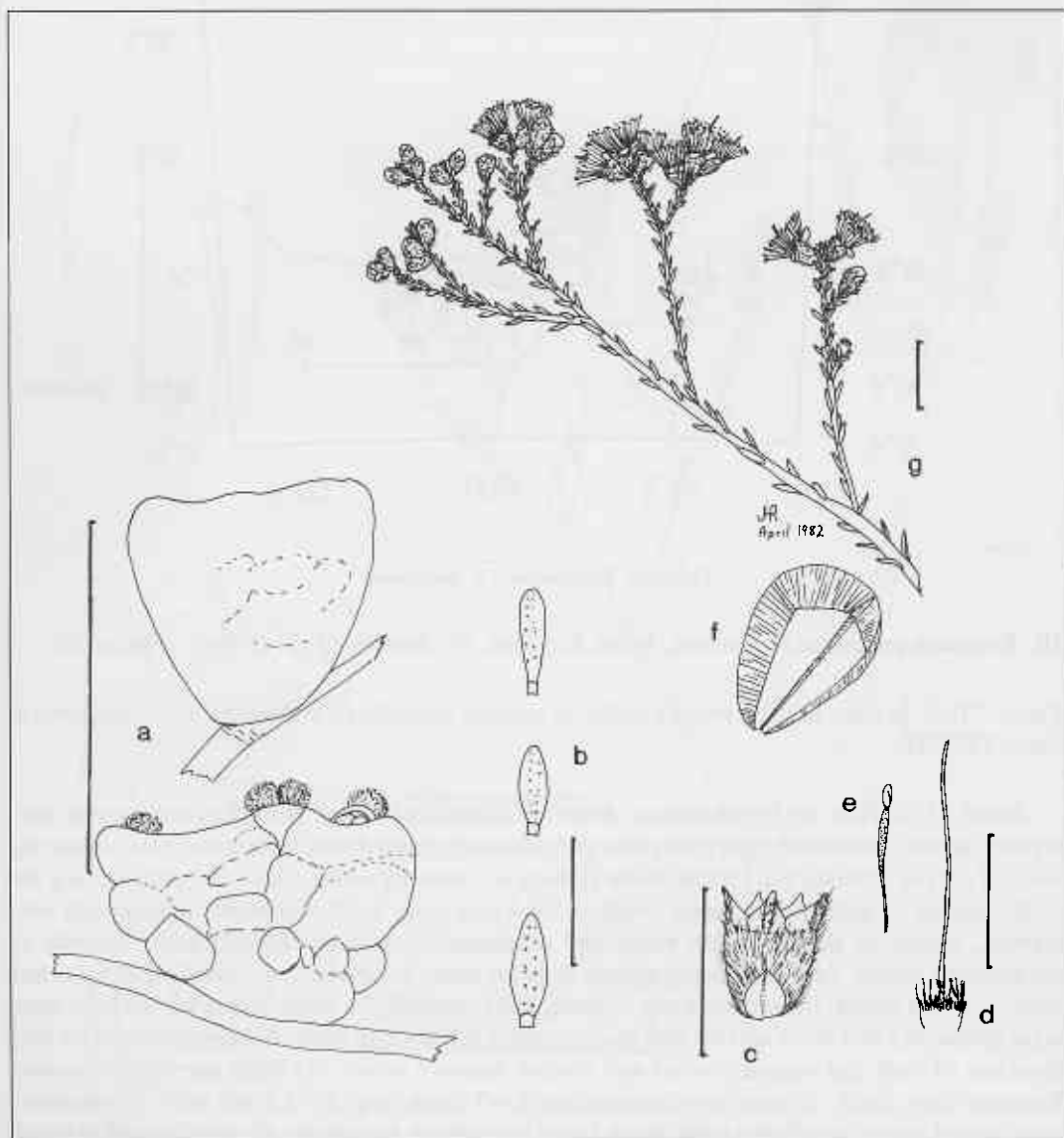


Figure 26. *E. purpurea*: a: fruits; b: leaves (scale bar 5 mm); c: hypanthium, calyx and perules; d: style and top of ovary (scale bar 5 mm); e: stamen; f: seed; g: habit. NE of Lake Pinjar, R.J. Hnatiuk 790196 (PERTH). Scale bar, not otherwise indicated, 10 mm.

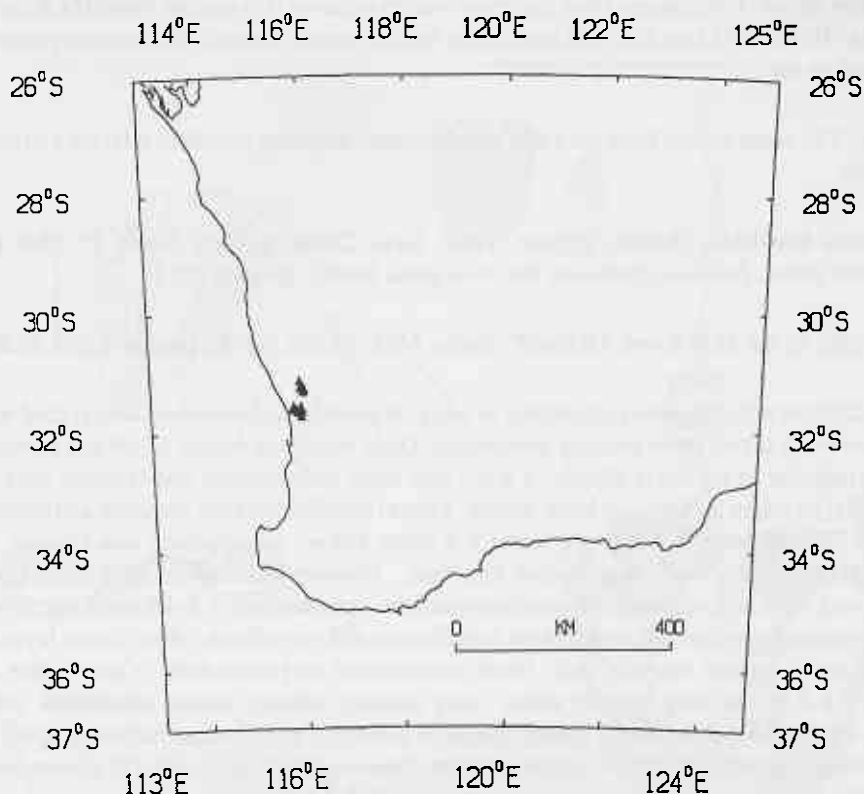


Figure 27. Distribution of *E. purpurea*.

Selected specimens examined. WESTERN AUSTRALIA: 5.9 km W of Upper Swan, *D. Halford* 14/12/2 (PERTH); 0.62 km S of Cullalla Stn, *D. Halford* 15/12/5 (PERTH); NE of Wanneroo, 0.9 km N of Neaves Rd on Seismic Rd, *R.J. Hnatiuk* 790194 (PERTH); Pinjar on road to Bullsbrook, *M.E. Phillips*, 27 Oct. 1962 (CBG, NSW); Muchea, *H. Steedman*, 2 Feb. 1935 (PERTH); Bullsbrook, *L. Steenbohm*, 13 Dec. 1959 (PERTH); 12 km W of Beverley, *G. Tindale-Davies*, June 1991 (CBG).

Distribution. Darling District. A recent specimen from near Beverley extends its range considerably to the east and into the Avon District (Figure 27).

Habitat. Lateritic uplands to coastal plains; associated vegetation low woodland, or open low woodland; soil bright yellowish brown sand, deep grey sand, or white sand over brownish grey sand.

Flowering period. December to January.

Notes. *E. purpurea* is part of section *Ebracteata*, but is only distantly related to other members as measured in the isozyme study (Coates & Hnatiuk 1990). Morphologically it is also isolated, but the presence of unusual features such as long hairs on top of the ovary, flowering on new wood, and corky eruptions on the fruits are shared with *E. ebracteata*.

Conservation status. I recommend that the conservation status of this species should be Priority Four - Rare Taxa. Its range is less than 100 km across, but the extent to which it occurs on reserved land is not known to me.

Etymology. The name comes from the Latin word *purpura* meaning purple in reference to the colour of the flower.

11. *Eremaea brevifolia* (Benth.) Domin, Vestn. Kral. Ceske Spolecn. Nauk, Tr. Mat.-Prir. 2:2 (1921). Base name: *Eremaea fimbriata* var. *brevifolia* Benth. (Figure 28)

Typus: "Valley of the Hutt River, Oldfield", (holo: MEL 84206; iso: K; photos: CBG, PERTH).

Shrub, 220 cm tall. *Branches* ascending to erect. *Branchlet indumentum* two-layered with very dense pilose outer layer; inner densely tomentose. *Over-wintering bracts* 13-19 per terminal bud, narrowly triangular to narrowly elliptic; 4.8-6.5 mm long; indumentum one-layered, very densely villous, white, on edges and all over back; striate. *Leaves* broadly obovate, crowded and overlapping, obtuse, 4.5-7.2 mm long, 3.3-5.8 mm wide; 5-9 veins below; indumentum one-layered, villous, becoming glabrous; dry leaf cross-section flat, thin. *Flowers* terminal on long branches of last season's wood; 1 per inflorescence. *Hypanthium* shallow, campanulate; 3.5-4.8 mm long, 3.9-5.6 mm wide; indumentum two-layered, upper layer very densely silky to villous, white; lower layer densely tomentose; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* lobes broadly triangular; 1.8-4.5 mm long, 4 mm wide; very densely villous, white, sometimes yellowish; persistent. *Petals* 3.8-6.8 mm long; glands sparse to abundant; thin-margin narrow at apex, to wide at sides, weakly minutely fringed or jagged or entire. *Stamens* 50-70 per bundle; filaments fused only shortly at base to filaments fused in lower quarter; smooth; 8.2-8.5 mm long; orange; swollen slightly on long filaments; claw 0.5-4.3 mm long, 3.7-3.8 mm wide. *Ovary* with 13-14 ovules per loculus; densely short-pubescent without sparse long hairs. *Style* 11-12 mm long, indumented very sparsely on lower half. *Fruit* cupulate, 7 mm long, smooth to rough, lumpy or mammillate especially in lower parts, densely villous glabrescent; light brown to coppery brown; 8.5-11.5 mm wide; undulate, or with prominent pointed lobes; valves exserted and backed or not by lower part of lobes. *Seeds* 1.8 mm long; smooth; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: South of Ogilvie, *J.S. Beard* 2104 (PERTH); 5 miles [8 km] W of Nanson, 24 miles [38.4 km] NNE of Geraldton by road, *R. Coveny* 3063 (PERTH); Geraldton, *R. Filson* 101 (MEL); 12 miles [19.2 km] N of Northampton, *C.A. Gardner* 1960 (PERTH); Howatharra Hill Reserve, 21 road mls [33.6 km] N of Geraldton, *D. & N. McFarland* 1138 (PERTH); 7 miles [11.2 km] south of Northampton, *F.W. Went* 32 (PERTH).

Distribution: Irwin District (Figure 29).

Habitat. Lateritic uplands to coastal plains; associated vegetation low closed heath; soil red laterite to sand.

