A revision of the Australian species of Salicornieae (Chenopodiaceae)

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Abstract

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A taxonomic revision is presented for the Australian representatives of five genera in the tribe *Salicornieae* (Chenopodiaceae). Three of the genera, *Pachycornia* Hook.f., *Sclerostegia* P. G. Wils. gen. nov., and *Tegicornia* P. G. Wils. gen. nov. are endemic to Australia. *Halosarcia* P. G. Wils. gen. nov. is found in countries bordering the Indian Ocean while *Sarcocornia* A. J. Scott is widely distributed in both the northern and southern hemispheres. The genera *Pachycornia* (which is monotypic) and *Sclerostegia* (with five species) have their flowers arranged in axillary 3-flowered cymules in which the lateral flowers are male and the central hermaphrodite. *Tegicornia* (with one species) is dioecious and has solitary flowers. *Halosarcia* (with 23 species) has either hermaphrodite or female flowers and differs from the genus *Arthrocnemum* (from which it is here segregated) in having only one stamen in each flower and in lacking sclereids in the chlorenchymous tissue. The genera *Halosarcia*, *Tegicornia*, *Sclerostegia*, *Pachycornia*, and *Tecticornia* appear to be more closely related to each other than they are to *Sarcocornia* or to any of the extra-Australian members of the *Salicornieae*.

Introduction

The articulate members of the Chenopodiaceae with fleshy stems and reduced flowers have been variously separated from the rest of the family at the levels of tribe or subfamily; they have even been treated as a separate family. While the Salicornioideae have been generally recognised as a discrete assemblage, the circumscription of the genera has been the cause of considerable debate. This has been partly due to the poor material that the taxonomists have had available to them, and partly due to the paucity of characters on which to base both the genera and species. With the availability of fresh or pickled material of some representatives, and good dried specimens of others, it has been possible to more clearly delineate the genera and recognise many of their constituent taxa.

In this paper five of the six genera recognised as being present in Australia are revised. A revision of the genus *Tecticornia* has already been published (Wilson 1972).

Morphology

Stem: The articulate branches characteristic of the Salicornioideae have generally been assumed to be made up of a stem axis surrounded by the decurrent abaxial portions of leaf bases (Tölken, 1967). An alternative structure has been proposed in which it is assumed that the succulent sheath represents a true cortex and that the leaves are reduced to small lobes (Fahn, 1963). Whichever view is correct it is apparent that there is no boundary of demarcation in the sheath that could suggest a division into material of foliar and stem origin.

No detailed investigation of the anatomy has been undertaken in the present study; it is apparent, however, that there are considerable differences in the morphology of the stem between different members of the Salicornioideae. In all species the young internodes have a central stele surrounded by a water tissue which consists of thin-walled parenchyma cells filled with a (usually) saline sap. Around the water tissue are one or more layers of chlorenchymous palisade cells covered by an epidermis. The epidermis contains numerous stomata which are easily visible with a hand lens: these always have their pores aligned transversely to the stem axis. A single leaf trace arises on each side of the node; it divides into three, the central branch passing upwards towards the 'leaf' tip while the lateral branches curve downwards into the water tissue below the node. Each trace branches repeatedly to form an anastomosing network in the aqueous tissue, the degree of anastomosis varying between the different species. In all Australian genera of the Salicornioideae the decurrent branches from one leaf trace also anastomose with those of the opposite trace so as to form a complete network around the stem; this union takes place even in *Pachycornia triandra* where the chlorenchyma is absent in two opposite vertical strips which delineate the apparent decurrent foliar tissue. The ultimate branches of the vascular network terminate either as simple vascular strands or as club-shaped clusters of tracheids (tracheoids) situated just beneath the chlorenchyma. The former is the case in *Pachycornia*, *Sarcocornia*, *Sclerostegia tenuis*, and *Halosarcia indica*, while the latter occurs in *Sclerostegia arbuscula*, *S. disarticulata*, *Tegicornia* and most species of *Halosarcia*. De Fraine (1912) stated that in *Salicornia* the vascular network arising from one leaf-trace does not anastomose with that of the opposite leaf-trace, a situation which is contrary to that observed in Australian members of the Salicornioideae and is also contrary to the observations of Fahn and Arzee (1959) on species of *Arthrocnemum*, *Sarcocornia*, and *Salicornia*. In the branches of all three traces the phloem tissue faces towards the outside of the stem and the xylem the inside.

The palisade tissue normally consists of two or more layers of cells which may be sharply differentiated from the aqueous tissue (as in *Sarcocornia*) or may merge into it through a zone of cells of an intermediate type (as in *H. halocnemoides*). In one species complex both the stele and the tissue of the palisade layer differ markedly from that found

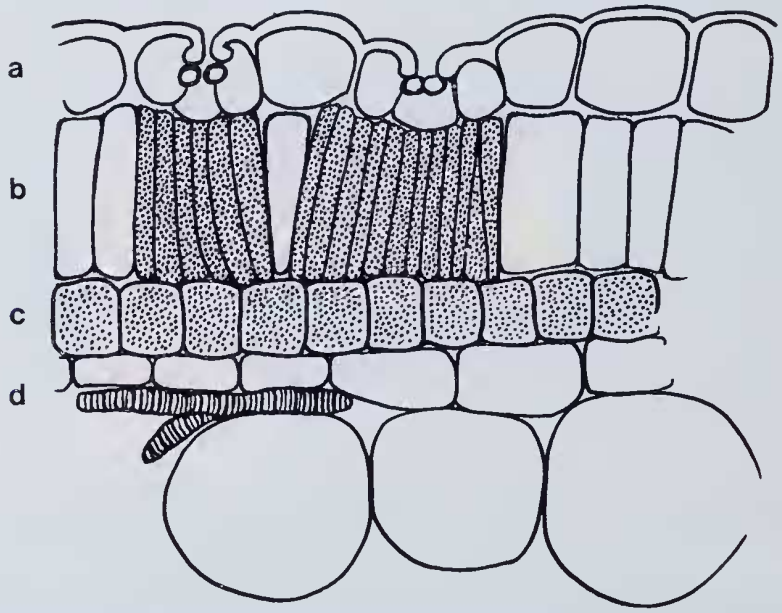

Figure 1. *Halosarcia indica:* longitudinal section through outer tissues (a—epidermis, b—palisade tissue with clear 'passage' cells between groups of chlorenchymous cells, c—thick-walled chlorenchymous isodiametric cells, d—parenchymatous cells with vascular strands).

in all other Australian members of the *Salicornieae;* this complex consists of *H. indica* sensu lato, which is here taken to include *Arthrocnemum ciliolatum* Ung.-Sternb., *A. bidens* Nees, and *A. leiostachyum* (Benth.) Paulsen. In this species the palisade tissue is of a single layer and is made up of compact clusters of chlorenchymous cells set in a reticulum of cylindrical colourless cells of similar shape to (but somewhat thicker than) the chlorenchymous. A cluster of chlorenchymous cells is situated beneath each of the stomata. Within the palisade tissue is a single layer of close-fitting thick-walled isodiametric chlorenchymous cells which form a continuous sheath between the palisade and aqueous tissues; this layer frequently becomes lignified with age (Fig. 1). Although this type of palisade tissue appears to be unique in the *Salicornieae* it is found in other tribes of the Chenopodiaceae, for instance the *Salsoleae.* In *Salsola kali* the palisade tissue of both the leaf and stem consists of a single row of cells within which is a single row of thick-walled isodiametric cells. This is underlain by parenchymous tissue which, in the leaf, has a reticulate network of vascular strands beneath the isodiametric layer; in the stem there is no cortical vasculature. (See also Carolin *et al.* 1975.)*

A reticulum of colourless cells in the palisade tissue is also found in many other species of *Halosarcia;* these are called 'passage cells' by Tölken (1967) but their function is not clear.

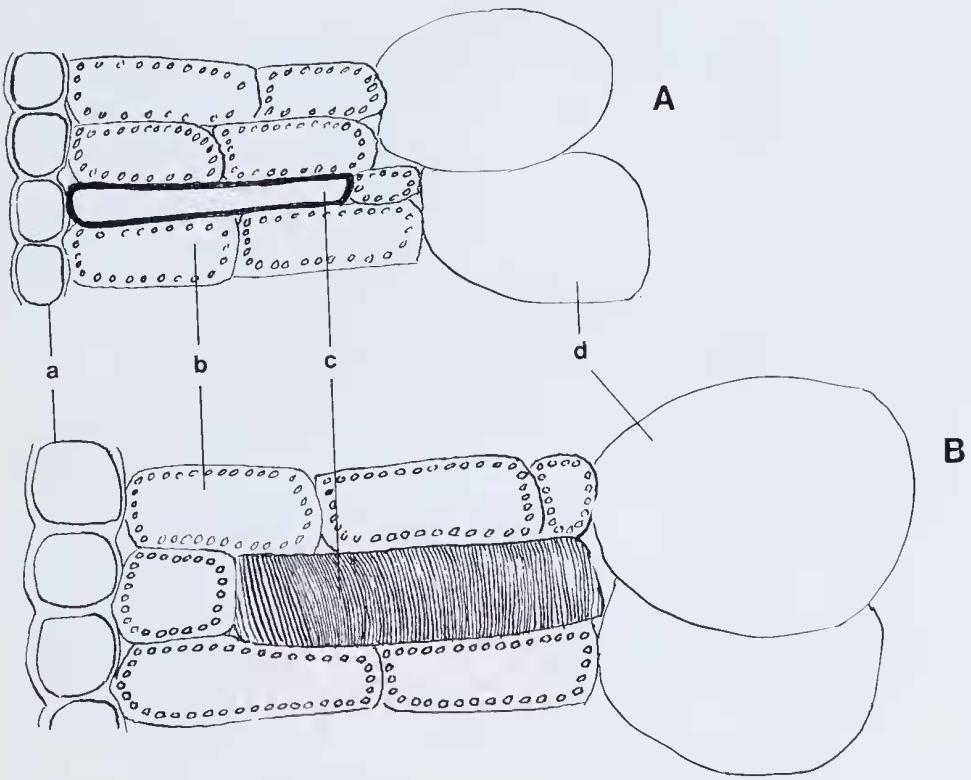

Figure 2. Sclereids in chlorenchyma: A—*Sarcocornia quinqueflora* showing evenly thickened sclereid; B—*Sarcocornia blackiana*, showing spirally thickened sclereid (a—epidermis, b—chlorenchyma, c—sclereid, d—aqueous tissue).

* This is a typical Kranz type structure—R. C. Carolin and S. W. G. Jacobs pers. comm. A more detailed account will be published by these authors.

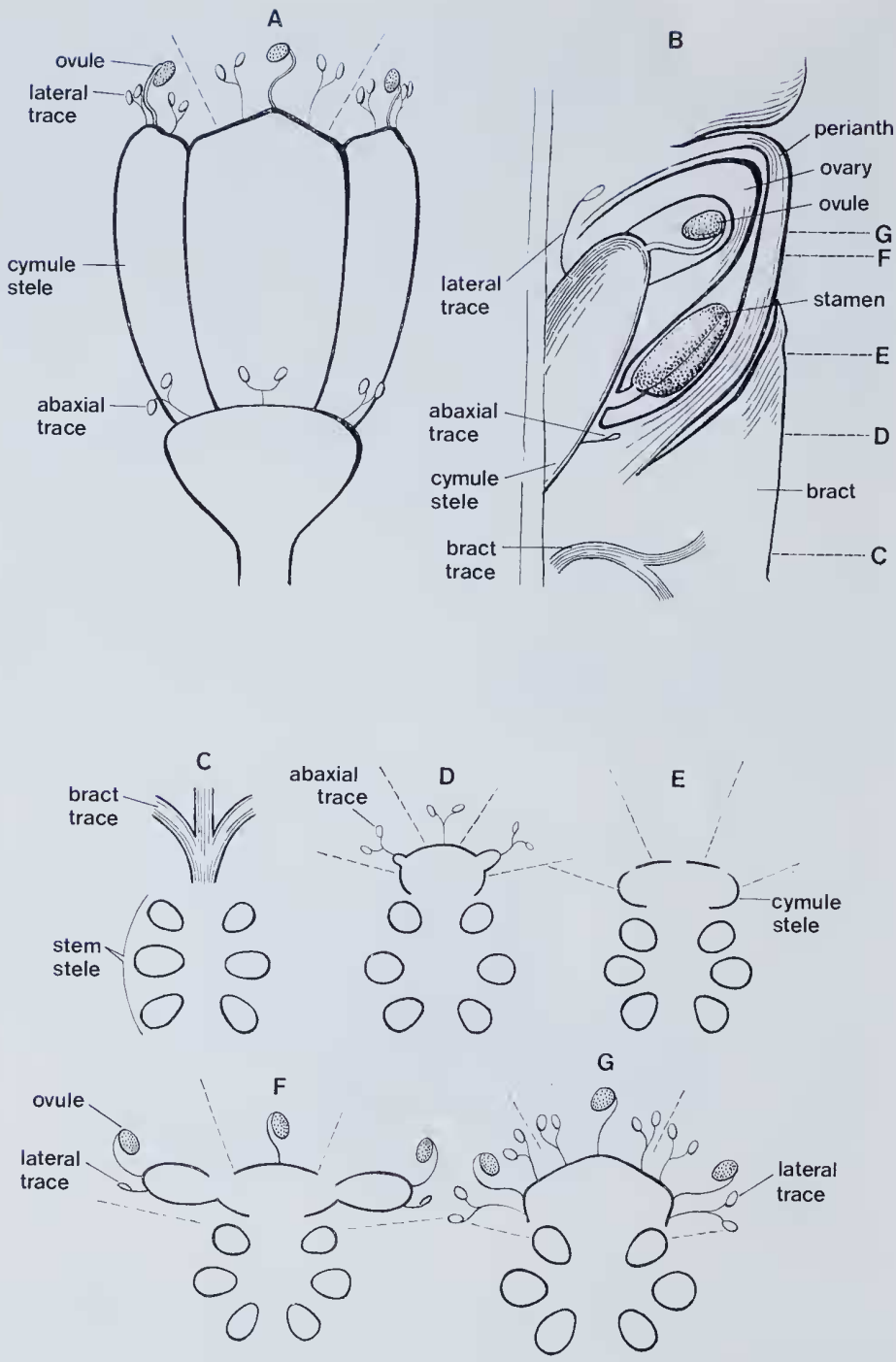

Figure 3. *Halosarcia lepidosperma*, vasculature of inflorescence: A—Abaxial view of vasculature of triad of flowers; B—L.S. (medial) of flower; C—G—T.S. at levels indicated in figure B. (all diagramatic).