Flowering period. August to October.

Notes. *E. brevifolia* is the most northern member of subgenus *Okriocarpa*. It is distinguished by its large fruits with a conspicuously undulate rim, its broadly expanded, multi-veined leaves which are crowded and overlapping, and the long, villous or almost silky, white, conspicuous hairs around the upper leaves, perules and flowers.

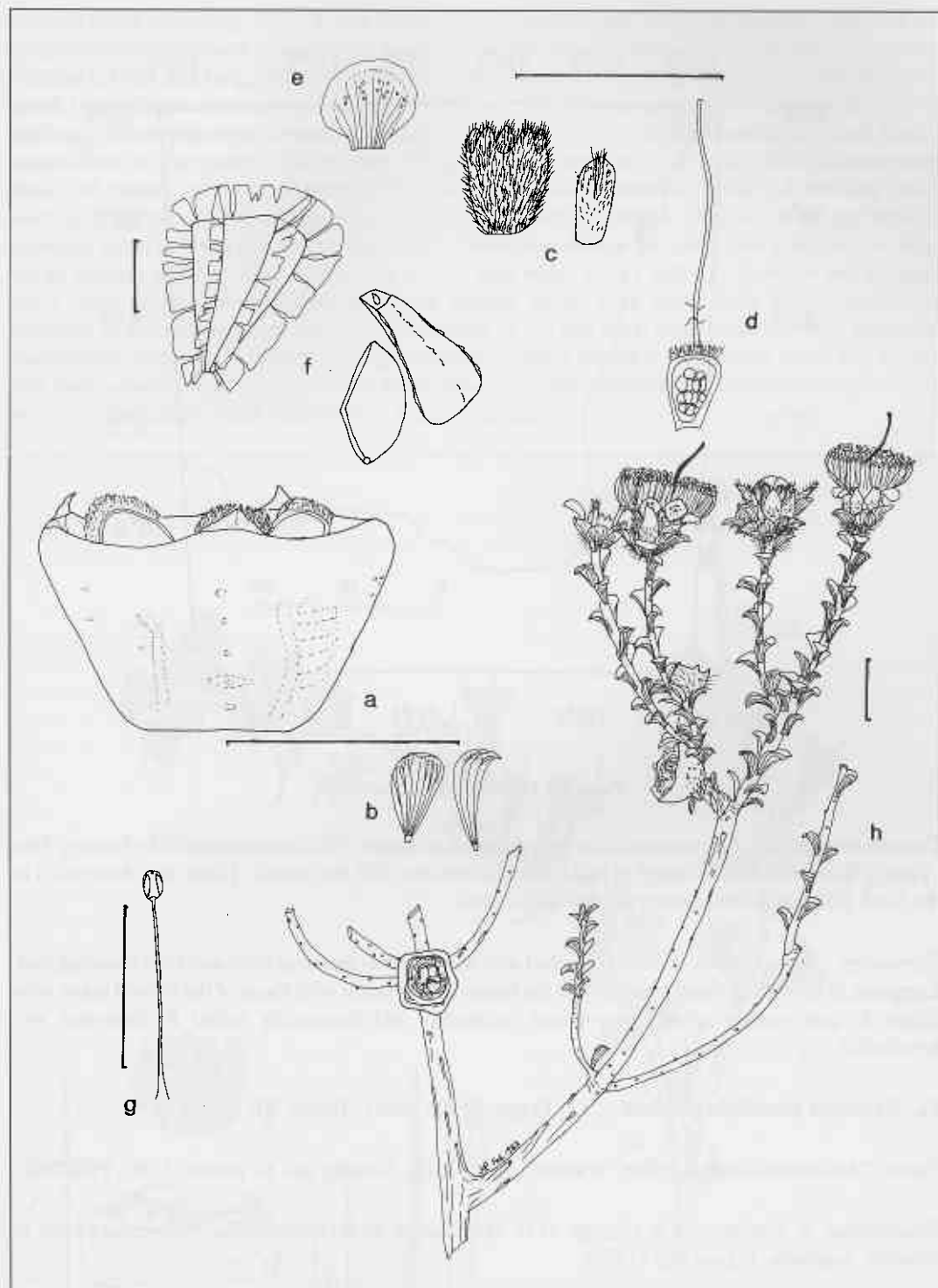


Figure 28. *E. brevifolia*: a: fruit; b: leaves; c: hypanthium, calyx and perule; d: style and ovary (longitudinal section); e: petal; f: seed and chaff (scale bar 1 mm); g: stamen (scale bar 5 mm); h: habit. Ogilvie, *J.S. Beard* 2104 (survey specimen # 36) (PERTH). Scale bars, unless otherwise indicated, 10 mm.

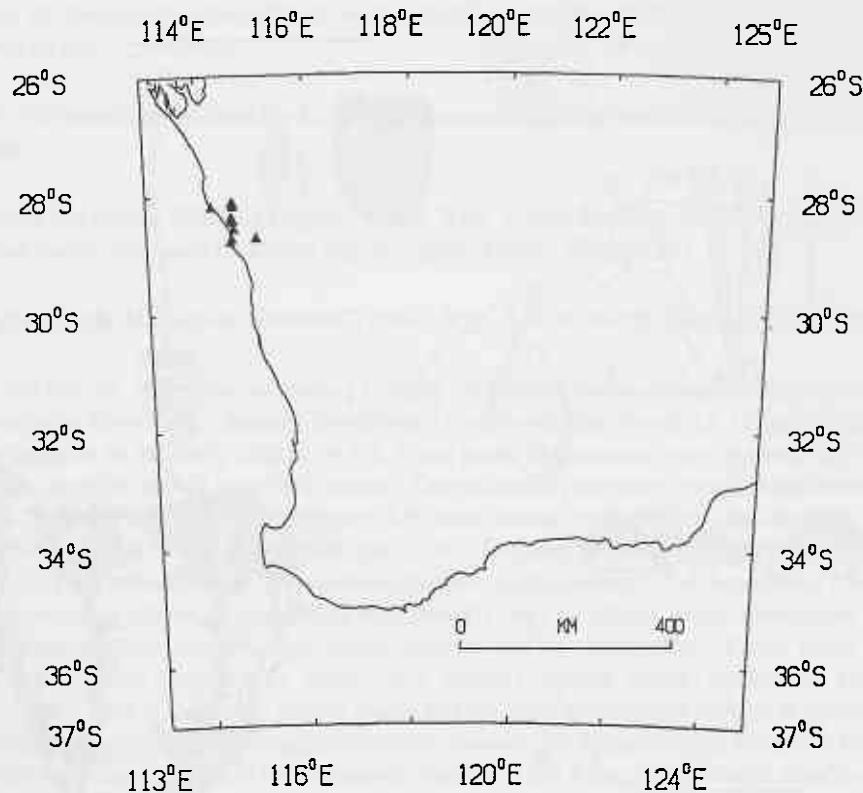


Figure 29. Distribution of *E. brevifolia*.

Conservation status. I recommend that the conservation status of this species should be Priority Two - Poorly Known Taxa. Its range of occurrence is less than 100 km across. I have not observed it in the field. Further, current observations are needed.

Etymology. "*Brevifolia*" is derived from the Latin words *brevi-* meaning short and *folia* meaning leaf. It appears to have been chosen to contrast the leaves of this taxon with those of the related taxon now called *E. asterocarpa* subsp. *asterocarpa* (originally and incorrectly called *E. fimbriata* var. *brevifolia*).

12. *Eremaea acutifolia* F. Muell., [X1] Fragm. 2:30 (1860). (Figure 30)

Typus: "Ad sinum Champion Bay. Walcott" (holo: MEL 526440; iso: K; photos: CBG, PERTH).

Illustrations. R. Erickson, A.S. George, N.G. Marchant & M.K. Morecombe, Flowering Plants of Western Australia: Figure 303 (1979).

Shrub, 70 cm tall; not lignotuberos. **Branches** spreading to erect. **Branchlet indumentum** two-layered, glabrescent, with sparse pilose outer layer; inner dense tomentose (when young). **Overwintering bracts** 13-15 per bud, obovate; 3-3.5 mm long, 1.1-1.7 mm wide; indumentum two-layered, pilose to tomentose on edges and all over back; smooth, or striate. **Leaves** narrowly elliptic to linear

acute, 3.6-9.5 mm long, 0.5-1.2 mm wide; 1 vein conspicuous on lower surface; glabrous or indumentum one-layered, pilose (with hairs 1.1-1.3mm long). Dry leaf cross-section triangular. *Petioles* 0.3-0.8 mm long. *Flowers* terminal on short laterals along long branches; on last season's wood; 1 per inflorescence (rarely 2); fragrance not recorded. *Hypanthium* shallow campanulate, 2.5-5 mm long; indumentum one-layered, very dense, velutinous all over; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* lobes triangular, 3-3.5 mm long, 2-2.5 mm wide; indumentum dense, velutinous, persistent (lasting till fruit matures but not permanent). *Petals* 3-4 mm long (held erect or spreading); glands sparse; thin-margin narrow; weakly fringed. *Stamens* 28-34 per bundle, filaments fused in lower quarter; smooth; 5.5-7.5 mm long; orange, or rarely dark pink; may or may not be swollen distally; 1.2-2.5 mm long, 1.7-2.1 mm wide. *Ovary* with 11-13 ovules per loculus. *Valve* outer surface densely short-pubescent without sparse long hairs. *Style* 8.5-10 mm long, glabrous, or indumented near apex. *Fruit* turbinate, 3.5-6 mm long, outer surface rough, lumpy or mammillate especially in lower parts; light brown to coppery brown; 8-9 mm wide; when dry, valves with many small callosities, exerted and not enclosed by lower part of lobes. *Seeds* 2 mm long, smooth or rough; shed freely when fruit is dry. "Rusty *Eremaea*".



Figure 30. *E. acutifolia*: a: fruit; b: leaf (scale bar 5 mm); c: style and top of ovary; d: stamen; e: hypanthium, calyx and perules; f: habit. 257 mile peg, Geraldton Hwy, A.S. George 9223 (PERTH). Scale bars, unless otherwise indicated, 10 mm.

Selected specimens examined. WESTERN AUSTRALIA: 15 mi [24 km] south of Geraldton-Mullewa Rd on Casuarina Rd, *A.M. Ashby* 2284 (AD, PERTH); 39 km NW of Strawberry on Burma Rd, *M.G. Corrick* 8287 (MEL); near 257 mile peg, Geraldton Highway, *A.S. George* 9223 (PERTH); 17 miles [27.2 km] from Geraldton, *M.E. Phillips* 019323 (CBG, NSW); Flumina Moore et Murchison, *E. Pritzel* 606 (NSW); Kojerina, east of Geraldton, *E. Wittwer* 16 (PERTH). (Approximately 30 specimens examined in Australia.)

Distribution. Found in the Irwin Botanical District east of Geraldton (Figure 31).

Habitat. Broad uplands, dominated by kwongan (open heath) on grey or yellow deep sand.

Flowering period. August to November.