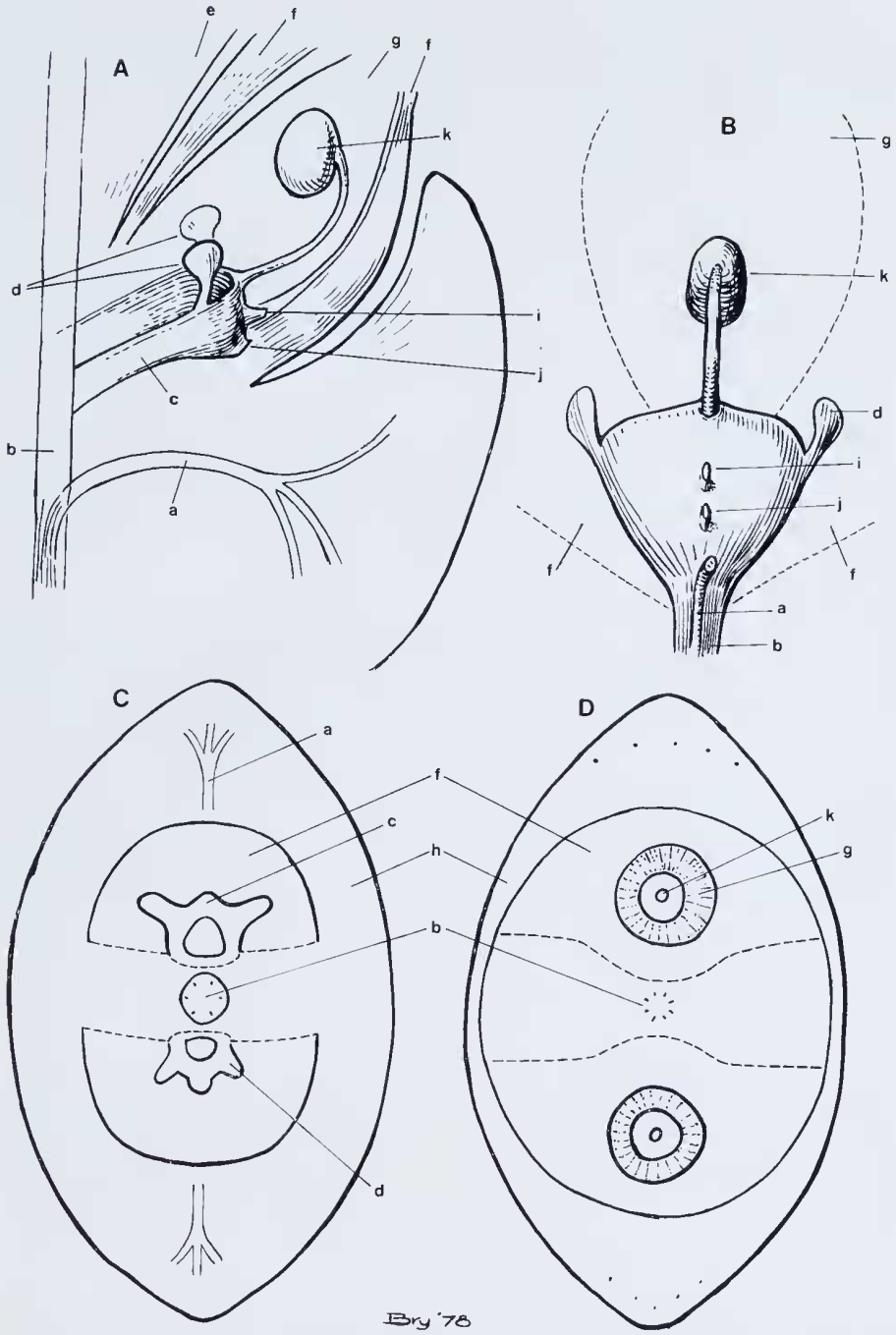

Figure 4. *Tegicornia uniflora*, vasculature of female flower: A—Optical longitudinal section; B—Abaxial view of vasculature of a one-flowered cymule; C and D—T.S. through flowers at different levels (a—bract trace, b—stele of stem, c—stele of axillary one-flowered cymule, d—vestigial lateral traces, e—upper bract, f—perianth, g—ovary, h—lower bract, i—trace to vestigial staminode, j—trace to abaxial base of perianth, k—ovule).

In *Sarcocornia*, sclereids occur in the palisade tissue (Fig. 2); these may be evenly thickened or they may have a spiral thickening. Sclereids have not been observed in other Australian *Salicornieae*, but they do occur in both species of true *Arthrocnemum*, i.e., *A. glaucum* (Delile) Ung.-Sternb. and in *A. subterminale* (Parish) Standley which are respectively Mediterranean and North American in their distribution.

Inflorescence: A detailed discussion of the inflorescence in the *Salicornieae* will, it is hoped, be the subject of a future paper; for the present it is sufficient to indicate that it consists of decussate axillary clusters of flowers, each cluster being sessile within a common bract; there are no secondary bracts (or bracteoles). The axillary clusters are in most species arranged in a spike-like structure and the whole then called a pseudo-spike (although actually a thyrse). In several species of both *Halosarcia* and *Sclerostegia* the spike very soon becomes intercalary in position through vegetative growth at its apex; it may then eventually have the appearance of a normal branch. A few species, e.g. *Tegicornia uniflora* and *Sclerostegia medullosa*, have the flowers (or flower clusters) in the axils of "foliage" leaves and no obvious compound inflorescence is formed.

In the majority of the *Salicornieae* the axillary clusters are three-flowered. Each cluster has generally been accepted as constituting a cymule (a dichasium); due to the congested arrangement of the flowers, however, and the fact that they are sessile on the inflorescence axis, the vasculature of the cymules is difficult to determine. In *Halosarcia lepidosperma* (in which the verticils are relatively widely separated) it is apparent that an axillary stele composed of many vascular strands forms a dorsiventrally compressed, somewhat globular reticulum and terminates in the central flower of the cymule (Fig. 3). It gives rise to a pair of smaller lateral steles which terminate in the lateral flowers of the cymule. Each of the steles gives rise to a (bract?) trace on the abaxial side of their respective flowers, and also to a pair of lateral (bracteole?) traces, while the traces themselves divide to form a pair of club-shaped spurs or tracheoids (the possible nature of these traces is discussed later). Since the vasculature of the axillary flower cluster consists of a central and a pair of lateral steles the classical view of its structure being that of a cymule is accepted.

In *Tegicornia uniflora* only one flower is present within each of the leaf-like bracts (Fig. 4). This flower is served by an inflorescence stele which terminates in the flower and gives rise to a pair of small globose lateral steles that are embedded in the axial tissue below the base of the perianth. These lateral steles are presumably homologous to the lateral steles of the cymule vasculature in *Halosarcia* and therefore it is probable that the solitary flower in *Tegicornia* is the result of reduction from a three-flowered dichasium.

In *Sarcocornia blackiana* and *S. quinqueflora* five or more flowers are found in the axil of a bract. This cymule is similar to that found in *Halosarcia* except that each of the lateral branches of the cymule stele gives rise to a monochasium (in fact a drepanium) composed of from two to several flowers.

Flowers: The flowers are surrounded by succulent bracts or leaves and in some cases are completely hidden by these. The perianth is gamotepalous, at least in the bud, and bears 2–4 terminal lobes. The number and position of these lobes is normally constant within a genus. In *Sarcocornia* there are two lateral lobes, an outer adaxial lobe and usually an abaxial lobe (which may be very reduced); in *Halosarcia* there are two lateral lobes and an abaxial lobe which may be either inside or outside the two laterals; in *Tecticornia* there are two lateral lobes; in *Tegicornia* there are two lateral lobes and an inner abaxial lobe; in *Pachycornia* there are two lateral lobes; while in *Sclerostegia* there are two lateral lobes with or without an inner abaxial lobe.

The imbrication of the lateral lobes follows a regular pattern; the situation can be most readily observed in *Halosarcia* where the flowers are always in triads and, depending on the species, the outer florets always have one or other of two possible types of imbrication. In some species, e.g. *H. halocnemoides* and *H. pergranulata* the outer florets usually have the outer lateral lobe overlapping the lobe nearest to the central floret (Fig. 5C–D), in others, e.g. *H. indica* the reverse is the case (Fig. 5A–B). The central floret has its imbric-

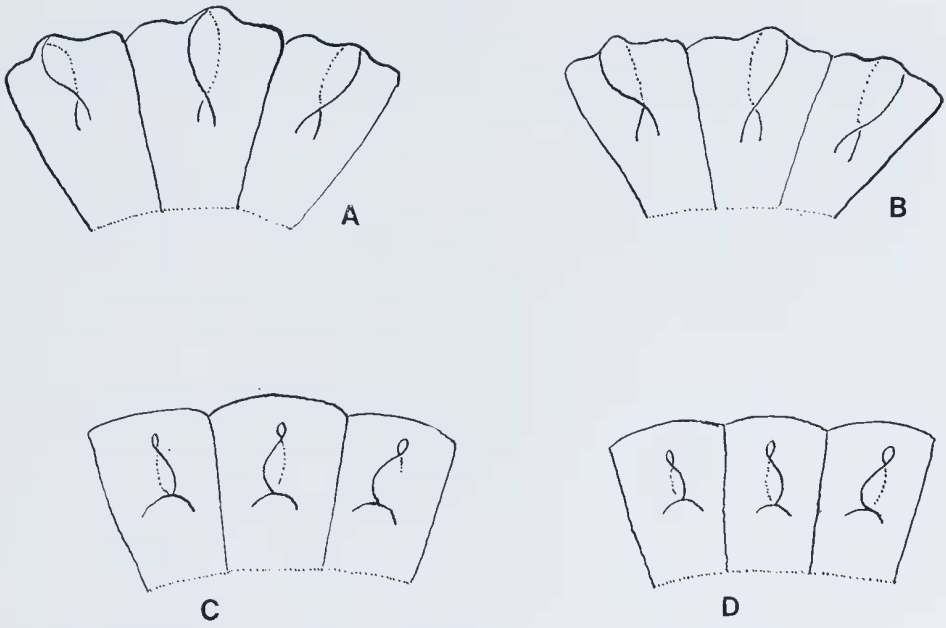

Figure 5. Imbrication of perianth lobes showing opposite triads: A and B—*Halosarcia pruinosa;* C and D—*Halosarcia pergranulata.*

ation in either symmetry (i.e. overlapping to the right or to the left) and varies up the spike in a manner which has not yet been determined; however, the opposite triads have the imbrication of all three florets as mirror images of each other (Fig. 5). The lobes of the perianth are best observed in the bud since in some species the orifice is small and the emergence of the relatively massive anther may cause the perianth to split or the lobes to be displaced. The type of imbrication is somewhat correlated with the shape and texture of the perianth and the shape of the seed; thus those species in which the perianth has a rounded apex, remains soft, and in fruit tears away from its sunken base, typically have the imbrication as in *H. halocnemoides*, while those in which the perianth is obtuse to acute, becomes variously hardened in fruit, and falls entire from the spike, usually have the imbrication as in *H. indica.*

The vasculature of the perianth has not been fully clarified and is itself involved in the larger problem of the vasculature of the axillary cyme. However, certain general principles are apparent. In *Sarcocornia quinqueflora* and *S. blackiana* there are four traces which separately pass from the cymule stele to the base of the perianth, one to each of the four sides (Fig. 6). They terminate in the tissue made up of the fused portions of the perianth base, the upper or lower bracts, and the radial plates which extend between the flowers from the inflorescence axis (see paragraph on Fruit); as there is here no differentiation between the floral and axial (or bracteal) tissues it is not possible to determine whether the traces penetrate the perianth itself or remain in the axial or bracteal tissues. In *Halosarcia lepidosperma* there are three traces, one of which passes to the abaxial margin of the perianth base and the others to its sides; again the traces terminate within the indefinite axial-perianth tissue (Fig. 3). In all cases the traces bifurcate at their ends to form club-shaped spurs (tracheoids). The three traces in *Halosarcia* flowers may indicate the presence of vestiges of bract and bracteoles, especially as the traces do not actually penetrate the free perianth tissue; however, since four traces are present in *Sarcocornia* the probability is that in both genera they are perianth traces, related in number and position to the perianth lobes (four in *Sarcocornia*, three in *Halosarcia*). In *Tegicornia uniflora* only one trace has been observed and this is abaxial; in this species, however,

the inflorescence stele is extremely condensed and remains of the other traces may have been lost (Fig. 4). Perianth traces have not been observed in such species as *H. indica* and *H. pruinosa* where the flower is not 'sunk' into the inflorescence axis and this possibly provides support for a bracteole origin of the traces since in these species there is no non-floral axial tissue which might represent vestigial prophylls.

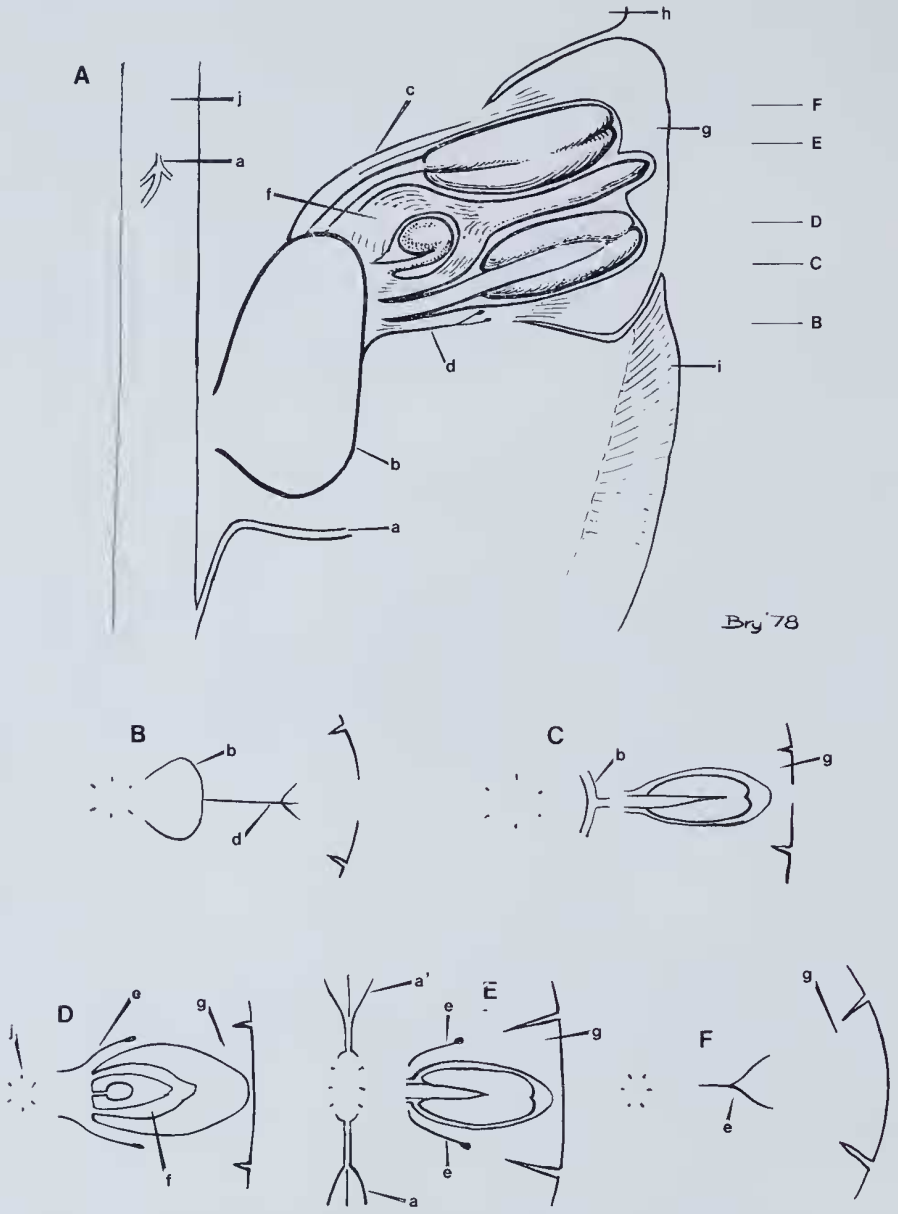

Figure 6. *Sarcocornia quinqueflora*, vasculature of inflorescence: A—L.S. through central flower; B to F—T.S. through central flower at different levels (a—bract traces, b—stele of axillary cymule, c—trace to adaxial side of flower, d—trace to abaxial side of flower, e—traces to lateral side of flower, f—ovary, g—perianth, h—upper bract, i—lower bract, j—stele of axis).

The perianth at anthesis may be succulent or membranous; at the fruiting stage it may have changed in texture to become spongy, brittle or pithy. The ovary wall may initially be membranous or fleshy, while in fruit it can be brittle or woody; in some of those species with a membranous pericarp this may fuse with the perianth and is very difficult to discern.

Fruit: In *Sarcocornia* the fruitlets (perianth with pericarp and seed) tear away from the inflorescence leaving a number of deep depressions in its broad axis; these apparent depressions appear to be caused by the intrusion of the axial tissue between the flowers to form plate-like septa to which the basal sides of the perianth are fused. These septa remain on the spike (with a portion of adherent perianth) since the abscission zone develops between the free perianth and the plates. The axial portion of the perianth is here extremely thin and breaks down with the ripening of the seed: thus, when the fruitlets fall, the seed protrudes from their base with the remains of the pericarp adherent to it, or the seed may for a short time remain attached to the axis while the perianth and pericarp fall away.

In some species of *Halosarcia* (e.g. *H. halocnemoides*) the fruitlets also tear away from the radiating plates of the spike axis, exposing the seed and leaving behind a portion of the perianth and pericarp; but in the majority of species (e.g. *H. pruinosa*) the fruitlets drop entire leaving only a small scar or depression on a comparatively slender axis; in these species there are no interfloral axial septa but the flowers are attached along their narrow base to the inflorescence axis. In several species of *Halosarcia* (e.g. *H. syncarpa*) the fruitlets are not immediately shed when mature but remain attached to the axis and enclosed within the bracts while the spike apex continues growth vegetatively: the fruitlets are eventually cast off, along with the surrounding bracts and cortical tissue, on the formation of periderm and the onset of secondary thickening in the spike axis (which has now become part of the branch).

In *Pachycornia* the seed is surrounded by the bract bases and the broad inflorescence axis both of which become lignified; it presumably germinates only on the decay of the infructescence.

In *Sclerostegia* the seed is always surrounded by a hard pericarp which may be free from the axis (as in *S. disarticulata*), embedded in it (as in *S. tenuis*), or occupy an intermediate state.

Seed: In the *Salicornieae* the seed provides diagnostic characters for the discrimination of both genera and species. At the species level it is of particular importance since the seed is one of the few organs not materially altered on drying. The seed coat is composed of two layers, an inner membranous layer (the tegumen) which is closely applied to the embryo and perisperm, and an outer layer (the testa proper); this outer layer is membranous in *Sarcocornia*, *Pachycornia*, *Sclerostegia*, and some species of *Halosarcia*, while in other species of *Halosarcia* it is hard and brittle. Generally speaking, the hardness of the testa in *Halosarcia* is inversely proportionate to the hardness of the pericarp or fruiting perianth. The Australian species in the genus *Arthrocnemum* (i.e. *Halosarcia*) were segregated into two sections by J. M. Black (1919) on characters based entirely on the hardness of the pericarp and the testa; while this produced a neat distinction in the material available to him, now that far more species are known, some of which exhibit a variety of intermediate characters, the use of these criteria for an infrageneric classification is no longer tenable.

The embryo is horse-shoe shaped in *Pachycornia* and *Sarcocornia* but is straight or curved in the other genera; other characters, however, suggest that relationships of *Pachycornia* are more with *Sclerostegia* and *Halosarcia* than with *Sarcocornia*.

The albumen in the seed of Chenopodiaceae is largely stored as perisperm (Mohabale & Solanky, 1954; Hindmarsh, 1966; Corner, 1976). This is present in the mature seed of all genera of Australian *Salicornieae* except *Sarcocornia*. The endosperm is largely absorbed by the developing embryo and normally only a few layers remain around the radicle.

Sex: The flowers in most genera of the *Salicornieae* are basically hermaphrodite but they may be functionally female through the failure of the stamens to fully develop; the latter state is especially noticeable in flowers borne towards the apex of an inflorescence.

In *Tegicornia* the plants are strictly dioecious while in both *Pachycornia* and *Sclerostegia* the lateral flowers of a triad are male and the central hermaphrodite. In *Halosarcia indica* only plants bearing female flowers have been observed in India and Africa*; in Australia at some localities only female plants have been found whereas in others the species is hermaphrodite. In spite of the apparent absence of either male or hermaphrodite flowers, plants of *H. indica* which were observed by the author at Townsville, Queensland set seed in abundance. In several other species of *Halosarcia* at some localities only female plants have been noted and in these the style and stigmas are often folded back on top of the ovary and remain within the perianth; seed is formed, and apparently without fertilization being possible. (See also comments under *H. pergranulata* ssp. *queenslandica* and *H. leptoclada*.)

Both apomixis and dioecy are probably far more widespread in the Australian *Salicornieae* than is reported here. Herbarium material, however, does not provide a good guide to the prevalance of these phenomena since abortion of stamens is of frequent occurrence and appears to be often related to environmental factors.

Taxonomy

When Linnaeus wrote the first edition of his Species Plantarum (1753) he recognised only one genus, *Salicornia*, in the group here referred to the Salicornioideae. Robert Brown (1810) was the first person to describe a member of this subfamily from Australian material (*Salicornia arbuscula*); at the same time he recorded *S. indica* Willd. as being present in Australia although the specimens he referred to this name in fact belonged to other species.

In the first half of the 19th century several genera were described as segregates, or as close relatives of the genus *Salicornia*, and into three of these were placed species based on Australian types, or species that had been recorded from Australia. The genera with Australian representatives were *Halocnemum* Bieb. (1819), *Sarcatlria* Raf. (1837), and *Arthrocnemum* Moq. (1840). A non-specialist, working with very imperfect material, has difficulty in assessing the merits of the different genera, and it is not surprising that Bentham (1870), when writing up the *Salicornieae* for the Flora Australiensis, chose to recognise only one genus, *Salicornia;* he noted that the material available to him was unsatisfactory and that living plants should be examined in order to obtain a proper appreciation of taxonomic affinities. Subsequently J. D. Hooker (1880) described two further genera, *Tecticornia* and *Pachycornia*, in both cases basing them on a single Australian species; he also recognised the presence in Australia of the genus *Arthrocnemum*, in which decision he was largely following the revisions of the *Salicornieae* by Ungern-Sternberg (1866, 1876). The circumscription adopted by J. D. Hooker for Australian taxa was accepted by Volkens (1892) and in a modified form by Ulbrich (1934). The only person after Bentham to revise the Australian *Salicornieae* as a whole was J. M. Black (1919) who distinguished the same genera as those recognised by Hooker. Black noted the importance of the seed characters when circumscribing species but unfortunately many type specimens were not available to him and the material he studied was seldom in a condition suitable for critical analysis.

* Tölken (1967) records having observed a stamen in some flowers in material from Lourenco Marques.

The genera within the subfamily Salicornioideae were reviewed by A. J. Scott (1978) who described a new genus *Sarcocornia* into which he placed the perennial species of *Salicornia* (including the two Australian members). He also re-established the lectotypification of the genus *Arthrocnemum* by the species now correctly known as *A. glaucum* (Delile) Ung.-Sternb.;* this action will be further discussed since it affects the names of many Australian taxa.

During the present investigation of the Australian *Salicornieae* it became apparent that the accepted generic concepts, even after the paper by Scott, inadequately catered for the variation found within that tribe. It was further apparent that, except for the species here placed in *Sarcocornia*, the Australian species (irrespective of genus) showed greater affinity to each other than they did to any non-indigenous species. The *Salicornieae* of Australia have therefore, except for *Sarcocornia*, probably evolved from a common ancestor within that country.

The Australian *Salicornieae* can be divided into two very distinct groups. In the first group is found *Sarcocornia* which is distinctive in possessing the following characters:

(1) Sclereids present in chlorenchyma tissue.
(2) Flowers with an adaxial perianth lobe.
(3) Flowers with both an adaxial and an abaxial stamen.
(4) Absence of albumen (perisperm) in the seed.

The remaining members are fairly uniform in flower morphology and it is only by a combination of characters that they may be discriminated. They have in common the following characters:

(1) Absence of sclereids in chlorenchyma tissue.
(2) Flowers without an adaxial perianth lobe.
(3) Flowers with a single (abaxial) stamen.
(4) Abundant albumen (perisperm) in the seed.

Within this second group a number of endemic (or nearly endemic) genera have been segregated out leaving the bulk of the species in the genus usually known as *Arthrocnemum*. As recognised by Scott (1978) this genus, in addition to the Australian species, contains one species in California and another in the Mediterranean-Indian area. The two extra-Australian species (*A. subterminale* (Parish) Standley and *A. glaucum* (Delile) Ung.-Sternb.) are distinctive in having plain sclereids in the chlorenchyma tissue and in having two stamens to each flower, one adaxial and the other abaxial in position; they are therefore intermediate in character between the genus *Sarcocornia* and the Australian members of "*Arthrocnemum*". The two groups of species I consider to be sufficiently distinct to warrant separation as separate genera. This then raises the question as to which group should bear the name *Arthrocnemum*.

The lectotypification of the name *Arthrocnemum* was discussed by Scott (1978). The genus as originally defined by Moquin-Tandon (1840) included species here considered to belong to five genera; e.g.:

(1) *Halostachys* (i.e. *A. belangerianum* Moq.).
(2) *Sclerostegia* (i.e. *A. arbuscula* (R.Br.) Moq.).
(3) *Sarcocornia* (i.e. *A. fruticosum* (L.) Moq. and *A. fruticosum* var. *radicans* (Sm.) Moq.
(4) 'Extra-Australian' *Arthrocnemum* (i.e. *A. fruticosum* var. *macrostachyum* (Moric.) Moq. and var. *glaucum* (Delile) Moq.)
(5) 'Australian' *Arthrocnemum* (i.e. *A. indicum* (Willd.) Moq.)

* See note added in proof p. 152.

Moquin later (1849) modified his original circumscription of the genus and it was further defined by Ungern-Sternberg (1866, 1876) who retained of the original species only *A. indicum*, *A. arbuscula*, and *A. macrostachyum* (Moric.) C. Koch (which had been treated by Moquin as a variety of *A. fruticosum*). The genus was first lectotypified by Standley (1916) on "A. fruticosum Moq." by which he evidently meant *A. fruticosum* (non (L.) Moq.) sensu Moq. (i.e. *A. macrostachyum*) since he included *Salicornia fruticosa* (L.) L. (which is based on the same name as *A. fruticosum*) in *Salicornia* (see also Standley, 1914). This lectotypification was re-iterated by Ulbrich (1934) and accords generally with Moquin's concept of the genus. Unfortunately, in a posthumous paper by Moss (1954), the type species is stated to be *A. fruticosum* (L.) Moq., which statement was repeated by Tölken (1967), and by the Index Nominum Genericorum where, however, the typification is incorrectly referred back to Ulbrich. It is apparent that the lectotype has to be selected from one of the three species retained in the genus by Ungern-Sternberg of those originally included by Moquin; the choice is therefore between *A. indicum*, *A. arbuscula*, and *A. macrostachyum* (= *A. glaucum* (Del.) Ung.-Sternb.).

The lectotypification of the genus *Arthrocnemum* is critical for the nomenclature of Australian Salicornieae, since if, as stated by Moss (1954) and Tölken (1967), the type is *A. fruticosum* (L.) Moq. then those species now included in *Sarcocornia* would have to be transferred to *Arthrocnemum* and the species at present placed in the latter genus would require a new generic name. If *A. indicum* is chosen then the Australian species currently referred to *Arthrocnemum* would remain in that genus but the two non-indigenous species would require a new generic name. If *A. arbuscula* is selected then the name *Arthrocnemum* would become synonymous with (and would replace) the name *Sclerostegia*. The remaining alternative is that adopted, in effect, by Standley (1916) and Ulbrich (1934), and which has been recently re-iterated by Scott (1978): to choose *A. glaucum* as the lectotype.

Of the four alternatives only three can be seriously considered since the species *A. fruticosum* had already been excluded from the genus by Ungern-Sternberg (1866 and 1876) and his circumscription was followed by Hooker (1880), Volkens (1892), Standley (1916) and Ulbrich (1934). The two names *A. indicum* and *A. arbuscula* have never been proposed as types. It therefore remains only to accept *A. glaucum* as the type. *Arthrocnemum glaucum*, with *A. subterminale* (Parish) Standley, is here considered to be generically distinct from the Australian species currently included in that genus; the Australian taxa are therefore here placed in a new genus *Halosarcia*.