Notes. *E. acutifolia* is a member of section *Okriocarpa*. It is distinguished by its needle-like leaves, and tendency to flower on short lateral shoots as in *E. violacea* but from which it is distinguished by its orange stamens, rough surface to the fruit and valves that have numerous small callosities compared to only two callosities or lobes in *E. violacea*.

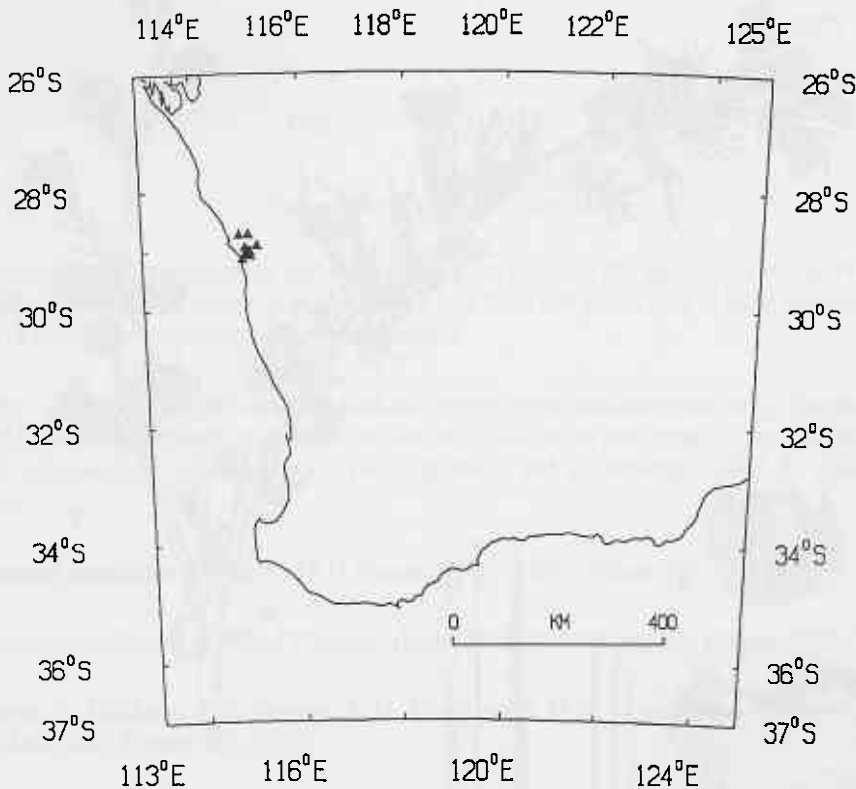


Figure 31. Distribution of *E. acutifolia*.

Conservation status. I recommend that the conservation status of this species should be Priority Two - Poorly Known Taxa. Its range is less than 100 km across and is represented in the Burma Road Reserve. Field survey is required to confirm current status.

Etymology. "*Acutifolia*" comes from Latin words *acuti*- meaning pointed and *folia* meaning leaves in reference to the shape of the leaves.

13. *Eremaea ectadioclada* R.J. Hnatiuk sp. nov. (Figure 32)

Frutex, interdum cum lignotubero. Rami patentes ad arcuati. Folia ovata, angusta, acuta, glabra vel indumento unistrato; vena 1 vel raro 3 in pagina abaxiali visibilia. Flores in ramis anni proximi terminales, 1 vel 2 per inflorescentia, suaveolentes. Hypanthium vadosum ad longo-campanulatum; indumentum bistratum, strato supero densissimo velutino, infero dense pubescente. Stamina per fasciculo 24-60, in parte quarta inferiore connata, aurantia. Fructus turbinatus, scaber, irregulariter pustulatus, vel mammillatus praecipue in dimidio infero, lobis prominentibus acutis, valvis exsertis callis parvis aliquot ornatis.

Typus: c. 4 km S of Eneabba on Western Titanium Rd, 29°52'S lat., 115°16'E long., 18 Oct. 1978, R.J. Hnatiuk 780205 (holo: PERTH; photo: CBG) [plus 1 dupl.].

Shrub, 70 cm tall; sometimes lignotuberous. *Branches* spreading to arching. *Branchlet indumentum* two-layered with sparse, pilose outer layer, inner dense, tomentose. *Over-wintering bracts* 6-20 per terminal bud, obovate to rarely ovate; 3.5-7.4 mm long, 1.1-2.8 mm wide; indumentum one-layered, pilose or tomentose on edges and on upper (distal) back; smooth or finely striate. *Leaves* narrowly ovate, acute; 4-10 mm long, 0.4-2 mm wide; 1 or rarely 3 veins below; glabrous, or indumentum one-layered, outer layer pilose with hairs 0.5-1.3mm long; dry leaf cross-section triangular; petioles 0.2-1.7 mm long. *Flowers* terminal on long branches of last season's wood; 1 or sometimes 2 per inflorescence; fragrance sweet. *Hypanthium* shallow to long campanulate; 2.7-3.8 mm long, 3-4 mm wide; indumentum two-layered, very dense, velutinous; lower layer dense pubescent all over; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* lobes triangular to broadly triangular; 3-6 mm long, 2.2-5 mm wide, villous; caducous or persistent. *Petals* 4-6.7 mm long; glands abundant; thin-margin narrow, weakly fringed. *Stamens* 24-60 per bundle; filaments fused in lower quarter; papillose; 5-9 mm long; orange; swollen distally; claw 1.7-4 mm long, 1.7-3 mm wide. *Ovary* with 9-18 ovules per loculus (usually 12-13); valves densely short-pubescent without sparse long hairs. *Style* 10-12.6 mm long; indumented on lower quarter, rarely to near apex. *Fruit* turbinate; 6-8 mm long; rough, lumpy or mammillate especially in lower parts; grey brown; 7.4-12.5 mm wide; with prominent pointed lobes or undulate rim (variable); valves with several callosities, exserted and backed by lower part of lobes. *Seeds* 1.6-2.2 mm long; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: 25 km by road W of Winchester, C. Chapman, 23 March 1979 (PERTH); Track SW of Mt Lesueur, R.J. Cranfield 1252 (PERTH); Alexander Morisson Natl Park, Coorow-Greenhead Rd, E.A. Griffin 1561 (PERTH); Western Titanium Leases, 8 km S of Eneabba, E.A. Griffin 1183 (PERTH); E of Lake Indoon, R.J. Hnatiuk 771034 (PERTH); 7 km E of Junction of Coorow-Greenhead Rd and Cockleshell Gully Rd, R.J. Hnatiuk 780261 (PERTH); 6 km N of Badgingarra, R.J. Hnatiuk 790050 (PERTH); Tathra National Park, R.J. Hnatiuk 800051 (PERTH); Eneabba Flora Reserve, A. Kessell 6138 (PERTH).

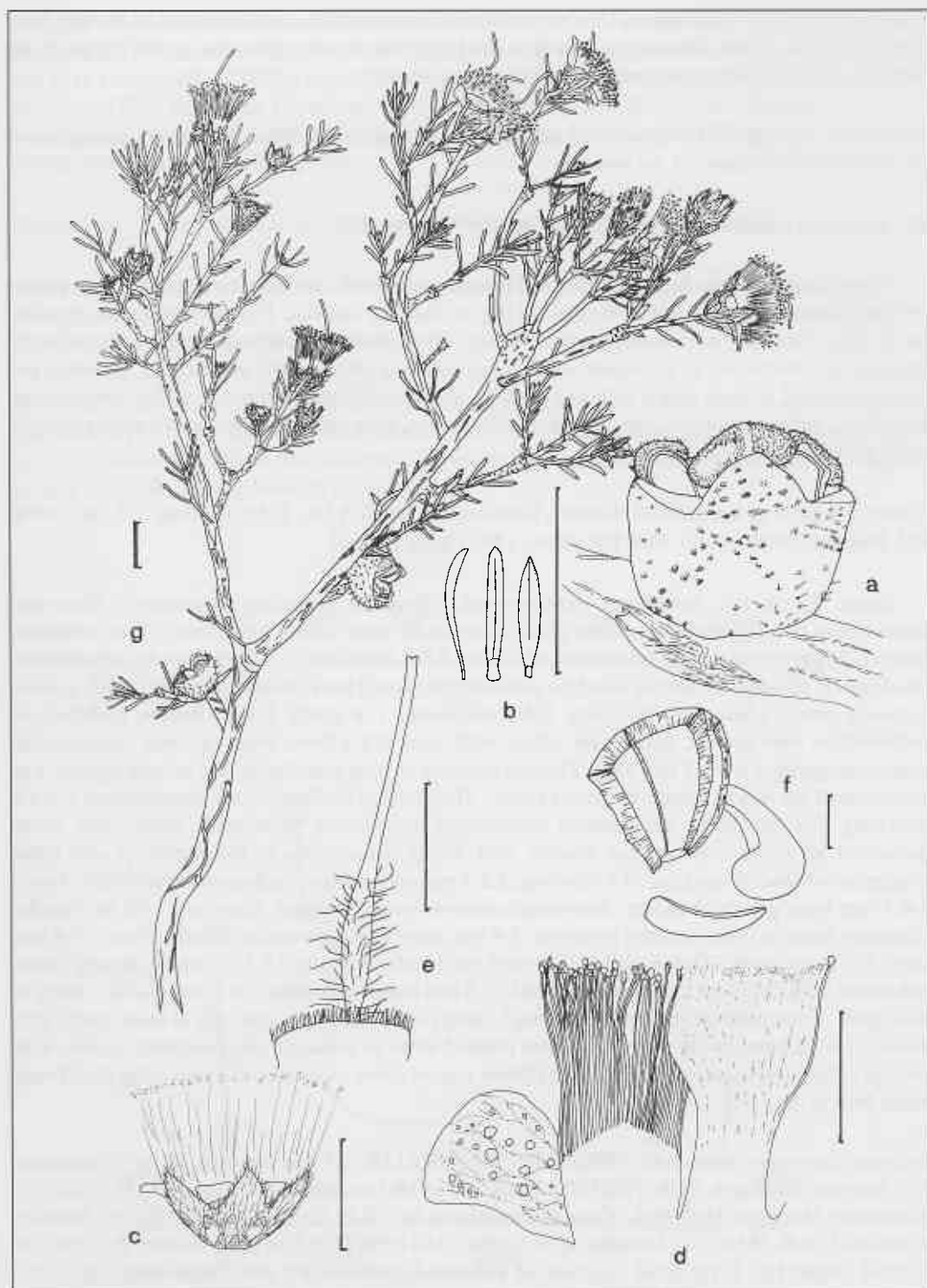


Figure 32. *E. ectadioclada*: a: fruit; b: leaves; c: hypanthium, calyx, and perules; d: staminal bundle (scale bar 5 mm); e: style and top of ovary (scale bar 1 mm); f: seed and chaff (scale bar 1 mm); g: habit. 4 km S of Eneabba, R.J. Hnatiuk 780205 (PERTH). Scale bars, unless otherwise indicated, 10 mm.

Distribution. Irwin District on the coastal plain from just north of Eneabba to Jurien (Figure 33).

Habitat. From lateritic uplands to coastal plains; associated vegetation species rich kwongan: open heath, low open heath, or low closed heath; soil deep grey sand, or grey sand over laterite.