Systematic Position

It is not intended in this paper to critically discuss the rank to which the group colloquially called samphires should be accorded, except to remark that it is considered by all recent workers to be a natural group clearly separable from, although obviously closely related to, the rest of the Chenopodiaceae. The group of genera that developed around the name *Salicornia* was first recognised as belonging to a distinct tribe, the "*Salicornieae*", by Dumortier (1827); subsequently most taxonomists have accepted the circumscription and rank of this taxon. However, J. D. Agardh (1858) recognised it as a family ("Salicornieae") and Ulbrich (1934) as a subfamily (Salicornioideae) of the Chenopodiaceae. Ulbrich divided the Salicornioideae into two tribes, the *Haplopeplideae* and the *Salicornieae*, the latter being subdivided into the subtribes *Halostachyinae* and *Salicorniinae*; all the Australian genera were referred to the tribe *Salicornieae* with *Tecticornia* in the *Halostachyinae* and the rest in the *Salicorniinae*. The distinction made by Ulbrich in recognising these two subtribes was basically as to whether the opposite bracts of the inflorescence articles were united or free. That this is not a natural character for use in subdividing the Australian representatives is apparent from the lack of correlation between this and other characters; in fact in this present treatment the genera *Halosarcia* and *Sclerostegia* both contain species with free bracts and species with united bracts. In some species

spikes on the same plant may have both free and united bracts, while one species (*Halosarcia pterygosperma*) exhibits a transition in its morphology from spikes with clearly united bracts (in southern Western Australia) to those in which they are quite free (in the vicinity of Carnarvon).

Recently Scott (1978) reinstated the family Salicorniaceae. He supported this action largely on the unique morphology of the stem and leaves since the floral characters by themselves do not permit a clear separation from the rest of the Chenopodiaceae. This does not appear to be sufficiently substantial to warrant recognition of the samphires as representing a distinct family and I have retained the broad concept adopted by Ulbrich (1934) and most other workers. Both Scott and Ulbrich recognised the tribe *Salicornieae*, into which they place all the samphire genera found in Australia.

No attempt is here made to erect a new generic classification within the Australian *Salicornieae*. The genus *Tecticornia*, which seemed at first to be so distinct (Wilson, 1972) is clearly linked to the genus *Halosarcia* through *H. flabelliformis*. The genus *Sclerostegia* approaches on the one hand *Pachycornia* in its floral morphology, and on the other (through *S. arbuscula*) members of the genus *Halosarcia*. The genus *Sarcocornia* is clearly distinct from the other Australian genera although closely related to *Salicornia*.

The name 'Samphire'

The members of the *Salicornieae* are, in Australia, generally referred to as 'samphires', although in some recent floras the name 'glasswort' is preferred. The word samphire is derived from the earlier English name 'samperc' which itself comes from the French name 'herbe de St. Pierre'; this name was initially applied to *Crithmum maritimum*, a coastal member of the Apiaceae, which was (and still is) eaten either fresh or as a pickle. The English coastal plant *Salicornia europaea* is also used in this way and presumably for this reason was sometimes also called samphire; the name subsequently became applied to all the succulent articulate chenopods.

The common name 'glasswort' is another early English name for species of *Salicornia* and arose from the use of the ashes of these plants in the manufacture of glass.

Citation of Specimens

Only a selection of herbarium specimens of each species is cited except for those taxa which have been seldom collected. An attempt has been made to map all records which indicate a significant extension of the range of a species.

Subfamily Salicornioideae, Tribe Salicornieae

Shrubs or *herbs* with succulent apparently articulate branches. *Leaves* opposite, connate (alternate and amplexicaule in one extra-Australian genus), forming an insignificant, fleshy, bilobed rim at the apex of each article (internode). *Flowers* hermaphrodite or unisexual, sessile, arranged in a spike-like thyrse usually made up of axillary 3-flowered cymules; secondary bracts or bracteoles absent. *Perianth* gamotepalous, (2) 3-4 lobed, frequently succulent. *Stamens* 1 or 2, free, placed in anterior-posterior position; anthers 4-locular (tetrasporangiate). *Ovary* sessile; stigmas 2 (3). *Fruiting* perianth and pericarp membranous to spongy or crustaceous. *Seed* vertical; testa membranous to crustaceous, smooth or variously ornamented; perisperm abundant or absent; embryo straight, curved, annular, or hippocrepiform and incumbent.

Type genus: *Salicornia* L.

Key to Genera

1. Perianth with truncate or rounded apex (outer face); stamens two; seeds orbicular, embryo horseshoe-shaped, perisperm absent ..... 5. **Sarcocornia**
1*. Perianth various; stamens solitary, seeds with perisperm 2
2. Flowers solitary in axil of foliage leaves ..... 3. **Tegicornia**
2*. Flowers in opposite 3-flowered cymules (triads), usually in spike-like inflorescences 3
3. Lateral flowers of triad male, central hermaphrodite 4
3*. Flowers of triad hermaphrodite or female 5
4. Leaf lobes prominent, fleshy, divaricate; embryo annular ..... 1. **Pachycornia**
4*. Leaf lobes insignificant, scarious; embryo ± straight ..... 2. **Sclerostegia**
5. Opposite bracts united ..... 4. **Halosarcia**
5*. Opposite bracts free from each other 6
6. Plants woody perennials or shrubs; perianth gamotepalous ..... 4. **Halosarcia**
6*. Plants annuals or short-lived perennials; perianth of two succulent (eventually free) laterally placed tepals ..... **Tecticornia**†

1. **Pachycornia** Hook.f.

Hook.f. in Benth. et Hook.f., Gen. Pl. 3:65 (1880); Volkens in Engler et Prantl, Nat. Pflanzenfam. III. 1a:77 (1892); J. M. Black, Trans. Roy. Soc. S. Austral. 43:363 (1919); Ulbrich in Engler et Prantl, op.cit. ed. 2. 16c:549 (1934); A. J. Scott, Bot. J. Linn. Soc. 75:369 (1978).

Dwarf *shrubs* with succulent stems. *Leaves* opposite, of short fleshy spurs apparently decurrent along internode. Inflorescence a spike-like thyrse consisting of triads of flowers borne in the axils of opposite decurrent bracts. *Flowers* dimorphic, the lateral male and the central hermaphrodite. *Perianth* gamotepalous, membranous, unchanged in fruit. *Stamens* solitary (abaxial in central flower). *Ovary* with a solitary ovule attached to base; stigmas two, narrowly triangular, papillose. *Fruit:* pericarp hard, fused to and sunken into the woody spike axis. *Seed* orbicular; testa thin; embryo annular; perisperm central.

Type species: *P. triandra* (F. Muell.) Black

A single species endemic to Australia.

Origin of name: from a Greek word *pachy* = thick and a Latin word *cornu* = a horn, but also evidently cognate with the name *Salicornia* which is a latinization of the French word '*salicot*'.

1. Pachycornia triandra (F. Muell.) J. M. Black, Fl. S. Austral. 206 (1924). Fig. 11.

Arthrocnemum triandrum F. Muell., Fragm. 1:139 (1859).—*Salicornia robusta* F. Muell., Fragm. 6:251 (1868) nom. superfl., based on preceding; Benth., Fl. Austral. 5:202 (1870).—*P. robusta* (F. Muell.) Bail., Hist. Pl. 9:184 (1888) comb. illeg.; A. J. Ewart, Pl. Indig. Victoria 2: tab. 83 (1910); J. M. Black, Trans. Roy. Soc. S. Austral. 43:363 (1919).—*S. triandra* (F. Muell.) Druce, Rep. Bot. Exch. Cl. Brit. Isles 1916:644 (1917).

Lectotype: "Near above the junction of the Darling on the Murray and on the lower Darling as far down the Murray as Lake Victoria", Dec. 1853, *F. Mueller* (holo: MEL 71400) lecto. nov.

Divaricately branched bright green *subshrub* ca. 50 cm high. *Internodes* cylindrical 1–2 cm long with thick rigid acute lobes ca. 3 mm long that are ciliolate towards their base; at union of lobes arise opposite ciliolate grooves which run for length of internode. *Spike* broadly ovoid, 1–2 cm long, 0·8–1·2 cm wide, bracts congested, the lobes acicular and strongly divaricate forming a decurrent groove at their union. *Flowers* steeply ascending, ca. 4 mm long, free (except near their base) from each other and from upper and lower bracts. *Perianth* membranous, dorsiventrally compressed, irregularly fimbriate

† See P. G. Wilson (1972).

at the terminal aperture; central floret with a pair of abaxial imbricate lobes (lateral florets with indefinite lobing). *Anther* oblong, ca. 3 mm long, filament stout. *Ovary* vertical, succulent, fused to spike axis; style firm, narrowly oblong (dorsiventrally flattened), not exserted; stigmas narrowly triangular. *Fruiting spike* scarcely expanded; axis and base of bracts thick and woody; bracts pithy but firm; perianth membranous; pericarp thick, horny, fused to and apparently sunken into the woody axis. *Seed* orbicular, ca. 2 mm diameter; testa membranous, smooth, brown; embryo annular; perisperm central. Seed released by decay of spike.

Habitat: Usually in heavy somewhat saline soil; it has been recorded from gravelly or sandy situations but in these, presumably, the soil is underlain by clay.

Distribution: Eremaean areas of inland Australia. Map 1.

New South Wales: Wentworth, Sept. 1912, *H. B. Williamson* (MEL); Junction of Darling and Murray Rivers, May 1887, *W. J. Holding* (MEL).

Victoria: Merbein, May 1937, *J. H. Willis* (MEL); 1 mi E of Berribee Tank, 31 Aug. 1948, *J. H. Willis* (MEL).

South Australia: Charlotte Waters, 1889, *W. Schwartz* (MEL); Mildura, 1894, *C. French* (MEL); Lake Gardner, *J. Z. Weber* 3330 (PERTH).

Western Australia: Balgo Downs, *H. Demarz* 5230 (PERTH); Mongers Lake, *M. Koch* 1374 (PERTH); Zanthus, *R. D. Royce* 5359 (PERTH); 4 mi E of Kalgoorlie, 5 Aug. 1971, *J. Verschuer* (PERTH).

Northern Territory: 2 mi W of Maryvale HS., 4 July 1955, *G. Chippendale* (NT); 2 mi N of Rodinga, *P. K. Latz* 1853 (PERTH); 6·5 mi S of Alice Springs, *D. J. Nelson* 505 (PERTH).

Pachycornia triandra is remarkable in having very prominently lobed articles which possess opposite grooves decurrent from the junction of the lobes and beneath which the palisade tissue is lacking; the general appearance being similar to that of a *Salsola* species. The circular seed with its horseshoe-shaped embryo and central perisperm is also distinctive. Secondary thickening of the spike axis due to cambial activity does not take place although there is a slight increase in thickness with the maturation of the seed. However, the base of the bracts, the pericarp, and the broad axis of the spike, become lignified, which is the cause of the eventual solidity of the whole structure. This condition, then, is fundamentally different from that in *Sclerostegia tenuis* where the woody spike axis undergoes secondary growth.

Since the infructescence does not continue growth it dies after the maturation of the seed. However, the structure remains on the plant for some time, possibly several years, until the decay of the axis causes it to break off. In some cases this would appear not to take place until the death of the whole plant.

The genus *Pachycornia* was enlarged by Black (1919) so as to include *Sclerostegia tenuis*, and Scott (1978) logically added the closely related species *S. arbuscula*. Each of these species (and the newly described species in *Sclerostegia*) has a similar type of inflorescence in which the lateral flowers are male and the central hermaphrodite; they also have similar perianths and stigmata. The unique characters which distinguish *P. triandra*, and which I consider to be of generic significance, are the vegetative morphology (large leaf-lobes and decurrent grooves), the annular embryo, and the lignification of the inflorescence axis and bract bases.

2. **Sclerostegia** P. G. Wilson, gen. nov.

Fruticulus quasi aphyllus, articulatus, glaber. *Folia* succulenta opposita cauli adnata, apice modice dilatata sub-2-loba. Inflorescentia: spicoidea congestae, floribus lateralibus masculis, centralibus hermaphroditis. *Flores:* perianthium gamotepalum breviter 2-3-lobum; stamen solitarium, abaxiale; ovarium ovoideum, apice in stylo robusto attenuatum. *Fructus:* perianthium persistens utriculo includens; pericarpium durum semine omnino includens. Semen erectum, ovoideum; testa tenuiter crustacea, ± laevia; embryo rectus vel leviter curvatus; perispermium copiosum, laterale.

Type species: *Sclerostegia tenuis* (Benth.) P. G. Wilson (*Salicornia tenuis* Benth.)

Dwarf *shrubs*, seemingly leafless, glabrous; branches when young of articulated cylindrical to spherical segments (internodes) which are cup-shaped to two-lobed at apex; segments succulent, the fleshy outer portion ultimately shrivelling and falling away from the woody axis. *Inflorescence* either a spike-like thyrse consisting of triads of flowers (cymes) immersed in the axils of each fleshy bract, or of triads dispersed among the branch segments; bracts free from each other or united in opposite pairs. *Flowers* dimorphic, horizontal to almost vertical in position, the central one of the triad hermaphrodite and the lateral ones male; perianth gamotepalous, membranous or fleshy, with a pair of laterally placed imbricate lobes on the anterior (abaxial) side of the orifice and sometimes a small abaxial inner lobe; stamen solitary (abaxial in hermaphrodite flower); style short and stout, passing into the ovary; stigmas 2, narrowly triangular, papillose. *Fruit:* perianth remaining membranous or, when originally succulent, becoming shrivelled; pericarp firmly crustaceous or woody. *Seed* ovoid; testa thin, smooth or faintly granular over the embryo; embryo straight or slightly curved with the radicle inferior; cotyledons conduplicate; perisperm copious, lateral.

Five species, all endemic to Australia (including Tasmania).

Origin of the generic name: from the Greek words *scleros* (hard) and *stegos* (shelter); referring to the hard pericarp.

The genus *Sclerostegia* may be distinguished from the other members of the Salicornieae by a combination of two characters, (1) the dimorphic flowers, the central one of the triad being hermaphrodite and the lateral ones male, and (2) the straight or only slightly curved embryo with copious lateral perisperm. The first character by itself clearly differentiates it from all other members of the tribe except for *Pachycornia;* this genus is distinguished by its annular embryo and by its unique vegetative characters.

Sclerostegia tenuis, *S. medullosa*, and *S. moniliformis* possess membranous perianths which persist in this condition even when in fruit. In these three closely related species the flowers are nearly vertical in position, with the apertures (which are dorsiventrally flattened) at their summit. The aestivation of the perianth lobes is not clear; in some flower buds studied there was a pair of laterally placed conduplicate lobes (with each of the lobes over-lapping on one of its margins and under-lapping on its other); in other flowers only the imbrication on the abaxial side of the perianth could be distinguished, the adaxial lobing being either absent or not apparent. In all cases only the aestivation of the central hermaphrodite florets was noted since that of the lateral florets is difficult to observe. In *S. arbuscula* the perianth is succulent and fused to the upper bract but the flowers are otherwise similar to those of the preceding three species. In *S. disarticulata* the flowers are almost horizontal, the perianth succulent, and the aperture on the outer truncate face. In this case there is a pair of large lateral imbricate lobes and a smaller inner abaxial lobe which links the lateral pair together.

In all species of *Sclerostegia* the pericarp becomes hard and completely encloses the seed which has only a thin testa. In *S. moniliformis*, *S. medullosa*, and occasionally in *S. arbuscula*, the 'spike' (or fertile branch) continues growth vegetatively and the shrivelled bracts eventually become sloughed off along with the old flowers and fruit. In *S. tenuis* the spike-axis always undergoes thickening and lignification. The stele of this axis consists (in the mid internodal position) of two sets of vascular strands, one set on each side of the transversely placed axis (see Fig. 14F). Lignification and eventual secondary thickening of the stele results in the formation of two opposite vertical bands between the pairs of triads (the bands being therefore opposite and decussate, changing their position at each node) causing the fruit to become more and more deeply imbedded in the spike axis. As the stele undergoes this thickening the woody pericarp also grows in thickness although not so markedly.

Key to the species of Sclerostegia

1. Spikes with the opposite bracts free from each other ..... 1. **S. disarticulata**
1*. Spikes with the opposite bracts clearly united, or the flowers not in spikes but in the axils of the leaves along the branches 2
2. Perianth fleshy; style hard and protruding in fruit (especially when dry) ..... 2. **S. arbuscula**
2*. Perianth membranous; style not protruding 3
3. Fertile and vegetative articles alike, cylindrical; leaf lobes markedly denticulate; pericarp not embedded in a woody axis ..... 5. **S. medullosa**
3*. Fertile and vegetative articles either dissimilar or the former not cylindrical 4
4. Fertile articles obovoid, becoming dry, globular to obovoid and pithy in fruit; pericarp crustaceous, not embedded in a woody axis ..... 3. **S. moniliformis**
4*. Fertile articles obovoid to cylindrical, becoming thick and woody in fruit; pericarp woody and embedded in the woody axis ..... 4. **S. tenuis**

1. **Sclerostegia disarticulata** P. G. Wilson, sp. nov. Fig. 12, 34.

Articuli doleiformes vel obovoidei 3–6 mm longi, apice breviter et obtuse lobato, margine integro (raro denticulato). *Inflorescentiae* terminales, vel laterales et pedunculatae, anguste cylindriceae, 5–10 (20) mm longae, 3–4 mm diam.; bracteae discretae, facie exteriore semicirculari. *Flores* horizontales, connati, apice truncati; flores laterales parvi, centrali magni. *Perianthium* succulentum, orificio in facie exteriore. *Fructus* late obovoideum, ca. 1·7 mm longus, in perianthio succulento (demum areolato) obtectus, ad flores laterales adnatus; pericarpium obovatum, omnino corneum. *Infructescentia* demum in parte discreta secedens.

Type: N. end of Mongers Lake, 28°46′S, 117°22′E, Western Australia, 6 Aug. 1969, *P. G. Wilson* 8603 (holo: PERTH, iso: CANB, K).

Divaricately branched rounded *subshrub* 0·3–1·5 mm high. *Branches* slender; articles fleshy, dolciform to obovoid 3–6 mm long, dull to bright green (often black when dry), apex very shortly and bluntly lobed, margin entire (or rarely denticulate). *Spikes* terminal, or lateral and then shortly pedunculate, narrowly cylindrical, 5–10 (20) mm long, 3–4 mm wide (2·5–3 mm in dried state); fertile articles 5–10 (20); opposite bracts free (or almost free) from each other, outer surface hemispherical, upper margin horizontal or slightly convex. *Flowers* in triads at right angles to spike axis, intimately fused to each other, at first adherent in proximal half to the upper bract; apex (outer exposed surface) of triad truncate and triangular, only partially obscured by subtending bract; lateral (male) flowers small, central (hermaphrodite) flower large. *Perianth* at first membranous at apex but eventually entirely fleshy with the aperture along the outer surface; lobes (of central floret) 3, a pair of long lateral and imbricate lobes and a small inner anterior (abaxial) lobe. *Anther* ca. 1 mm long. *Ovary* thick and fleshy, adherent (at first) to perianth and fused to spike axis along vertical length of flower; style not exserted; stigmas very narrowly triangular. *Fruit:* pericarp broadly obovoid, vertical, ca. 1·7 mm long, horny all over, surrounded by the thin fleshy (eventually areolate) perianth and fused to the lateral flowers. *Seed* vertical (parallel to axis of spike), ovoid, ca. 1·5 mm long; testa membranous, smooth, pale brown; embryo slightly curved. The spike, when mature, breaking up into separate bracts and triads, each of the latter consisting of an obovoid horny pericarp surrounded by the dry perianth and fused laterally to the small shrivelled male flowers; pericarp eventually dividing longitudinally to release seed.

Habitat: Many of the herbarium specimens (especially those from New South Wales) record the habitat as stony, or as a gravelly hillside, but the species is widespread along the southern margin of the Nullarbor Plain where it grows over limestone, while collections made in Western Australia from the more northern limits of its distribution appear to have come from clay pans. One specimen is stated to have been collected from the coast near Adelaide (C. M. Eardley, 19 April 1936, ADW 3208), but the environment here is so different from that of the other collections that the data are open to doubt.

Distribution: Central and southern Australia, in Eremaean and suberemaean areas, south of 26° lat. and east of 144° longitude. Map 2.

New South Wales: 18 mi W of White Cliffs, *E. F. Constable* 4600 (NSW); 16 km NW of Milparinka, *G. M. Cunningham* and *P. L. Milthorpe* 1097 (NSW); Tero Ck. Stn., 30°3′S, 142°50′E, 2 Dec. 1968, *P. Martensz* (AD, CANB, NSW).

South Australia: 3 km S of Leigh Ck., *Hj. Eichler* 12982 (AD); Evelyn Downs, 8 Oct. 1953, *E. H. Ising* (AD); 80 mi W of Penang, 6 Sept. 1962, *M. E. Phillips* (AD); 8 mi S of White Wells, 28 Aug. 1947, *J. H. Willis* (MEL).

Western Australia: 5 mi E of Kalannie, *K. M. Allan* 48 (PERTH); 9 mi N of Carnarvon, *T. E. H. Aplin* 1565 (PERTH); 2 mi E of Norseman, *J. S. Beard* 5204 (PERTH); 3 mi N of Coolgardie, *E. M. Bennett* 3257 (PERTH); 6 mi W of Hamelin Stn., *J. W. Green* 1409 (PERTH); Jimba Jimba, Gascoyne R., *C. A. Gardner* 6141 (PERTH); Windimurra Stn., 19 Aug., 1976, *V. Semeniuk* (PERTH); Jimba Jimba Stn., *D. G. Wilcox* 158 (PERTH).

Northern Territory: Henbury Stn., *T. S. Henshall* 789 (NT); Finke R., 1889, *W. F. Schwarz* (MEL); Glen Helen-Alice Springs Rd., 1 mi W of Ormiston Gorge turn-off, *A. C. Beauglehole* 24247 (PERTH).

Sclerostegia disarticulata exhibits little regional variation apart from that which might be expected from the same species growing in different environments. However, at Jimba Jimba, in the Gascoyne River area of Western Australia, is found a variant with more deeply lobed articles which, with the bracts, are prominently denticulate on their margins (Wilcox 158 and Gardner 6141).

The species may be recognised by its slender spikes with free opposite bracts, and by the manner in which the spike breaks up when mature into single bracts and compact triads each of which contains a single seed. The specific epithet has reference to the general disintegration of the mature infructescence.

2. Sclerostegia arbuscula (R.Br.) P. G. Wilson, comb. nov. Fig. 13A–D, 35.

Salicornia arbuscula R.Br., Prod. 411 (1810).—*Arthrocnemum arbuscula* (R.Br.) Moq., Chenop. Enum. 113 (1840).—*Halocnemum arbuscula* (R.Br.) F. M. Bailey, Synopsis Qld. Flora 409 (1883).—*Pachycornia arbuscula* (R.Br.) A. J. Scott, Bot. J. Linn. Soc. 75:369 (1978).

Lectotype: Port Dalrymple, Jan. 1804, R. Brown (3074) (holo: BM) lecto. nov.

Much branched *shrub* to 2 m high with ascending branches. *Articles* slightly glaucous or dull green, obovoid, ca. 5 mm long, shortly lobed, entire. *Spikes* terminal to both main and lateral branchlets (sometimes sessile), of 2–6 articles, slightly torulose (articles laterally compressed), succulent; bracts shortly lobed, united in opposite pairs and almost enclosing the flowers. *Flowers* ascending, intimately fused to each other and to the upper bract, free from the lower; lateral flowers (these occasionally aborted) male and smaller than the central hermaphrodite flower. *Perianth* fleshy at lateral margins and apex, membranous abaxially with the aperture at or just below the apex on the outer face; lobes 2, lateral, rounded and overlapping but becoming obscure with emergence of style and anther, sometimes also with a small abaxial lobe. *Ovary* fused along vertical length of spike axis, passing distally into a short stout style; stigmas narrowly triangular. *Fruit:* perianth shrivelled, weak; pericarp thick and hard, deltoid in lateral view and passing into the thick hard persistent style which is exserted from the perianth. *Seed* vertical, elliptic, ca. 1·5 mm long; testa pale brown, thin, smooth except for faint granulation over radicle; embryo slightly curved, perisperm lateral.

Habitat: Sclerostegia arbuscula (in its typical form) is coastal or near coastal in its distribution and frequently occupies marshes subject to occasional inundation by the sea.

Distribution: Principally in coastal areas of southern New South Wales, Victoria, Tasmania, South Australia, and south east Western Australia. Map 3.

New South Wales: Currarong, 20 June 1970, *L. A. S. Johnson* (NSW).

Victoria: Griffith Is., *A. C. Beauglehole* 19487 (PERTH); Goat Is., *A. C. Beauglehole* 32158 (PERTH); Hastings, Jan. 1937, *A. Meebold* (NSW); Port Phillip, 1848, *F. Mueller* (MEL).

Tasmania: C. Wickham, King Is., 1885, *Dobson* (MEL); Ralph Bay, *F. H. Lang* 138 (HO); Double Creek, 28 Feb. 1976, *J. W. Parham* (PERTH); S arm of R. Derwent, *F. A. Rodway* 7154 (NSW).

South Australia: Point Riley, *B. Copley* 1300 (AD); 1·5 km N of Prospect Hill, Kangaroo Is., *Hj. Eichler* 15479 (AD); Outer Harbour, Pt. Adelaide, *M. A. Fagg* 120 (AD); Coobowie Inlet, Yorke Pen., *D. N. Kraehenbuehl* 1978 (AD); Fowlers Bay, 29 Sept. 1959, *D. E. Symon* (ADW).

Western Australia: 2 km NW of Pt. Charles, Fitzgerald R., *K. Newbey* 4028 (PERTH); Israelite Bay, *P. G. Wilson* 10079 (PERTH).

Sclerostegia arbuscula may be readily distinguished from other species of the genus, and from those of related genera, by the presence of a hard protruding style when in fruit; this character is even more pronounced in the dried state.

In *Sclerostegia arbuscula* the spikes typically terminate a branchlet although occasionally one may resume growth to form a vegetative branch. Normally the bracts and perianths become dry and the spike breaks up into separate articles, each of which contains a pair of opposite fruitlets. Further disintegration presumably occurs on the decay of the articles. Where the spike has continued growth to form a branch the fruitlets may remain attached to the axis for up to at least one year and then fall away with the decay of the bract tissue.

Bentham (1870) confused *Sclerostegia arbuscula* with *H. halocnemoides* and *H. syncarpa* (a species which at that time was undescribed); much of the material cited by him (under *Salicornia arbuscula*) belongs in fact to these latter species.

In the eastern States and in South Australia the fertile articles are somewhat laterally compressed so as to produce an uneven appearance to the spike, whereas in Western Australia the articles are circular in cross-section.

At Israelite Bay on the south coast of Western Australia *S. arbuscula* and *S. moniliformis* grow together. Some plants intermediate in form between these two species have been collected in that area and the fact that these plants are apparently sterile suggests that they are of hybrid origin. Examples are as follows:

Western Australia: Israelite Bay, *R. Huatiuk* 761206, 761233 (PERTH); ibid., *R. D. Royce* 6302 (PERTH).

A plant with similar flowers to those of *S. arbuscula*, but with a very different inflorescence and habit, has been collected in South-western Western Australia (12 km W of Koninin, *P. G. Wilson* 10240, PERTH and Mt. Caroline, 1886, *Mrs. G. R. Sewell*, MEL 71557). In this plant the spikes are sessile, ellipsoidal in form (circular in cross section), and are divaricately spreading, while the pithy bracts retain their shape on drying. No material with mature seed has been collected and the nature of this taxon is at the moment obscure.

In South Australia, along the coast near Adelaide, *S. arbuscula* and several *Halosarcia* species grow in the same locality and collections have been made of a plant apparently intermediate in habit between *S. arbuscula* and members of the genus *Halosarcia;* this plant is seemingly abnormal in its floral morphology. The 'intermediate' plant has a fruiting spike which is pithy in texture and does not contract around the fruit on drying as is usual for *S. arbuscula*. The sex of the flowers is as in *Sclerostegia;* the perianth has a small but obvious inner abaxial lobe, membranous in texture, an organ lacking in *S. arbuscula*. Field observations are necessary to ascertain whether this plant is of hybrid origin or whether it is a discrete taxon. Some collections are as follows (all AD):

South Australia: Ethelton, 13 Jan. 1921, *J. M. Black;* Glenelg, 14 Dec. 1919 and 21 Jan. 1920, *J. M. Black;* Port Gawler, *J. P. Jessop* 2118.

From the south coast of Victoria come three collections which appear to be intermediate between *S. arbuscula* and *H. pergranulata*. These specimens have hermaphrodite flowers but have the style and stigmas of *S. arbuscula*. In one collection (Morrison s.n.) the florets are fused together and the perianth has simply a pair of lateral lobes set in a fleshy apex; the seed is deformed and has faint porcate ribbing. In another collection (*Williamson* s.n.) the florets are partially free, the imbrication of the three perianth lobes is variable, and the immature seed again has faint porcate ribbing. Both *S. arbuscula* and *H. pergranulata* have been collected in the same general area as that in which the apparently intermediate plants were found. Records of this plant are as follows:

Victoria: Mouth of Yarra, Port Melbourne, 2 Apr. 1885, *A. Morrison* 336 (CANB); North Williamstown, 16 Feb. 1895, *A. Morrison* (BRI, CANB, NSW); Geelong, *M. B. Williamson* (AD 97526144 p.p.).