Flowering period. October to November.

Notes. *E. ectadioclada* is a member of section *Okriocarpa*. It is most closely related to *E. asterocarpa* from which it differs in the narrowness and straightness of its leaves which usually have only 1 vein (rarely 3) visible on the underside of the leaves; the relative sparseness of leaves on branches; and the low, spreading and arching branching habit.

Conservation status. I recommend that the conservation status of this species should be ?Priority Three - Poorly Known Taxa. Its range is less than 100 km across, probably occurs in reserves in the area which could mean that it was not threatened. Further field work is required to confirm status.

Etymology. The name is derived from the Greek words *ektadios* meaning outstretched and *klados* meaning branch and refers to the wide spreading habit of the branches in contrast to those of its close relative, *E. asterocarpa*.

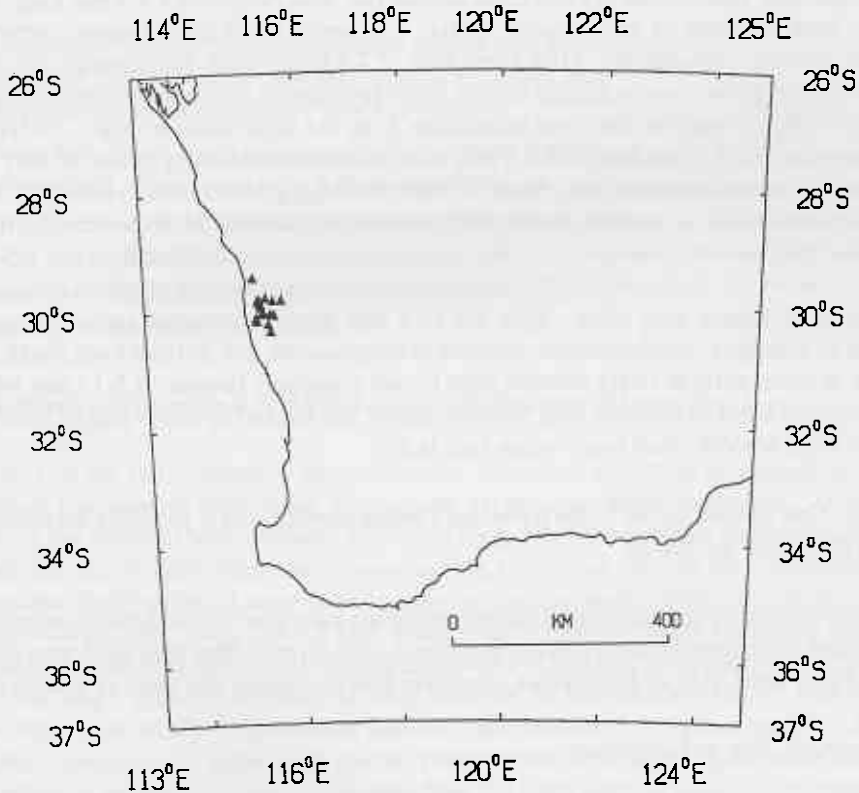


Figure 33. Distribution of *E. ectadioclada*.

14. *Eremaea asterocarpa* R.J. Hnatiuk sp. nov.

Frutex cum vel sine lignotubero. Folia obovata ad elliptica, angusta ad lata, ad apicem recurva, in parte quarta distali cymbiformia, acuta vel obtusa, glabrescentia; vena in pagina abaxiali 3, 5 vel 7. Flores in ramis longis anni proximi terminales, 1 vel 2 per inflorescentia, ut in *Mus* odorati. Hypanthium campanulatum, vadosum; indumentum bistratum, strato supero sparsim strigoso ad densissime villosa, infero dense pubescenti ad puberulo. Lobi calycis late triangulares, dense villosi ad densissime pilosi, in fructu persistentes. Fructus doliiformis, cupulatus vel campanulatus, scaber, irregulariter pustulatus, inferne mammillatus vel raro laevis, pallide brunneus vel cupreus, lobis prominentibus acutis vel labro undulato, valvis exsertis.

Typus: 5 km S of Coorow-Greenhead Rd on Cockleshell Gully Rd, 30°07'S lat., 115°07'E long., 19 Oct. 1978, R.J. Hnatiuk 780256 (holo: PERTH; photo: CBG).

Shrub, 130 cm tall; with or without lignotubers. *Branches* spreading, ascending or erect, or short and contorted. *Branchlet indumentum* two-layered with dense, pilose outer layer; inner dense, pubescent or tomentose. *Over-wintering bracts* 6-14 per bud; obovate to spatulate; 2.5-5.9 mm long, 2.1-3.5 mm wide; indumentum one-layered; usually glabrous on back and fimbriate, but also tomentose all over back or villous on upper (distal) back and fimbriate; finely striate. *Leaves* narrowly to broadly obovate to elliptic, recurved at apex and cymbiform in distal quarter, acute or obtuse; 3.4-8.3 mm long, 1.0-4.5 mm wide; 3, 5 or 7 veins visible on undersurface; indumentum one-layered pilose and fimbriate, glabrescent; dry leaf cross-section flat, thin. *Petioles* 0.4-1.4 mm long. *Flowers* terminal on long branches of last season's wood; 1 or rarely 2 per inflorescence; scent musty. *Hypanthium* shallow, campanulate, 2.0-3.8 mm long, 2.7-4.6 mm wide; indumentum two-layered, upper layer sparsely pilose to very densely villous; lower layer dense, pubescent to puberulous all over outer surface which is uneven, dull, and tuberculate from the large bases of hairs. *Calyx* (lobes) broadly triangular; 2.2-4.0 mm long, 2.0-4.3 mm wide; indumentum densely villous to very densely pilose, persistent in part in mature fruit. *Petals* 4.0-6.0 mm long; glands sparse to abundant; the thin-margin of the lamina wide or narrow, weakly fringed or entire. *Stamens* 16-36 per bundle, filaments fused in lower half; smooth; filaments 7.5-10.0 mm long; orange; swollen distally; claw 1.5-4.5 mm long, 1.3-3.3 mm wide. *Ovary* with 9-23 ovules per loculus; upper surface of valves densely short-pubescent without sparse long hairs. *Style* 8.2-10.5 mm long; indumented on lower quarter or occasionally to near apex. *Fruit* doliform, cupulate or campanulate; 6.9-8.0 mm long; rough, lumpy, mammillate in lower parts or rarely smooth; light brown to coppery brown; 10.5-17 mm wide with prominent pointed lobes or undulate rim; valves exserted but backed by lower part of lobes. *Seeds* 2.0- 2.3 mm long; smooth; shed freely when fruit is dry.

Distribution. This species occurs in the Irwin and Darling districts and is probably the second most widespread species of the genus.

Habitat. From lateritic uplands to coastal plains; vegetation kwongan: closed heath, low open heath, low closed heath, high shrubland or open low woodland; soils diverse: deep grey sand, grey sand over red brown clayey sand, grey or light brown sand over laterite, laterite and sand, or yellow sand.

Flowering period. July to November.

Notes. For some time this species was wrongly called *E. fimbriata*. This dates from Bentham's "Flora Australiensis". From specimens he appears to have seen, it is clear that he saw both the true *E. fimbriata* and the present taxon. However, in the published account, under the name *E. fimbriata*

Lindley, was inserted the description of a taxon, which is here given the name *E. asterocarpa*. Because of the confusion, the name *E. rosea* Gardner & George was published for the true *E. fimbriata*, but was later found by A. George (pers. comm.) to be a synonym of *E. fimbriata*.

E. asterocarpa is a member of subgenus *Okriocarpa*. From *E. brevifolia* it is distinguished by having narrower leaves with generally fewer veins, by a much less dense indumentum around the leaves and perules of the over-wintering stem apices, by the generally smaller fruits with prominent woody calyx lobes (only an undulating rim to the fruit of most *E. brevifolia*) and a roughened surface. The arrangement of leaves in *E. asterocarpa* is not as dense and the leaves are more spreading than in *E. brevifolia*.

Within *E. asterocarpa*, there is considerable variation in growth form and branching pattern. This variation is described here as a number of subspecies. These taxa appear to be geographically separate from one another.

Etymology. The name is derived from the Greek words *astero-* meaning star and *karpa* meaning fruit in reference to the characteristically star-shaped fruits formed from the indurated and usually spreading calyx lobes.

Key to subspecies

1. Leaves with 3 (rarely 5) veins, generally narrow and widest about the middle, distal portions only very slightly recurved; non lignotuberos; fruits sometimes with 4 or 6 lobes 14b. subsp. *histoclada*
1. Leaves with 5-7 or more veins, generally recurved in upper quarter; fruits always with only 5 prominent lobes 2
2. Plants erect with straight or slightly arching branches; leaves widest above the middle 14a. subsp. *asterocarpa*
2. Plants low with branches short, zig-zag or contorted; leaves generally widest about the middle 14c. subsp. *brachyclada*

14a. *Eremaea asterocarpa* R.J. Hnatiuk subsp. *asterocarpa* (Figure 34a-c)

Shrub, 130 cm tall; frequently lignotuberos. *Branches* spreading to ascending. *Branchlet indumentum* two-layered with dense, pilose outer layer; inner dense tomentose. *Over-wintering bracts* 6-11 per terminal bud; obovate; 3-5.9 mm long, 2.6-3.5 mm wide; frequently glabrous and fimbriate, but occasionally indumentum one-layered, tomentose all over back, occasionally pilose and fimbriate; finely striate. *Leaves* broadly obovate to occasionally elliptic, recurved at apex, acute or obtuse; 4.4-8.3 mm long, 2.4-4.5 mm wide; 5 or 7 rarely 9 veins visible on undersurface; indumentum one-layered, pilose and fimbriate, glabrescent; dry leaf cross-section flat, thin. *Petioles* 0.4-1.1 mm long. *Flowers* terminal on long branches of last season's wood; 1 or rarely 2 per inflorescence; scent musty. *Hypanthium* shallow, campanulate, 2.3-3.8 mm long, 2.7-4 mm wide; indumentum two-layered, upper layer sparse, pilose; lower layer dense, puberulous all over outer surface which is uneven, dull, and tuberculate from the large bases of hairs. *Calyx* (lobes) broadly triangular to triangular; 3-4 mm long, 2.7-4.3 mm wide; indumentum very dense, pilose, persistent in mature fruit. *Petals* 4.6-6 mm long; glands sparse or rarely abundant; the thin-margin of the lamina wide, weakly fringed. *Stamens* 23-30 per bundle, filaments fused in lower half; smooth; filaments