3. Sclerostegia moniliformis P. G. Wilson, sp. nov. Fig. 13E–H.

Articuli obovoidei ca. 5 mm longi, lobis apiculatis integris. *Inflorescentiae* terminales demum intercalares, 1–2 (6) articulis, bracteis inclusi, dimidio superiore dorsi-ventraliter applanati, orificio terminali. *Perianthium* membranaceum; stylus robustus in perianthio inclusus. *Infructescentia* sicca interdum moniliformis; verticilli bractearum obovoidei vel sphaerici, medullosi, 5–6 mm diam.; perianthium membranaceum; pericarpium crustaceum ad axem adnatum.

Type: W. bank of Lake King near causeway, Western Australia, margin of salt lake, subshrub 0·3 m high, articles dull green and slightly glaucous, 29 Sept. 1970, *P. G. Wilson* 9983 (holo: PERTH, iso: AD, BRI, CANB, K, MEL, NSW).

Much-branched *shrub* ca. 1 m high with slender branchlets. *Articles* dull green, fleshy, obovoid, ca. 5 mm long; apex lobed, apiculate; margin scarious, entire. *Spikes* terminal (becoming intercalary with age) of 1–2 (6) articles; bracts similar to the vegetative articles and enclosing the flowers. *Flowers* almost erect, ca. 3 mm high, dorsiventrally flattened distally, the aperture terminal, coalescent in lower two-thirds to each other and to upper bract, free from lower bract except near base. *Perianth* membranous; central floret with a pair of abaxial imbricate lobes reaching half-way to base of flower; lateral flowers irregularly lobed. *Anther* ca. 2 mm long. *Ovary* narrow, fused to spike axis along vertical length of flower, continuing outwards as a stout style; stigmas narrowly triangular. *Fruiting spike* dry, sometimes moniliform, the bracts broadly obovoid to spherical, pithy, 5–6 mm diameter, completely obscuring the flowers; perianth ± erect, membranous; pericarp crustaceous, adhering to spike axis; style weak, not exserted. *Seed* ovoid, ca. 1·5 mm long; testa thin, smooth, pale brown; embryo slightly curved; perisperm lateral.

Habitat: Moderately saline areas in periodically waterlogged situations.

Distribution: South-western Western Australia from Bullfinch south to Lake Grace and east to Israelite Bay. Map 4.

Western Australia: Lake King, *A. S. George* 9355 (PERTH); 7·2 mi E of Pt. Malcolm, *R. Hnatiuk* 761203 (PERTH); 23 mi N of Bullfinch, *P. G. Wilson* 8736a (PERTH); Mt. Le Grand to Lucky Bay, *P. G. Wilson* 10014 (PERTH); Israelite Bay, *P. G. Wilson* 10081 (PERTH); Pine Hill, 20 km N of Mt. Ragged, *P. G. Wilson* 10101 (PERTH).

Sclerostegia moniliformis resembles the western variant of *S. tenuis* which was described by Ewart and White as a distinct species, *Salicornia donaldsonii*. In *S. moniliformis* the habit is more branched and the articles are obovate rather than cylindrical; the scarious margin of the lobes is also less prominent. The main distinction between the two species, however, lies in the fruit: in *S. tenuis* the pericarp becomes woody, fuses with, and becomes immersed in, the enlarged woody spike axis, while in *S. moniliformis* the pericarp is thinly crustaceous and does not fuse with the spike axis which at first remains slender. The bracts of the latter species do not shrivel but become pithy, retain their spherical shape, and then remain around the fruit while the spike tip continues to make vegetative growth. The bracts disintegrate with age and are eventually sloughed off with the enclosed fruits.

Sclerostegia arbuscula is also similar to *S. moniliformis* but may be distinguished by its fleshy perianth which is totally fused to the upper bract. Intergradation between these two species is discussed under *S. arbuscula*.

4. Sclerostegia tenuis (Benth.) P. G. Wilson, comb. nov. Fig. 14.

Salicornia tenuis Benth., Fl. Austral. 5: 204 (1870).—*Pachycornia tenuis* (Benth.) Black, Trans. Roy. Soc. S.A. 43: 363 (1919).

Lectotype: "Howitt's Expedition" (holo: MEL 71381; iso: K) cf. J. M. Black, op. cit. 364, see also comment below.

Salicornia donaldsonii Ewart et White, J. Roy. Soc. N.S.W. 42: 194 (1909).—*Arthrocnemum donaldsonii* (Ewart et White) C.A. Gardn., Enum. Pl. Austr. Occ. 39 (1930).

Lectotype: Cowcowing, Sept. 1904, *M. Koch* 1147 (holo: MEL 71457; iso: K), lecto nov.

Divaricately branched *sub-shrub* to 0·6 m high. *Branchlets* slender; articles pale green narrowly turbinate to cylindrical, ca. 10 mm long; apex shortly lobed (the lobes rounded to obtuse, sometimes apiculate) with a broad scarious margin, entire (rarely slightly denticulate). *Spikes* slender, ca. 2 cm long, narrowed towards the apex, of 5–10 articles, usually continuing growth vegetatively for at least 1–2 cm; bracts united in opposite pairs, slightly lobed, ca. 4 mm long, enclosing the flowers, similar at first to the vegetative articles. *Flowers* almost erect, ca. 4 mm high, dorsiventrally flattened distally, the aperture terminal, coalescent in proximal two-thirds to each other and, except near apex, fused to the upper bract. *Perianth* membranous; central floret with a pair of abaxial imbricate lobes; lateral florets irregularly lobed. *Ovary* narrow, fused to spike axis along vertical length of flower, passing into a stout style; stigmas narrowly triangular. *Fruiting spike* narrowly ellipsoidal (sometimes slightly moniliform), woody, covered by the shrivelled remains of the bracts, or these soft, pithy and persistent; perianth membranous; pericarp thick and woody and eventually embedded laterally in the enlarged woody spike axis; style not exserted. *Seed* narrowly ovoid, 2·5–3 mm long; testa thin, smooth, pale brown; embryo straight; perisperm lateral.

Habitat: Found in a variety of saline soils but usually with underlying clay. A collection made in New South Wales ca. 38 km N of Hay (*M. A. Wilson* 34) was growing in a heavy clay with 1·2% salt made up of almost equal quantities of common salt (NaCl) and gypsum (Na_2SO_4).

Distribution: Eremaean areas of Australia. Map 4.

Queensland: Between the Barcoo and the Roma, 1871, *Birch* (MEL); Dynevor Lakes, *M. E. Phillips* 475 (PERTH).

New South Wales: 15 mi SW of Yantabulla, *D. H. Benson* and *J. Pickard* 1825 (NSW); Corona, *M. Collins* 43 (NSW); One Tree, *Margaret Wilson* 34 (PERTH); Junction of Darling and Murray River, 1896, *R. R. Harvey* (MEL); ibid., 1889, *Mrs. Holding* (MEL).

Victoria: 3 mi NE of Lake Wallawalla, *A. C. Beauglehole* 40677 (PERTH); W side of Lake Walla-Walla, 31 Aug. 1948, *J. H. Willis* (MEL); Kulkyne Nat. Park, 16 Oct. 1960, *J. H. Willis* (MEL); near Mildura, 20 Oct. 1937, *W. J. Zimmer* (MEL).

South Australia: 5 mi SW of Pt. Augusta, *C. R. Alcock* 2148 (ADW, CANB); Yudnapinna Stn., *J. G. Davies* (ADW); 80 km S of Kingoonya, *M. Fagg* 371 (AD); 2 km NW of Mt. Lyndhurst, *M. Lazarides* 8258 (PERTH); 10 mi NE of Woomera, *M. Lazarides* 8405 (PERTH).

Western Australia: W end of Hopkins Lake, *D. E. Symon* 2348 (ADW); Mongers Lake, *Ruth Watson* 5 (PERTH).

Northern Territory: Alice River, 1884, *C. W. Birch* (MEL); Finke R., *B. G. Briggs* 1258 (NSW); 12·4 mi N of Andado H.S., 6 Sept. 1956, *G. Chippendale* (NT).

In *Sclerostegia tenuis* the bracts of the fruiting spike normally shrivel to form a thin covering to the woody axis. In some collections, however, the bracts have become firm and spongy and assume a moniliform appearance similar to that found in *S. moniliformis* but with the seed embedded in the spike axis. The spikes sometimes become intercalary due to the continued vegetative growth at their apex; in most cases this vegetative growth is short-lived producing only a few centimetres of branch. In the variant found at Lake Cowcowing, Western Australia, (which was described as a distinct species, *Salicornia donaldsonii*), however, vegetative growth sometimes continues indefinitely with the result that the spike becomes embedded in thick branches several years old. In those species of *Halosarcia* where the spike becomes intercalary and the branch continues growth for several years, the fruit (seed with surrounding pericarp) is on the outside of the stele and is eventually shed with the rest of the bract structure; whereas in *S. tenuis* the stele of the young spike consists of two sets of vascular strands, one set on each side of the transversely placed axis (Fig. 14F); with the lignification and eventual secondary thickening of the stele the ovary is enclosed in the spike, which may become a portion of a branch, and the seed is only shed on the death and eventual decay of the spike or branch.

Another noticeable variant is found in northern New South Wales near Yantabulla (*Benson and Pickard* 1825). This plant is rather larger in all its parts than in the typical *S. tenuis* and has firm spreading acute apices to the bracts.

J. M. Black (1919) noticed that the seeds in one plant he examined had rotated 90° relative to the inflorescence axis. Material I have studied suggests that while rotation sometimes does take place this is not usually as much as 90°, and is presumably a passive response to the thickening of the axis.

Lectotypification: Bentham (1870) cited four collections with his description of *Salicornia tenuis* as follows: (1) Victorian Expedition; (2) Mitchell; (3) Howitt's Expedition, and (4) McDouall Stuart's Expedition. The lectotype was selected by J. M. Black (1919) as being the specimen collected on the Howitt Expedition (MEL 71381). The specimen (in herb. K) from the Victorian Expedition is conspecific with the lectotype. The collection from the Major Mitchell Expedition ("Interior of New Holland, 1838", herb. K) is *Sarcocornia quinqueflora* (Ung.-Sternb.) A. J. Scott. The sheet at K of the collection made on McDouall Stuart's Expedition contains three specimens, one being *Halosarcia halocnemoides* subsp. *longispicata* P. G. Wils., a second *H. pergranulata* ssp. *elongata* P. G. Wils., and the third a vegetative fragment of another (unidentifiable) *Halosarcia* species. The description drawn up by Bentham combined in it the features of the various collections seen by him. The specimens from the Howitt and Victorian Expeditions (*S. tenuis* sensu lectotypico) Bentham considered to be of male plants, and those from the other expeditions to be of female, but he expressed doubts as to whether the plants of the 'two sexes' were conspecific.

5. Sclerostegia medullosa P. G. Wilson, sp. nov. Fig. 15.

Articuli (internodia) cylindracei, 4–5 mm longi, 2–3 mm diam., demum medullosi, lobis acutis marginibus denticulatis. *Flores* in axilla foliorum positi, fere verticale, ca. 2 mm longi, parte superiore dorsiventraliter applanato, orificio ciliatis; stylus robustus, in perianthio inclusus. *Articulus fructificans* medullosus cylindraceus; perianthium membranaceum; pericarpium crustaceum, ad stelam adnatum.

Type: Theldarpa-Yandama Stn. (ca. 30 mi W of Milparinka); bushy, 1–2 ft.; locally frequent along small water course on gibber hill; 2 June 1955, *L. A. S. Johnson* and *E. F. Constable* (holo: NSW 40039, iso. PERTH).

Much-branched *subshrub* to 1 m high. *Articles* cylindrical, 4–5 mm long, 2–3 mm diam., papillose (at least when dry), becoming pithy with age; apex acutely lobed; margin denticulate. *Flowering articles* interspersed among the vegetative and not differentiated from them. *Flowers* almost vertical, ca. 2 mm long, dorsiventrally flattened distally with the aperture terminal, united to each other and in proximal part to upper bract, adherent to lower bract in proximal two thirds; perianth membranous; anther ca. 2 mm long; ovary narrow, membranous, fused to axis along vertical length of flower; style stout, included in perianth; stigmas narrowly triangular. *Fruiting articles* pithy, cylindrical; perianth membranous; pericarp hard and brittle ca. 2·5 mm long, adherent to stele of axis. *Seed* vertical, ellipsoidal, ca. 2·5 mm long; testa membranous, colourless; embryo slightly curved; perisperm copious, lateral.

Habitat: The only indication of habitat is that given on three herbarium specimens, of which one, the type, is cited above; the second, from Whynot Stn. Queensland (*Smith* 6069), provides the note "growing among good grass on Borie (*Acacia* sp.) slope, near but not along drainage line", while the third from near Woomera, South Australia (*Lazarides* 8401) indicates that it was "co-dominant with *Atriplex vesicaria* and *Frankenia* on gently sloping, stony floodplain".

Distribution: Southern Queensland, western New South Wales, and north of Port Augusta in South Australia. The localities are too few and too scattered to obtain a clear idea of the plant's distribution. Map 20.

Queensland: Whynot Stn. (38 km SW of Quilpie), *L. S. Smith* 6069 (BRI); Whynot, *S. L. Everist* 5904 (K).

New South Wales: Wilcannia, Darling River, 1885, *Mrs. Kennedy* (MEL); Grey Ranges, (*Baeuerlen?*) 409 (MEL); "Koorningbirry" (=Koonenberry), *W. Baeuerlen* 220 (MEL); 5 km S of Binerah Downs—Fort Grey road junction, *S. Jacobs* 3434 (NSW).

South Australia: "Near Spender's Gulf", 1881, *Lattorf* (MEL); Mt. Gunson, 31°30′S, 137°15′E, *M. N. Cole* 51 (K); 7 mi NE of Woomera, *M. Lazarides* 8401 (PERTH); NE of William Creek, 28°21′S, 136°17′E, *D. E. Symon* 11313 (ADW).

Sclerostegia medullosa is distinctive in having the triads of flowers scattered inconspicuously along the branches, the fertile articles being identical in outward appearance to the vegetative. The divaricately branched habit is also a characteristic feature of this species. The nature of the fruiting article is similar to that of *S. moniliformis*, for in both species the pericarp is attached to the stele of the inflorescence axis and surrounded by pithy bracts. *S. medullosa* differs from *S. moniliformis* in the shape of the articles (and in their denticulate margins), the erect flowers and the thicker pericarp. The bracts, with the enclosed seeds, remain attached to the stem for some time after the formation of the fruit (probably for more than a year), but they eventually decay and allow the pericarp with seed to fall away.

The specific epithet has reference to the pithy nature of the articles.

3. **Tegicornia** P. G. Wilson, gen. nov.

Herba prostrata perennis quasi aphylla, articulata, glabra. *Folio* succulenta opposita cauli adnata, apice modice dilatata lobis minutis. *Flores* erecti dioecii solitarii in axillis foliorum caulinorum. *Perianthium* succulentum gamopetalum, ad apicem 3-lobum, ab foliis discretis. *Flos masculus:* stamen solitarium abaxiale ovarium vestigiale. *Flos femineus:* staminodium absens; ovarium erectum, stigmatibus anguste lanceolatis, papillosis. *Semen* verticale; testa tenuiter crustacea; embryo curvatus; perispermium copiosum, laterale.

Type species: Tegicornia uniflora P. G. Wilson.

Perennial seemingly leafless succulent herb. *Branches* apparently jointed due to the opposite leaves enveloping the stem in a succulent sheath; leaf-blade minute. *Flowers* dioecious solitary in the axils of the stem leaves. *Perianth* fleshy, free from bracts, united to summit; orifice terminal, 3 lobed. *Male flower:* stamen solitary abaxial; ovary vestigial, on adaxial side of stamen. *Female flower:* staminode absent, ovary erect, attached to base of perianth; stigmas 2, narrowly lanceolate, prominently papillose. *Seed* vertical, testa thinly crustaceous; embryo curved; perisperm copious, lateral.

Origin of name: from the Greek word *teges*, a mat, and *cornia*, alluding to its relationship to the plant *Salicornia*. The type species has a mat-like appearance.

One species endemic to southern Western Australia.

The genus *Tegicornia* differs from other members of the Australian *Salicornieae* in the shape and manner of insertion of the perianth, and in the solitary unisexual flowers. It is also unusual (although not unique) in having a prostrate habit and in bearing the flowers on the undifferentiated stem articles. Its affinities appear to be nearest to the genus *Halosarcia* as is suggested by the following characters:—

(1) Perianth 3-lobed with the median lobe in the inferior (abaxial) position.

(2) Stamen solitary and abaxial in position.

(3) Testa crustaceous; embryo curved; perisperm copious and lateral.

These characters in combination, agree with the genus *Halosarcia* but not with any other member of the *Salicornieae*. The presence of a short rigid style and narrowly triangular stigmas, as well as the position of the flowers, suggest a particular relationship with those species of *Halosarcia* centred around *H. pruinosa* (Paulsen) P. G. Wilson.

1. Tegicornia uniflora P. G. Wilson, sp. nov. Figs. 4, 7, 16, 17, 36, 37.

Herba prostrata dioecia. *Articuli* nitidi, anguste obovati, ad 15 mm longi, 6 mm lati (ad apicem), versus basem angustati, lobis apicalibus rotundatis integris. *Flores* unisexuales, solitarii. *Perianthium* erectum, dorsi-ventraliter compressum, translucens, 3 mm altum, in margine laterale succulentum aliter membranaceum; apice rotundatus, lobis parvis. *Flos masculus:* antherum 2 mm longum; pistillodium minutum, ca. 1 mm longum, stylo tenui ca. 0·2 mm longo. *Flos femineus:* staminodium abaxiale minutissimum ovarium ellipsoideum succulentum, translucens, ca. 1·5 mm longum; stylus brevissimus stigmatibus ca. 1 mm longis. *Fructus:* perianthium ± patelliforme, ca. 3 mm altum, marginibus succulentis; pericarpium succulentum, ad perianthium adnatum. *Semen* late ovatum, ca. 2 mm longum; testa rufa, crustacea, prominente concentrice pluricostata.

Type: Between Stirling Ra. and Porongurup Ra., Western Australia, 34 33′S, 118 4′E, 30 Oct. 1975, *P. G. Wilson* 11626, female plant (holo: PERTH; iso: AD, BRI, CANB, K, MEL, NSW).

Prostrate perennial *herb*, dioecious. *Articles* on young branches glossy, succulent, very narrowly obovoid, up to 15 mm long, 6 mm wide at apex, narrowed to a slender base; apex with rounded lobes, entire. *Flowers* solitary, unisexual. *Perianth* erect, strongly dorsiventrally compressed (transversely narrowly elliptical in cross section), oblong in male flower, broadly obovate in female, succulent in lateral wing-like margins, thin in centre, translucent, 3 mm high; apex rounded, with a small terminal aperture surrounded by 3 small lobes consisting of two semicircular posterio-lateral outer lobes and one anterior (abaxial) inner lobe. *Male flower:* anther 2 mm long; pistillode minute, ca. 1 mm long, with a single slender style ca. 0·2 mm long. *Female flower:* staminode a minute fleshy tube ca. 0·1 mm long on abaxial side; ovary ellipsoidal, succulent, translucent, ca. 1·5 mm long; style very short; stigmas ca. 1 mm long, orange or yellow. *Fruiting perianth* ± patelliform (circular in face view) with solid succulent margins, ca. 3 mm high; pericarp succulent, soft, fused to perianth; seed vertical, usually radially orientated, broadly ovate, ca. 2 mm long; testa reddish brown, crustaceous, with prominent concentric porcate ribs over the embryo, smooth elsewhere; embryo curved; perisperm lateral.

Figure 7. *Tegicornia uniflora;* on margin of salt lake between the Stirling and Porongurup Ranges, Western Australia. Photo by A. S. George.

Habitat: Growing in slightly saline loam periodically subject to inundation.

Distribution: Southern Western Australia, between the Porongurup Ra. and Ongerup. Map 5.

Western Australia: Salt lake 40 km NE of Ongerup, 16 Dec. 1973, *K. Newbey* 4014 (PERTH); Chillinup Rd., S of Stirling Ra., Oct. 1975, *N. G. Marchant* s.n. (PERTH); ibid., *B. R. Maslin* 4017 (PERTH); ibid. *A. S. George* 14238 (PERTH).

The prostrate habit of this plant, and insignificant flowers, are probably reasons for it being overlooked by collectors, for all the herbarium specimens seen, apart from that collected by K. Newbey, came from the margin of the same salt lake situated between the Stirling and Porongurup Ranges.

This species differs from all other members of the *Salicornieae* in being strictly dioecious and in the flowers being solitary (not aggregated into small axillary clusters). It is also unusual in having the flowers in the leaf axils and not arranged in an inflorescence.

The very short stele which serves the solitary flower of *Tegicornia uniflora* is similar to that found in *Halosarcia* although much abbreviated in form. The stele divides to form three prominent traces of which the central one passes into the funicle while the two lateral traces pass into the base of the perianth where they terminate in globular clumps of vascular tissue (Fig. 2A–B). The lateral traces arise in a manner similar to that of the traces serving the lateral flowers in *Halosarcia;* if the traces in the two genera are homologous it would indicate that the solitary flower in *Tegicornia* is derived from a cymose inflorescence. The short 'inflorescence' stele also gives rise on its abaxial side to a minute trace which passes into the base of the flower.

The flowers of both sexes bear vestiges of the male or female organ. In the male flower the pistillode is readily apparent even though small. In the female flower the staminode is minute and consists simply of a fleshy scale-like disc on the abaxial side of the ovary base; it is about 0·1 mm in length (Fig. 11D). That this is a rudimentary stamen is suggested by its position and by the fact that no such scale-like structure is present in the male flower.

Halosarcia sp. x Tegicornia uniflora Fig. 18

Recently several collections have been made near Truslove (60 km N of Esperance) of a plant which has the habit of *Tegicornia uniflora* but in inflorescence and floral morphology is intermediate between that species and a generalised species of *Halosarcia.* This plant exhibits considerable variation within the one population as may be apparent from the following description:

Prostrate *perennial herb,* polygamo-monoecious, forming a mat-like cover up to 1·5 m diameter. Ultimate *branchlets* ascending, ca. 3 cm long: articles obovoid, ca. 5 mm long, 3 mm wide, somewhat laterally compressed, glossy, apex deeply lobed, the lobes obtuse to acute or shortly acuminate. *Inflorescence* a terminal subglobular spike of 2–4 bract pairs: lowest bract-pair united and similar to the vegetative articles: bracts of the uppermost bract-pairs free, and of the middle bract-pairs slightly united or free (sometimes very shortly 3-lobed); bracts when free deeply concave adaxially to infolded (somewhat involute) and attached to axis by a small base (not decurrent). *Flowers* solitary or in triads: lowest bracts 3-flowered, the central flower hermaphrodite, the lateral female and often sterile (or rarely all three hermaphrodite): middle bracts 1–3 flowered, the central flower female or hermaphrodite and the lateral female and usually sterile, or much reduced in size and represented only by a vestigial perianth: upper bracts 1-flowered, or the terminal pair flowerless. *Flowers* free from bracts and from each other, steeply ascending and attached by a small base. *Perianth* of central flower urceolate (but dorsiventrally compressed); lateral margins fleshy; orifice terminal: lobes 3, the medial abaxial lobe broad, usually within the lateral pair which are united on the adaxial side. *Stamen*

abaxial (in lateral flowers usually represented by a minute staminode). *Ovary* ellipsoidal, succulent, not appreciably changing in fruit, attached to base of perianth: style short and stout; stigmas narrowly triangular. *Seed* broadly elliptic, ca. 1·3 mm long, usually aborting before reaching maturity; testa pale reddish brown (almost white when semi-mature) with 2–3 prominent porcately sculptured ribs on the margins otherwise smooth.

Western Australia: Truslove Reserve 27985 (ca. 60 km N of Esperance), 18 Jan. 1978, *G. J. Keighery* 1829 (PERTH); ibid., 16 Jan. 1979, *C. J. Robinson* and *J. M. Koch* (PERTH), from several plants. Map 5.

Habitat: Saline sand on margin of salt lake.

This taxon is recorded from a single population that is stated by one of the collectors (C. J. Robinson, pers. comm.) to cover many hectares of saline soil. Robinson also observed what he considered to be the same plant in a neighbouring area, but no collections were made. Within the population there is variation in vegetative morphology, in inflorescence shape and structure, and in floral morphology. The plant is anomalous in several ways in that it does not conform to the structure found in any of the recognised samphire genera. In particular the following characters make it unique within the Salicornioideae: (1) The terminal (and often the penultimate) pair of bracts are free from each other, their margins are often infolded, and they are attached to the axis by a small base; (2) The spike often ends abruptly in this terminal pair of often flowerless bracts; (3) The bracts are sometimes shortly 3-lobed; (4) The axillary cymules vary in their flower number from 1–3; (5) The lateral flowers of a cymule are usually female and sterile, or they may be vestigial and represented by a very reduced perianth. A further peculiarity which has not been observed in other species is that the spike sometimes appears to end in a terminal flower which is presumably axillary to one of the terminal bracts (while the other bract is sterile) and becomes displaced to occupy a terminal and axial position (Fig. 18–Ac).

In its general morphology, its flower structure and in the sculpturing of its testa, this plant is similar to *Tegicornia uniflora*, while the cymule character, the sexuality of the flowers, and the nature of the inflorescence are reminiscent of the genus *Halosarcia*. The variation in general morphology found within the population suggests that this plant is of hybrid origin, a suggestion which is supported by the irregularity of some spikes and the high degree of sterility of the flowers. In addition, most of the seed observed appeared to be immature and to have stopped growing at an early stage; this is apparent from the slightly decomposed nature of the surrounding tissue or of the seed itself.

Further field work is required before a conclusion can be reached as to what species might be involved in producing this population but, as suggested earlier, it seems probable that the plant is a hybrid between *Tegicornia uniflora* and a species of *Halosarcia*. At present it seems unwise to give the putative hybrid a name, since its parentage has still to be investigated; I therefore refer to it by a formula: *Halosarcia* sp. x *Tegicornia uniflora*.

4. **Halosarcia** P. G. Wilson, gen. nov.

Arthrocnemum sect. *Leiosperma* J. M. Black, Trans. Roy. Soc. S. Austral. 43: 358 (1919). *Lectotype: A. leiostachyum* (Benth.) Paulsen (= *H. indica* subsp. *leiostachya* (Benth.) P. G. Wilson), lecto. nov.

Arthrocnemum sect. *Trachysperma* J. M. Black, op. cit. 357. *Lectotype: A. halocnemoides* Nees (= *H. halocnemoides* (Nees) P. G. Wilson), lecto. nov.

Arthrocnemum subgen. *Angianthemum* Moss, J.S. Afr. Bot. 20: 5 (1954). *Lectotype: A. indicum* (Willd.) Moq. (*H. indica* (Willd.) P. G. Wilson), lecto. nov.

[*Arthrocnemum* auct. non Moq. s.str.: Ungern-Sternberg, Salic. Syn. 281 (1876); J. D. Hooker in Bentham et Hooker, Gen. Plant. 3: 65 (1880) p.p.; Volkens in Engler et Prantl, Nat. Pflanzenf. III, 1a: 76 (1892); J. M. Black, Trans. Roy. Soc. S. Austral. 43: 357 (1919); Ulbrich, in Engler et Prantl, op. cit. ed. 2, 16c: 548 (1934) p.p.]

[*Salicornia* auct. non L.: Bentham, Fl. Austral. 5: 201 (1870) p.p.]

Fruticuli glabri; ramuli succulenti, internodiis ut videtur articulatis; chlorenchyma absque scleridibus. *Folia* opposita, in rima connata lobata redacta. *Inflorescentia* spicoidea; bracteae oppositae, connatae vel liberae; cymulae sessiles, 3-florae. *Flores* hermaphroditi (aut ovario vel stamine abortivi); perianthium

gamophyllum urceolatum vel varie compressum, lobis 3, duobus lateralibus et uno abaxiali; stamen solitarium abaxiale; ovarium sessile. *Fructiculi:* perianthium membranaceum aut spongiosum aut medullosum vel crustaceum; pericarpium membranaceum ad crustaceum. *Semen* erectum, ovoideum ad circulare; testa membranacea ad crustaceam; embryo curvatus, radicula inferiori; perispermium copiosum laterale.

Arthrocnemum Moq. affine, a quo chlorenchymis absque scleribidus, floribus unistamineis differt.

Type species: *Halosarcia halocnemoides* (Nees) P. G. Wilson.

Dwarf glabrous shrubs. *Branchlets* composed of succulent apparently articulate internodes; sclereids absent from peripheral chlorenchyma. *Leaves* opposite forming an insignificant fleshy bilobed rim (scarious on the margin) at the apex of each internode. *Inflorescence* a spike-like cyme (thyrse), usually terminal to the branchlets, consisting of three-flowered cymules each in the axil of a bract. Opposite bracts united or rarely free, succulent. *Flowers* sessile, usually hermaphrodite (but the stamen or ovary sometimes failing to develop) or in some species female; perianth gamophyllous, initially membranous or succulent, lobes 3 (two lateral and usually a medial abaxial); stamen solitary abaxial, filament initially turgid and terete, eventually lorate, sometimes indurated towards the base; ovary vertical, membranous or succulent; style slender, 2 (3) lobed. *Fruiting perianth* membranous, succulent, spongy, pithy, crustaceous, or corneous. *Seed* erect, ovoid to circular; testa membranous to crustaceous; embryo curved; radicle inferior; perisperm abundant, starchy, lateral.