7.5-9 mm long; orange; swollen distally; claw 1.5-4.5 mm long, 2-3.3 mm wide. Ovary with 14-23 ovules per loculus; upper surface of valves densely short-pubescent without sparse long hairs. Style 8.2-9.7 mm long; indumented on lower quarter or occasionally to near apex. Fruit cupulate or campanulate; 7.2-8 mm long; rough, lumpy or rarely smooth; light brown to coppery brown; 10.8-17 mm wide with prominent pointed lobes; valves bi-lobed with surface of each lobe irregularly mammillate, exerted but backed by lower part of lobes. Seeds 2.3 mm long; smooth; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: 5 miles [8 km] NW of Badgingarra, Hill River district, *B.G. Briggs s.n.* (NSW 146256); 10 km N of Yanchep, *N. Byrnes* 3962 (PERTH); Cockleshell Gully Rd, c. 0.8 km S of junction with Greenhead Rd, *M.G. Corrick* 8065 (MEL); 6 km W of Brand Hwy on S-most road to Nambung National Park, *R.J. Hnatiuk* 780099 (PERTH); 12 km S of Jurien Rd on Munbinea Rd, *R.J. Hnatiuk* 780167 (PERTH); 5 km S of Coorow-Greenhead Rd on Cockleshell Gully Rd, *R.J. Hnatiuk* 780256 (PERTH); S arm of McNamara Rd, 3.4 km E of Brand Hwy, *R.J. Hnatiuk* 790045 (PERTH); between Seismic & Perry Rds, NE of Lake Pinjar, *R.J. Hnatiuk* 790200 (PERTH); 27 miles [43.2 km] from Gingin towards Regan's Ford, *M.E. Phillips*

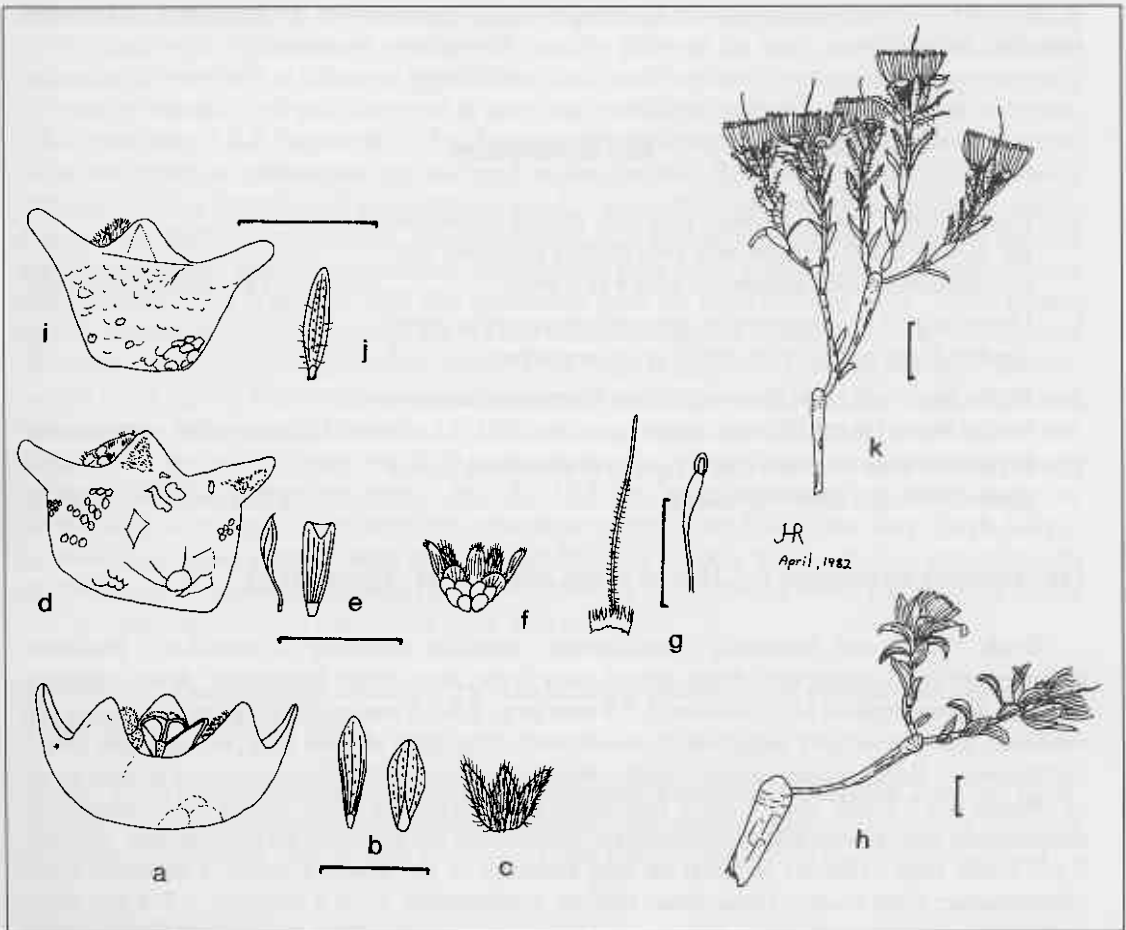


Figure 34. *E. asterocarpa* subsp. *asterocarpa*: a: fruit; b: leaves; c: hypanthium and calyx. 5 km S Coorow-Greenhead Rd on Cockleshell Gully Rd, *R.J. Hnatiuk* 780256 (PERTH). *E. asterocarpa* subsp. *brachyclada*: d: fruit; e: leaves; f: hypanthium, calyx and perules; g: style, top of ovary and stamen (scale bar 5 mm); h: habit. Base of Darling Scarp, *Cranfield* 27 (PERTH). *E. asterocarpa* subsp. *histoclada*: i: fruit; j: leaf; k: habit. 23 km S of Eneabba, *R.J. Hnatiuk* 780115 (PERTH). Scale bars, unless otherwise indicated, 10 mm.

1829 (CBG, NSW); 24 miles [38.4 km] from Jurien Bay towards Eneabba, *M.E. Phillips s.n.* (AD 96928343, CBG 026709); Mogumber-Regan's Ford Rd, 3/4 mi [1.2 km] W of Mission turn-off 9 mi [14.4 km] WNW Mogumber, 65 mi [104 km] directly NNE of Perth, *R.V. Smith 66/134* (MEL); South Irwin (South West) c. 8 km W of New Badgingarra, *D.J.E. Whibley 4790* (AD, PERTH).

Distribution: Irwin and Darling Districts (Figure 35).

Habitat. From lateritic uplands to coastal plains; vegetation closed heath, low open heath, low closed heath, or open low woodland; soils range over deep grey sand, grey sand over red brown clayey sand, grey sand over laterite, laterite and sand, or yellow sand.

Flowering period. August-October.

Notes. *E. asterocarpa* subsp. *asterocarpa* is the most widespread of the subspecies of *E. asterocarpa* and the most variable. In the northwest of the range it produces the most robust plants (e.g. NW of Mt Peron), and occurs in both woodland and kwongan vegetation.

Conservation status. This subspecies is thought not to be threatened. It is fairly widespread and occurs on a number of reserves. The protection of the extremes of the range is not known.

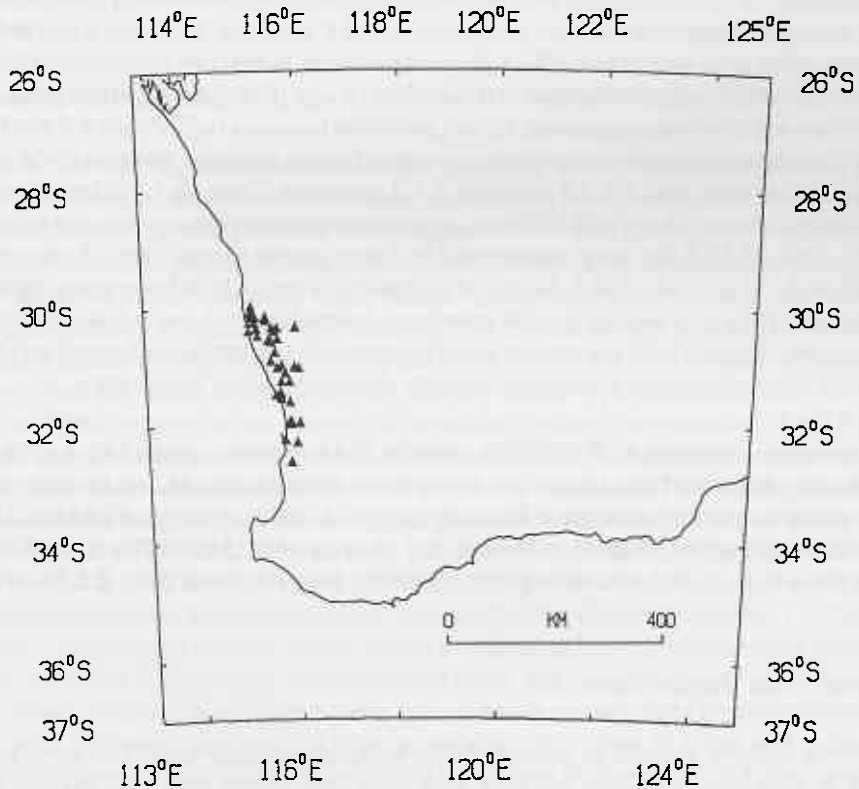


Figure 35. Distribution of *E. asterocarpa* subsp. *asterocarpa*.

14b. *Eremaea asterocarpa* R.J. Hnatiuk subsp. *histoclada* R.J. Hnatiuk subsp. nov. (Figure 34i-k)

Frutex sine lignotubero. Folia ovata vel parum obovata, angusta, acuta, indumento uniseriato, piloso; vena in pagina abaxiali 3, raro 5. Flores in ramis longis anni proximi terminales, 1 per inflorescentia. Hypanthium campanulatum, vadosum; indumentum biseriatum, strato supero densissime villosa, infero dense pubescenti. Lobi calycis late triangulares, dense villosi, in fructu persistentes. Stamina per fasciculo 16-36, ad medium connata, filamentis aurantiis. Fructus campanulatus ad doliiformis, scaber, irregulariter pustulatus, vel mammillatus praecipue in parte infero, pallide brunneus ad cupreus, lobis 4-6 acutis prominentibus, vel labro undulato; valvis exsertis.

Typus: 21 km E of Eneabba on road to Three Springs, 29°44' S lat., 115°28' E long., 12 Sept. 1978, R.J. Hnatiuk 780132 (holo: PERTH; iso: CBG, MEL, K; photo: CBG).

Illustration. R.J. Hubbard, Australian Plants 10 no. 77:13 (1978) as "*Eremaea fimbriata*".

Shrub, 110 cm tall; not lignotuberous. *Branches* ascending to erect. *Branchlet indumentum* two-layered with dense, pilose outer layer; inner pubescent. *Over-wintering bracts* 11-14 per terminal bud, obovate to spatulate; 2.5-3.8 mm long, 2.1-2.7 mm wide; usually glabrous and fimbriate, but occasionally indumentum one-layered, silky, on edges and on upper (distal) back; finely striate. *Leaves* narrowly ovate or slightly obovate, acute; 3.4-7.6 mm long, 1-2.4 mm wide; 3 to rarely 5 veins visible on underside; indumentum one-layered, pilose; dry leaf cross-section flat, thin. *Petioles* 0.4-1.4 mm long. *Flowers* terminal on long branches of last season's wood; 1 per inflorescence; fragrance musty. *Hypanthium* shallow, campanulate; 2-2.8 mm long, 3-4.6 mm wide; indumentum two-layered, upper layer very dense, villous; lower layer dense, pubescent; indumented all over; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* (lobes) broadly triangular, 2.2-3 mm long, 2-2.5 mm wide; indumentum dense, villous, persistent in mature fruit. *Petals* 4-5 mm long, 4-6.2 mm wide; glands abundant; thin-margin narrow, weakly fringed, or entire. *Stamens* 16-36 per bundle; filaments fused in lower half, 1.5-2.5 mm long, 1.3-2 mm wide; filaments 7.5-10 mm long, smooth, swollen distally, orange. *Ovary* with 9-14 ovules per loculus; densely short-pubescent without sparse long hairs. *Style* 10-10.5 mm long; indumented on lower quarter to near apex. *Fruit* campanulate to doliform; 6.9-7.9 mm long; rough, lumpy or mammillate especially in lower parts; light brown to coppery brown; 10.6-12.2 mm wide; with prominent pointed lobes, 4 and 6 lobes are frequent, or undulate; valves bi-lobed with the surface of each irregularly mammillate, exserted and backed by lower part of lobes. *Seeds* 2-2.1 mm long; smooth; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: Moora, about 140 km N of Perth, A.M. Ashby 63 (AD, PERTH); 19 mls [30.4 km] West of Watheroo, M.I.H. Brooker 1912 (AD, PERTH); 40 miles [64 km] west from Three Springs, C.A. Gardner 9136 (PERTH); 23 km S of Eneabba-Three Springs Rd, 38 km E of Eneabba, R.J. Hnatiuk 780115 (PERTH); 21 km E of Eneabba on road to Three Springs, R.J. Hnatiuk 780132 (PERTH); Tathra National Park, R.J. Hnatiuk 800052 (PERTH).

Distribution. Irwin District (Figure 36).

Habitat. From lateritic uplands to coastal plains; vegetation closed heath, low open heath, high shrubland, or open low woodland; soil deep grey sand, light brown sand over laterite, or lateritic gravel. Found on the plateaux immediately to the east of the coastal plain between Jurien and Eneabba.

Flowering period. July to November.

Notes. *E. asterocarpa* subsp. *histoclada* is distinguished from subspecies *asterocarpa* by its upright growth form, its total lack of lignotubers, its frequent production of flowers with aberrant calyx lobes and its generally smaller and less reflexed leaves. The apparent lack of lignotubers indicates that this subspecies relies upon seed for regeneration following fire, unlike the other two subspecies.

Conservation status. I recommend that the conservation status of this variety should be Priority Two - Poorly Known Taxa. Its range is less than 100 km across, it is known from reserves, but it is not well known, nor is its status in reserves known with certainty.

Etymology. The name is derived from the Greek words *histos* meaning erect and *klados* meaning branch in reference to the very erect growth form of the plant.

14c. *Eremaea asterocarpa* subsp. *brachyclada* R.J. Hnatiuk subsp. nov. (Figure 34d-h)

Frutex cum lignotubero. Folia ovata ad elliptica, lata, ad apicem recurva, obtusa; vena 5 vel 7 in pagina abaxiali visibilia. Flores in ramis anni proximi terminales, 1 per inflorescentia. Hypanthium campanulatum, vadosum; indumentum bistratum, strato supero denso, piloso ad strigoso, infero denso, puberulo. Lobi calycis late triangulares, dense pilosi, in fructu persistentes. Stamina per fasciculo 20-25, ad medium connata, filamentis aurantiis. Fructus cupulatus vel campanulatus, scaber, irregulariter pustulatus, vel raro laevis, pallide brunneus ad cupreus, lobis acutis prominentibus, valvis exsertis.

Typus: Base of Darling Scarp, WA, 12 Oct. 1977, R.J. Cranfield 27 (holo: PERTH; photo: CBG.)

Shrub, 70 cm tall; lignotuberous. *Branches* spreading to ascending, or short and contorted. *Branchlet indumentum* two-layered with dense, pilose outer layer; inner dense, tomentose. *Overwintering* bracts c. 10 per bud; obovate to spatulate; 3.7-4.7 mm long, 2.5-2.9 mm wide; usually glabrous and fimbriate, but occasionally indumentum one-layered, tomentose all over back or villous on upper (distal) back and fimbriate; finely striate. *Leaves* narrowly obovate to narrowly elliptic, slightly recurved at apex, obtuse; 5.6-6.6 mm long, 2.1-2.4 mm wide; 5 or 7 veins visible on under-surface; indumentum one-layered, pilose; dry leaf cross-section flat, thin. *Petioles* 0.3-0.4 mm long. *Flowers* terminal on "long" branches of last season's wood; 1 per inflorescence; scent has been recorded as "faint" otherwise not known. *Hypanthium* shallow, campanulate, 2.4-2.8 mm long, 3.6-4.3 mm wide; indumentum two-layered, upper layer densely villous to pilose; lower layer dense, puberulous all over outer surface which is uneven, dull, and tuberculate from the large bases of hairs. *Calyx* lobes broadly triangular; c. 2.1 mm long, c. 2.0 mm wide; indumentum densely pilose, persistent in part in mature fruit. *Petals* c. 4.5 mm long; glands sparse; the thin-margin of the lamina wide at sides and narrow at apex, weakly fringed. *Stamens* 20-25 per bundle, filaments fused in lower half; papillose; filaments 4.0-4.5 mm long; orange; swollen distally; claw c. 2 mm long, 1.7-2.0 mm wide. *Ovary* with 7-9 ovules per loculus; upper surface of valves densely short-pubescent without sparse long hairs. *Style* 5.3-8.0 mm long; indumented on lower half. *Fruit* cupulate or campanulate; 7-9 mm long; rough, lumpy, mammillate in lower parts or rarely smooth; light brown to coppery brown; 8-11 mm wide with prominent pointed lobes or undulate rim; valves bi-lobed with surface of each lobe irregularly mammillate or smooth, exserted but backed by lower part of lobes, apex with two irregular smooth or callosed lobes. *Seeds* 2.0- 2.3 mm long; smooth; shed freely when fruit is dry.

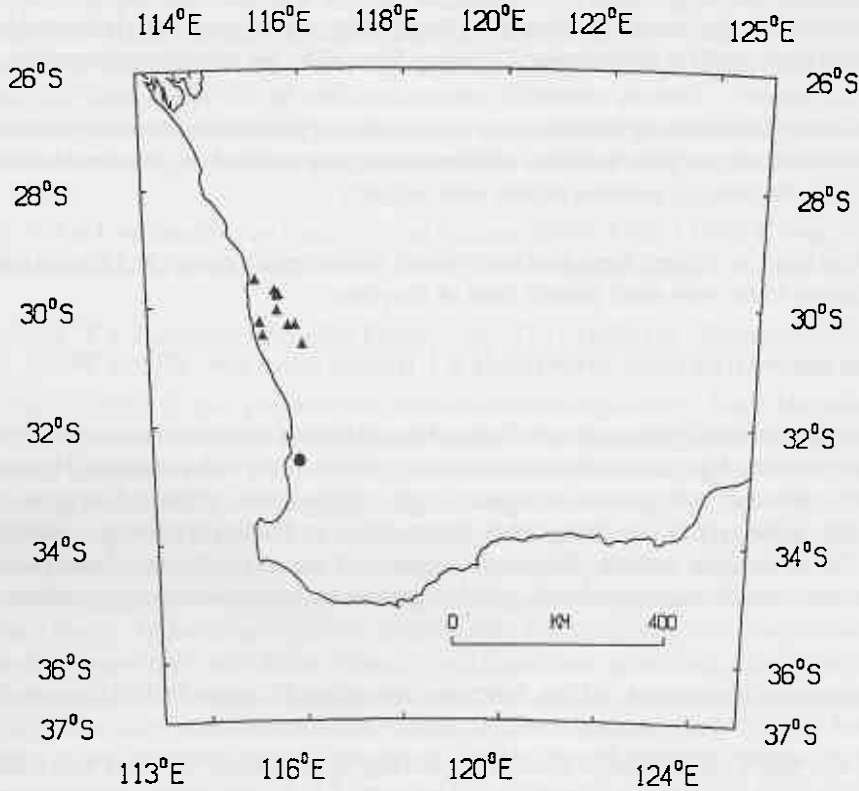


Figure 36. Distribution of *E. asterocarpa* subsp. *histoclada* (▲) and *E. asterocarpa* subsp. *brachyclada* (●)

Selected specimens examined. WESTERN AUSTRALIA: R.J. Cranfield 27 (PERTH); R.J. Hnatiuk 830059 (PERTH); M.E. Phillips 21/10/62(CBG). [Precise localities withheld.]

Distribution. Darling District south of Perth on the coastal plain (Figure 36).

Habitat. This subspecies occurs in kwongan and woodland vegetation on deep grey sand over yellow sand.

Notes. *E. asterocarpa* subsp. *brachyclada* is a shrub very similar to *E. asterocarpa* subsp. *asterocarpa*, but *E. asterocarpa* subsp. *b. achyclada* is lower in height, lignotuberous, and its branches are short (about 2-6 cm per growth cycle), zig-zag, or contorted. The fruits are usually smaller than those of subsp. *asterocarpa*.

It is not common and forms the southernmost outliers of the species and the section. Its unusual growth form, which is maintained in cultivation, and its geographic isolation, form the basis for its taxonomic recognition.

Conservation status. I recommend that the conservation status of this variety should be Priority One - Poorly Known Taxa. It is known from very few collections in areas south of Perth that are under heavy pressure to clear native vegetation for other uses. It needs to be assessed urgently.

Etymology. The name is derived from the Greek words *brachy-* meaning short and *klados* meaning stem referring to the shortness of the branchlets produced each growth cycle.

15. *Eremaea* x *codonocarpa* R.J. Hnatiuk sp. nov. (Figure 37)

Frutex. Rami fere prostrati ad erecti. Folia anguste ovata ad linearia, acuta, indumento unistrato, glabrescentia; vena in pagina abaxiali 1-3. Flores in ramulis brevibus ramorum anni proximi terminales, 1-3 per inflorescentia, leviter et dulce odorati. Hypanthium vadosum, campanulatum, dense velutinum indumento unistrato. Stamina per fasciculo 18-33, in parte dimidio inferiore connata, laevia, rosea vel atrorosea, raro violacea vel alba basi rosea. Fructus campanulatus vel globosus, laevis ad furfuraceus, cano-brunneus, labro undulato vel lobis parvis acutis, valvis exsertis.

Typus: 6 km N of Jurien Rd on Cockleshell Gully Rd, 30°15'S lat., 115°10'E long., 17 Oct. 1978, R.J. Hnatiuk 780200 (holo: PERTH; photo: CBG).

Shrub, 70 cm tall. *Branches* almost prostrate to erect (variable). *Branchlet indumentum* two-layered, with dense, pilose outer layer; inner densely tomentose. *Over-wintering bracts* 6-15 per terminal bud; ovate; 3.2-4.3 mm long, 1.7-3 mm wide; indumentum one-layered, finely puberulous and ciliate; on back and edges; finely striate. *Leaves* narrowly ovate to linear, acute; 4.1-11.2 mm long, 0.6-1.8 mm wide; 1-3 veins below; indumentum one-layered becoming glabrous, outer layer pilose; dry leaf cross-section triangular. *Petioles* 0.5-1.9 mm long. *Flowers* terminal on short laterals along long branches of last season's wood; 1-3 per inflorescence; fragrance faint, sweet. *Hypanthium* shallow, campanulate; 3.5-6 mm long, 3.5-4 mm wide; indumentum one-layered, densely velutinous all over; outer surface uneven, dull, finely mammillate to tuberculate. *Calyx* lobes triangular to broadly triangular; 2-4.5 mm long, 2.2-3 mm wide; densely velutinous on apical portion; caducous, or persistent. *Petals* 3-5.7 mm long, 3.5 mm wide; glands sparse; thin-margin narrow, weakly fringed. *Stamens* 18-33 per bundle; filaments fused in lower quarter to half; smooth; claw 5-9 mm long; pink, or dark pink, or rarely violet or white with pink bases; not swollen; 1.5-4.5 mm long, 1.7-2.5 mm wide. *Ovary* with 10-14 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 9.5-12 mm long; glabrous, or indumented on lower quarter. *Fruit* campanulate, or globose; 5-11 mm long, 5.8-7.4 mm wide; smooth to very flakey; grey brown; undulate, or with small pointed lobes; valves bi-lobed, surface of each lobe smooth; exserted and backed or not by lower part of lobes. *Seeds* 1-2.4 mm long; smooth; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: Mt Lesueur, N along Cockleshell Gully Rd, Cranfield 830 (PERTH); 18 km S of Eneabba on Brand Hwy, R.J. Hnatiuk 780225 (PERTH); 7 km E of junction of Coorow-Greenhead Rd and Cockleshell Gully Rd, R.J. Hnatiuk 780266 (PERTH).

Distribution. Irwin District (Figure 38).

Habitat. Lateritic uplands to coastal plains; associated vegetation, kwongan: low open heath, or low closed heath; soil deep light brown sand, deep grey sand, grey sand over laterite, white sand over clay colluvium, or red brown clay loam.

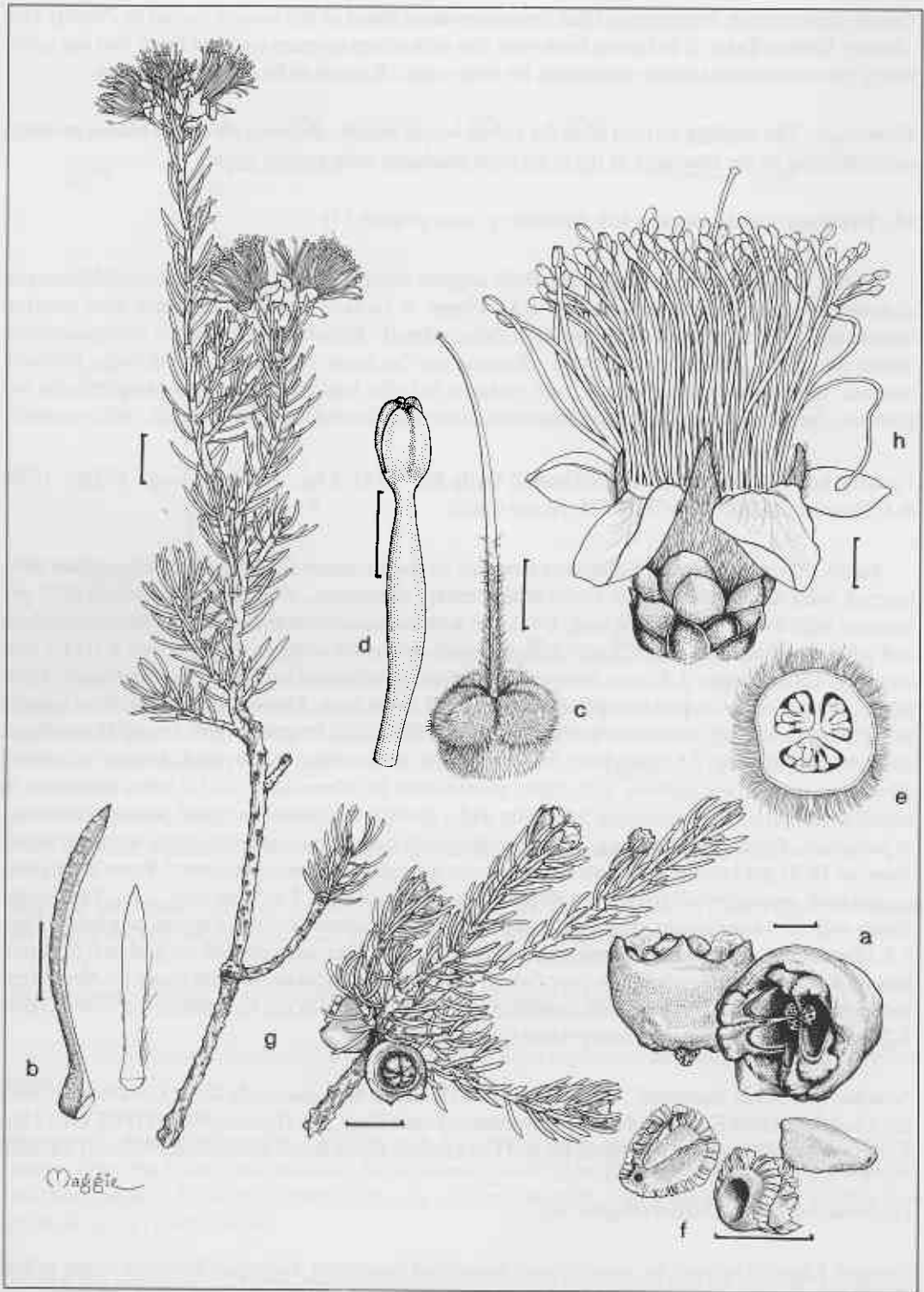


Figure 37. *E. x codonocarpa*: a: fruits; b: leaves (scale bar 2 mm); c: style and top of ovary (scale bar 2 mm); d: detail of stamen (scale bar 1 mm); e: transverse section of ovary (scale bar 2 mm); f: seeds and ovulode; g: habit; h: flower. Scale bars, unless otherwise indicated, 10 mm.

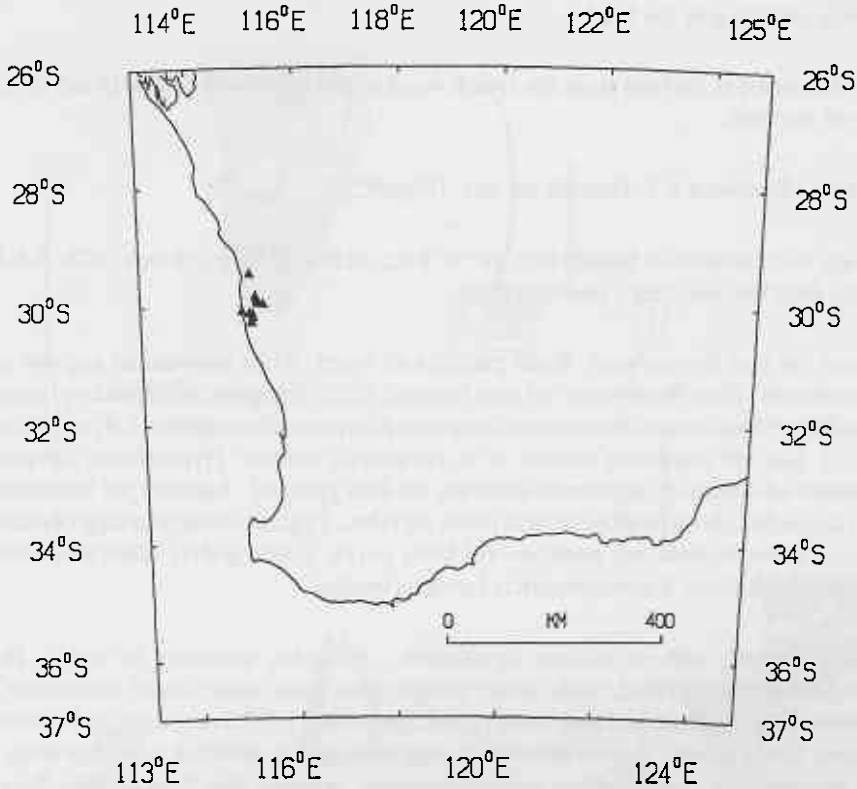


Figure 38. Distribution of *E. x codonocarpa*.

Flowering period. October to November.

Notes. *E. x codonocarpa* is believed to be a stabilised natural hybrid between *E. asterocarpa* var. *asterocarpa* and *E. violacea* subsp. *raphiophylla*. It occurs commonly on disturbed roadsides where the two putative parents occur together, but it also occurs in undisturbed vegetation with the two parents. The earliest specimen collected is significant. It is a fragment collected last century by an unknown woman. It was sent to von Mueller in Melbourne and recorded as "Coolgardie". This unlikely location may have been the place from which it was sent rather than collected. The area from which it probably came was very unlikely to have been "disturbed" as we know this term now, thus providing an indication that the hybrids are unlikely to be only a modern response to extensive habitat disturbance. Hybridisation is probably still occurring as there is no obvious reason for crossing not to continue. The taxon, although still variable, is generally recognisable. It is distinguished by leaves that are narrow, but wider than those of *E. violacea* subsp. *raphiophylla*; a hypanthium that is indumented, but less spreading at the top than in *E. asterocarpa*; stamens that are pink, not violet nor orange; and fruits that have undulate rims often with the remains of calyx lobes as small points. The plants generally produce very few seeds, but these are viable and produce offspring which closely resemble the maternal parent, but the sample size has been small. Isozyme analyses give further evidence of the hybrid nature of this taxon (Coates and Hnatiuk 1990).

Conservation status. I recommend that the conservation status of this species should be Priority Two - Poorly Known Taxa. Its range is less than 100 km across, it is not abundant, but does occur in reserves. Its status needs checking in the field.

Etymology. The name is derived from the Greek word *kodon* (bell) and *karpos* (fruit) in reference to the shape of the fruit.

16. *Eremaea* x *phoenicea* R.J. Hnatiuk sp. nov. (Figure 39)

Typus: c. 18 km S of Eneabba on Brand Hwy, 29°56'S lat., 115°16'E long., 18 Oct. 1978, R.J. Hnatiuk 780220 (holo: PERTH; iso: CBG; photo: CBG).

Frutex cum vel sine lignotubero. Rami patentes ad erecti. Folia obovata ad anguste elliptica, indumento unistrato piloso-tomentoso vel raro bistrato; vena in pagina inferiore 1 vel interdum 3. Flores in ramulis brevibus lateralibus ramorum longorum anni proximi terminales, 1-4 per inflorescentia (plerumque 2), non vel manifeste odorati ut in *Pimpinella anisum*. Hypanthium campanulatum longum, pilosum ad sericeum indumento unistrato vel raro glabrum. Stamina per fasciculo 19-26, ad basin vel raro in dimidio inferiore connata, rosea vel rubra. Fructus urceolatus ad globosus, laevis, cano-brunneus, labro elobato vel undulato vel lobis parvis acutis, valvis labro aequantibus vel brevioribus lobis apicalibus 2 hemisphaericis laevibus ornatis.

Shrub, 150 cm tall; with or without lignotubers. *Branches* spreading to erect. *Branchlet indumentum* one- to two-layered, with dense, pilose outer layer, inner dense tomentose. *Overwintering bracts* 12-23 per terminal bud; ovate; 2.7-4.2 mm long, 2.5-2.7 mm wide; indumentum one-layered, ciliate; finely striate. *Leaves* obovate to narrowly elliptic, acute; 4.2-6.8 mm long, 0.8-1.7 mm wide; 1 occasionally 3 veins below; indumentum one- or rarely two-layered, outer layer pilose tomentose; dry leaf cross-section triangular. *Petioles* 0.74 mm long. *Flowers* terminal on short laterals along long branches of last season's wood; 1-4 per conflorescence (usually 2); fragrance none to strong, aniseed. *Hypanthium* long, campanulate; 3.6-4.2 mm long, 2.5-4 mm wide; indumentum one-layered, or rarely glabrous, dense, pilose to silky; all over; outer surface uneven, dull, finely mammillate. *Calyx lobes* broadly triangular; 1.5-2.8 mm long, 1.5-2.5 mm wide; indumentum sparse, villous; apical portion caducous. *Petals* 3.5-4.6 mm long, 3.5 mm wide; glands sparse; thin-margin wide, weakly fringed. *Stamens* 19-26 per bundle; filaments fused only shortly at base to rarely fused in lower half; smooth; 7-8.8 mm long; rose or red; swollen distally; claw 0.8-2.4 mm long, 1.8-2.5 mm wide. *Ovary* with 10-14 ovules per loculus; valves densely short-pubescent without sparse long hairs. *Style* 9.2-12 mm long; glabrous. *Fruit* urceolate to globose; 5.8-7 mm long; smooth; grey brown; 4.6-6.4 mm wide; without lobes, or undulate, or with small pointed lobes; valves reaching rim of fruit, occasionally slightly below, ornamented by 2 smooth hemispheric apical lobes. *Seeds* 1.5-1.8 mm long; rough; shed freely when fruit is dry.

Selected specimens examined. WESTERN AUSTRALIA: 2.5 km SE of Mt Peron, NE of Jurien, E.A. Griffin 2468 (PERTH); 18 km S of Eneabba on Brand Hwy, R.J. Hnatiuk 780222, 780223, 780224, 780235 (PERTH); 23 km S of Eneabba on Brand Hwy, R.J. Hnatiuk 780242 (PERTH); 1 km E of Brand Hwy on Coorow Rd, R.J. Hnatiuk 780277 (PERTH); road off Brand Hwy, just south of Arrowsmith River going east, B. Jack, 12 Oct. 1977 (PERTH); 1-2 km E of Rose Rd on Greenhead Rd, E of Brand Hwy, V. Syme & B. Jack, 2 Nov. 1979 (PERTH).

Distribution. Irwin District (Figure 40).

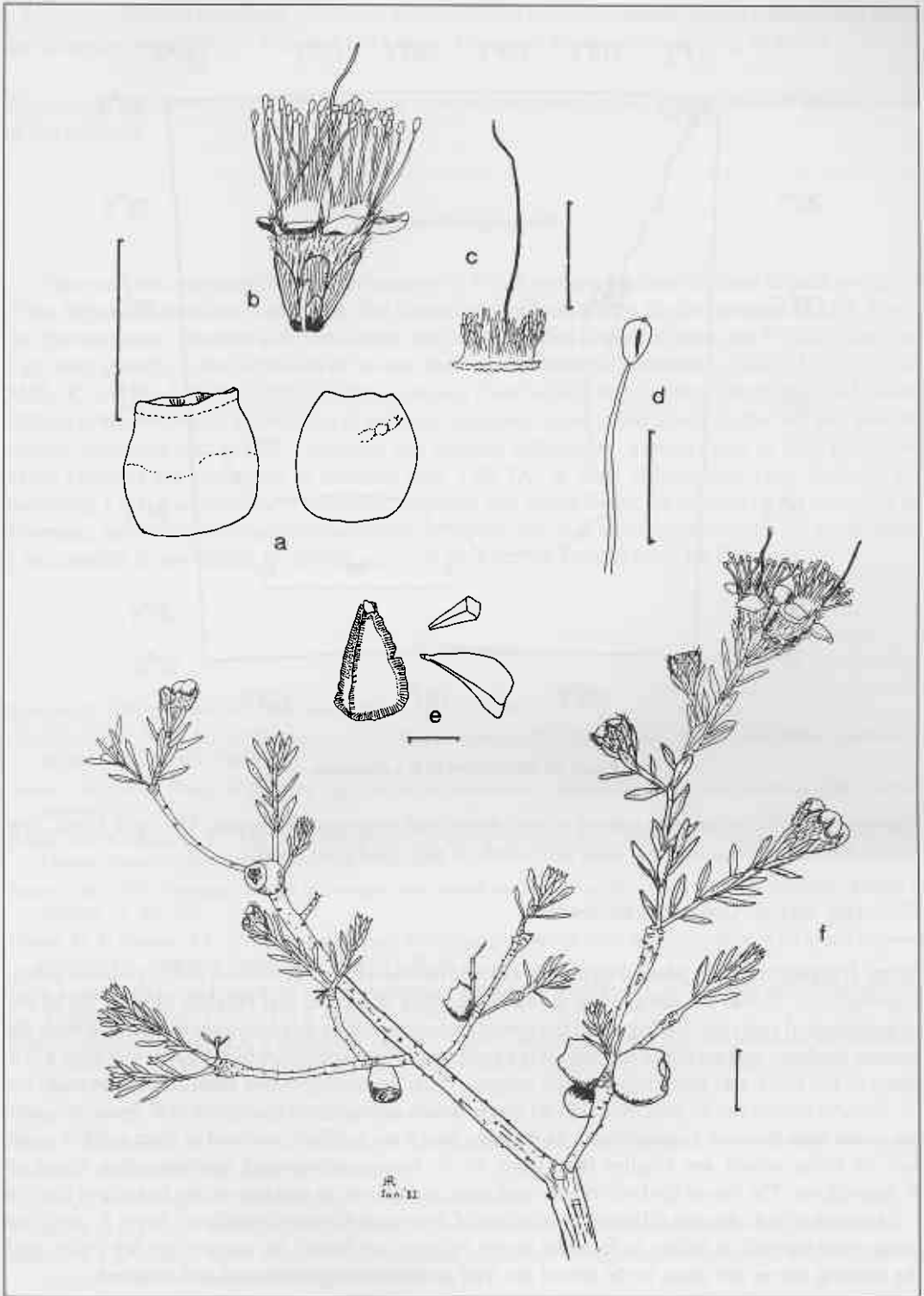


Figure 39. *E. x phoenicea*: a: fruits; b: flower; c: style and top of ovary (scale bar 5 mm); d: stamen; e: seed and ovulodes (scale bar 1 mm); f: habit. 18 km S of Eneabba, R.J. Hnatiuk 780223 (PERTH). Scale bar, unless otherwise indicated, 10 mm.

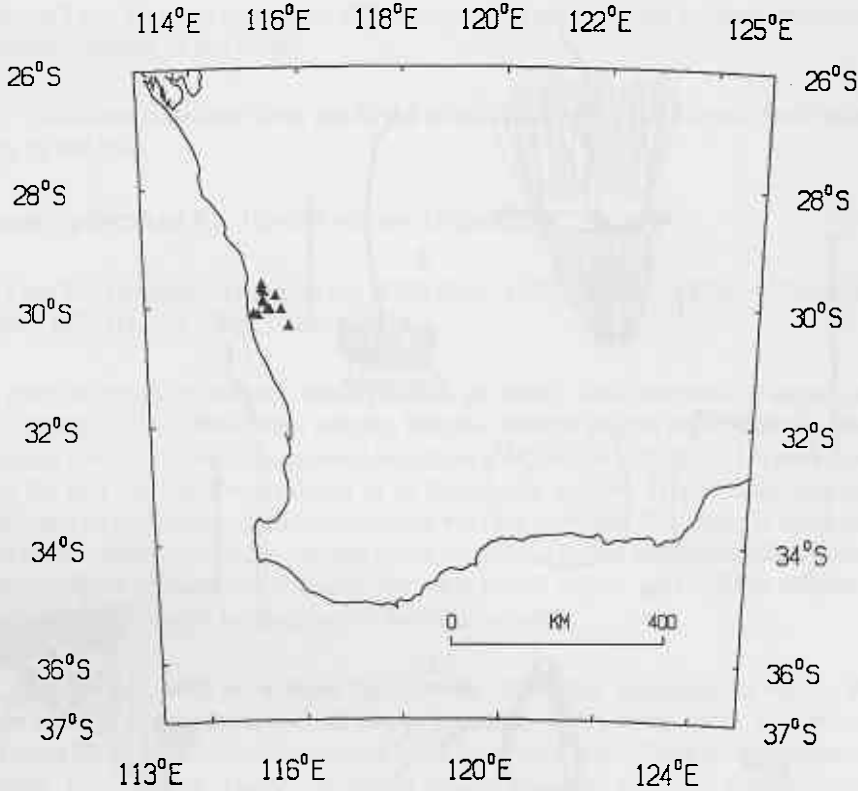


Figure 40. Distribution of *E. x phoenicea*.

Habitat. Lateritic uplands to coastal plains; associated vegetation kwongan: low open heath, low closed heath, or low scrub; soil deep grey sand, or grey sand over laterite.

Flowering period. October to November.

Notes. It appears that *E. x phoenicea* may be a hybrid between *E. beaufortioides* and *E. violacea* subsp. *raphiophylla*. It was not sampled in the isozyme study of Coates and Hnatiuk (1990), but in the morphological analysis (see Figure 2) the specimens representing this taxon are included in both the section *Violacea* and section *Eremaea*. It is a particularly rare species, which I have only seen a few times in the field, and then only on road verges. It can be distinguished from its closest relatives (*E. beaufortioides* and *E. pauciflora*) by its leaves which are narrower than those of *E. beaufortioides* but wider than those of *E. pauciflora*; its stamens which are brilliant rose, red or deep reddish pink; and its fruits which are smaller than those of *E. beaufortioides* and narrower than those of *E. pauciflora*. The rim of the fruit may be undulate, and the valves reach to or rise just above the rim - characters which also are different from either of its orange-flowered relatives. From *E. violacea* subsp. *raphiophylla* it differs in its wider leaves (elliptic not linear), its stamens are not violet, and the fruiting valves are close to the rim of the fruit and not strongly exerted and reflexed.

Conservation status. I recommend that the conservation status of this species should be Priority Two - Poorly Known Taxa. Its range extends less than 100 km across. Surveys of the areas around where

it has been collected have been numerous and few plants have been found, so it is unlikely that there are extensive populations. Detailed field work is required for clearly assessing its status.

Etymology. The name comes from the Greek word *phoinix* meaning red-purple and refers to the colour of the stamens.

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