In this genus 23 species are recognised of which all except one are endemic to Australia; H. indica is also found in Malaysia and in those countries bordering the Indian Ocean.

Origin of name: from the Greek words *halos* (salt) and *sarx* (fleshy).

The genus *Halosarcia* shows greater morphological variability than any other member of the *Salicornieae*, and possibly any other member of the Chenopodiaceae. This variability is most obviously shown in the inflorescence, flower, and fruit, but is also apparent in the anatomy of the vegetative parts. In particular there is a sharp distinction between the anatomy of *H. indica* and of that of the rest of the genus. In *H. indica* the palisade tissue of the articles forms a single layer and consists of groups of chlorenchyma cells (around the stomata) interspersed with colourless cells; beneath the palisade layer is a continuous sheath of small isodiametric chlorenchymous cells rich in starch (Fig. 1). In all other species of Halosarcia (and of the other members of the Australian *Salicornieae*) the palisade tissue is of several layers which may either gradually pass into the aqueous tissue or be sharply delimited from it.

The inflorescence varies from being confined to two or three intercalary articles identical in appearance to the vegetative ones, to forming a terminal well-defined spike-like thyrse. The flowers may be sunk into the succulent inflorescence axis or may merely abut onto a relatively slender axis; they may be truncate or dorsiventrally compressed at apex; and in fruit the perianth and pericarp vary in texture from membranous to pithy through to crustaceous or horny.

In spite of this great variability it has not seemed practical to provide a formal sectional treatment since there is no clear segregation of the species. Although in its stem anatomy *H. indica* differs from the other species it shows less evidence in flower and fruit characters of being sectionally distinct, and its seed is very similar in appearance to that found in other *Halosarcia* species with a hard pericarp.

Several *Halosarcia* species are very variable within themselves and this is particularly obvious when examining fresh material. Unfortunately the characters which can be used in practice for discriminating the species do not allow full justice to be given to all those characters which are obvious in the living plant, both in gross appearance and in the fine structure of the flower. For this reason the species have generally been broadly defined and it is apparent that further work will enable many more to be discriminated; this is important, since, as delimited here, a confused situation is presented as to the ecological requirements of several of the broadly based species.

In addition to those 'incipient' species which remain hidden through a too broad delimitation of others, there are many more which have not been recognised because of the imperfect material which is available in herbaria: furthermore it is apparent from recent collecting activities that some species are very restricted in their distribution and it is probable that many of these remain to be discovered.

Halosarcia and other genera

The two characters which most obviously distinguish *Halosarcia* from *Arthrocnemum* (i.e. absence of both sclereids and the adaxially placed stamen) are of fundamental importance and suggest that these genera are not closely related. However, the characters which distinguish *Halosarcia* from *Sclerostegia*, *Pachycornia*, *Tegicornia* and *Tecticornia*, although relatively obvious, relate to organs which tend to be plastic in their morphology. For this reason I consider that these five genera are closely related and, because of their virtual endemism, that they have evolved from a common ancestor within Australia.

Key to the species of Halosarcia

1. Opposite bracts free from each other (Fig. 24F) 2
1*. Opposite bracts united (Fig. 24A) 4
2. Flowers intimately fused to each other and to upper bract (Fig. 26) 13. **H. peltata**
2*. Flowers free from each other and from bracts 3
3. Seed pale brown, concentrically tuberculate over embryo (Fig. 52) ..... 12. **H. flabelliformis**
3*. Seed white with prominent uneven scale-like ribs covering whole of surface (Fig. 46) ..... 9. **H. pterygosperma**
4. Perianth rounded to truncate at apex 5
4*. Perianth dorsiventrally flattened at apex 14
5. Seed white; testa raised into scale-like ribs 6
5*. Seed brown, reddish brown, or black, tuberculate or granular 7
6. Spikes long and slender, even in outline; seeds with smooth ribs around circumference (Fig. 44) ..... 8. **H. lepidosperma**
6*. Spikes relatively short, undulate in outline; seeds with uneven ribs covering whole of surface (Fig. 46) ..... 9. **H. pterygosperma**
7. Seed dark reddish brown to black, covered with concentric porcate ribs (Fig. 42); abaxial perianth lobe often prominent, external 8
7*. Seed brown, variously tuberculate, abaxial perianth lobe small, usually inside lateral lobes (external in *H. fontinalis*) 9
8. Spikes even in outline (smooth); bracts ciliolate (Fig. 22F) 7. **H. doleiformis**
8*. Spikes even or undulate in outline; bracts entire (Fig. 22A) 6. **H. pergranulata**
9. Bracts denticulate or ciliolate; axillary cymules 3–7 flowered 10
9*. Bracts entire; axillary cymules 3-flowered 11
10. Axillary cymules 3-flowered; seed concentrically tuberculate over embryo (Fig. 38–41) ..... 1. **H. halocnemoides**
10*. Axillary cymules 3–5 (7)-flowered; seed concentrically porcate over embryo (Fig. 67) ..... 5. **H. pluriflora**
11. Perianth crustaceous in fruit; seed smooth (Fig. 50) ..... 11. **H. leptoclada**
11*. Perianth spongy to membranous in fruit; seed ribbed or tuberculate over embryo 12
12. Branches and spikes very slender and smooth in outline and remaining so on drying (resembling *Casuarina* branchlets); fruit apex mammillate when mature (Fig. 23) ..... 10. **H. lylei**
12*. Branches undulate in outline 13
13. Fruitlets falling entire (not tearing at base so as to expose seed); abaxial perianth lobe external (Fig. 24C–E) ..... 4. **H. fontinalis**
13*. Fruitlets tearing at the base to expose seed; abaxial perianth lobe internal (Fig. 19B) ..... 1. **H. halocnemoides**
14. Margin of articles and bracts denticulate or ciliolate 15
14*. Margin of articles and bracts entire 18

15. Perianth in fruit pithy; pericarp horny all over; fruitlets entire (not torn at base); chlorenchyma tissue of stem as in Fig. 1 ..... 23. **H. indica**
15*. Perianth thin in fruit, either membranous or cartilaginous; pericarp membranous (at least towards base); chlorenchyma tissue of 2–3 rows of palisade cells 16
16. Articles with broad rounded lobes; fruitlets falling entire; perianth cartilaginous (Fig. 31) ..... 19. **H. entrichoma**
16*. Articles with acuminate to caudate lobes; fruitlets tearing at base to expose seed; perianth thin, weak 17
17. Articles glossy, margin entire or crenulate; perianth entire at apical margin ..... 3. **H. nitida**
17*. Articles dull or glossy, margin fimbriate; perianth fimbriate on margin ..... 2. **H. fimbriata**
18. Perianth pithy in fruit, pericarp horny (at least towards apex); chlorenchyma tissue of stem as in Fig. 1 ..... 23. **H. indica**
18*. Perianth various (but not pithy) in fruit; chlorenchyma tissue of stem of 2–3 rows of palisade cells 19
19. Perianth papery or soft; fruitlets free from each other 20
19*. Perianth crustaceous; fruitlets free or united 21
20. Articles shortly acuminate; testa tuberculate over embryo 21. **H. cupuliformis**
20*. Articles truncate; testa smooth 20. **H. chartacea**
21. Fruitlets laterally united 22
21*. Fruitlets eventually free from each other and from bracts 24
22. Fruitlets persisting, released only on decay of perianth and bracts; pericarp forming a hard cap to seed (Fig. 25) ..... 22. **H. calyptrata**
22*. Fruitlets eventually splitting in medial sagittal plane to release seed; pericarp not forming a persistent cap 23
23. Spikes terminating branches; articles glaucous, barrel-shaped (Fig. 27) ..... 15. **H. auriculata**
23*. Spikes becoming intercalary; articles dull green, obovoid (Fig. 28) 16. **H. syncarpa**
24. Bracts truncate or slightly undulate on margin, cup-shaped at fruiting stage; fruitlets muricate outside; spikes usually terminal to branchlets (Fig. 27) ..... 14. **H. pruinosa**
24*. Bracts undulate, shrivelled at fruiting stage; spikes usually sessile 25
25. Fruitlets smooth and glossy outside; vegetative articles ca. 7 mm long ..... 17. **H. undulata**
25*. Fruitlets prominently muricate-areolate outside; vegetative articles ca. 15 mm long ..... 18. **H. bulbosa**

1. Halosarcia halocnemoides (Nees) P. G. Wilson, comb. nov.

Arthrocnemum halocnemoides Nees in Lehmann, Pl. Preiss. 1: 632 (1845).

Type: Fremantle, *Preiss* 1910 (iso: AD, K, MEL).

Spreading to erect *subshrub* to 0·5 m high. *Branchlets* slender; articles glossy to dull (rarely glaucous), globular, dolciform or obovoid, mostly 3–5 mm long, 2–3 mm diam., lobes rounded or attenuate, entire (denticulate in subsp. *caudata*). *Spikes* terminal to main and lateral branchlets, 2–3 mm diam., the articles circular or laterally compressed (when producing an uneven appearance to spike), opposite bracts united, undulate to truncate, entire (denticulate in subsp. *caudata*). *Flowers* free from each other and from bracts, exposed at apex, upper and lower surfaces vertical to spike axis (or the lower slightly ascending). *Perianth* succulent; apex truncate to rounded; lateral lobes large extending over length of apex; medial abaxial lobe small, hemispherical to triangular, situated within lateral lobes. *Fruiting perianth* either soft and becoming shrivelled on drying, or firm, chartaceous and translucent, free from bracts; pericarp thin, weak and translucent, intimately fused to perianth. *Seed* discoid, ovate to elliptic or circular, ca. 1 mm long; testa reddish brown, crustaceous, with small to prominent tubercles in concentric rows over embryo, otherwise smooth to granular; embryo curved. *Fruitlets* eventually breaking away from spike due to an abscission zone around proximal portion of perianth where fused to radial septa of spike axis; seed protruding from torn base.

Distribution: Australia (excluding Tasmania).

Halosarcia halocnemoides is widespread in Australia and exhibits considerable variability. Those variants which are most clearly recognizable are here segregated as subspecies, but there still remains much material which is far from homogeneous. In addition, none of the subspecies is clearly demarcated since specimens can be found which are intermediate in morphology between each of them and the heterogeneous "subsp. *halocnemoides*". The classification proposed here will therefore prove unsatisfactory if it is desired to distinguish by name many of the regional variants, but it has not seemed profitable, with the presently available knowledge, to recognise further taxa, nor has it seemed possible to provide critical characters for their differentiation. The most satisfactory organ on which to base discriminating characters is the seed and only in a small proportion of the specimens examined is this present in a mature state; therefore, within *H. halocnemoides* (which is probably a species aggregate), infraspecific taxa have only been recognised in those cases where morphological characters, additional to those found in the seed, can be recognised and described.

The name *Arthrocnemum halocnemoides* was included by Bentham (1870) in the synonymy of *Salicornia arbuscula* (= *Sclerostegia arbuscula*) and most of the specimens he saw of the former species were also included here. His description of *S. arbuscula* consisted of a combination of characters drawn from both species. J. M. Black (1919) included as a variety of *A. halocnemoides* the plant here recognised as a distinct species *H. pergranulata*, and later (1936) also the plant here recognised as *H. pterygosperma*. Apart from considerable differences in habit and in vegetative and seed morphology, *H. halocnemoides* differs markedly from the latter two species in its perianth; the lower lobe being small and included within the large lateral lobes in *H. halocnemoides*, whereas in both *H. pergranulata* and *H. pterygosperma* it is large and outside the lateral lobes.

Key to Subspecies

1. Articles dull green, denticulate, lobes caudate .... 1b. subsp. **caudata**
1*. Articles dull or glossy rarely glaucous, margin entire, lobes rounded or obtuse (rarely apiculate) 2
2. Spikes long and slender (up to 8 cm), even in outline; seed semicircular, smooth on sides .... 1c. subsp. **longispicata**
2*. Spikes up to 2 cm long (rarely more), undulate or even in outline; seed smooth or granular on sides 3
3. Branchlets moniliform, slender; seed ovate with smooth sides 1d. subsp. **catenulata**
3*. Branchlets with articles narrowly cylindrical, doleiform, or obovoid; seed suborbicular, granular on sides 4
4. Articles narrowly cylindrical to narrowly doleiform; spikes slender, even in outline 1e. subsp. **tenuis**
4*. Articles obovoid (often broadly so), glossy; spikes undulate in outline .... 1.a subsp. **halocnemoides**

1a. subsp. **halocnemoides** Fig. 19A–B, 38–41.

Erect much branched *subshrub* 10–15 cm high; branchlets soon losing the succulent cortical tissue. *Articles* glossy (to dull), narrowly obovoid to sub-globular, 2–5 mm long, apex obtusely 2-lobed to truncate. *Spikes* terminal, 0·5–2·5 cm long, 2–3 mm diam., of 2 to 14 articles, the articles somewhat laterally compressed producing an uneven appearance in spike; bracts undulate to truncate, entire; cymules disjunct or contiguous. *Fruitlets* frequently protruding beyond bracts; perianth soft and spongy when dry (chartaceous in some Eremaean material). *Seed* flattened, broadly ovate to suborbicular, ca. 1·1 mm long; testa concentrically tuberculate over embryo, somewhat granular on sides.

Habitat: A wide range of saline habitats, each of which appears to be occupied by a different variant. It is found in tidal salt marshes, around inland salt (NaCl) and gypsum lakes, and brackish seepages.

Distribution: North-western Victoria; subtropical South and Western Australia. Map 6.

Victoria: Lake Tyrell, *A. C. Beauglehole* 55466 (PERTH); Pink Lakes, 10 mi NNW of Underbool, *A. C. Beauglehole* 40376 (PERTH).

South Australia: Port Pirie, *H. W. Andrew* 23 (AD); Ethelton, *J. M. Black* (AD); Stenhouse Bay, *B. J. Brock* 14 (AD); Colona, *H. W. Caulfield* 149 (AD); Wilgena Stn., 26 Nov. 1925, *J. B. Cleland* (AD); Ooldea Soak, 27 April 1951, *J. B. Cleland* (AD).

Western Australia: 2 mi S of Beenong, *K. M. Allan* 146 (PERTH), 2 mi E of Meckering, *T. E. H. Aplin* 664 (PERTH); Lake Ninan, *T. E. H. Aplin* 734 (PERTH); Murgoo, *A. M. Ashby* 5364 (AD); Lake Anneen, *A. C. Beauglehole* 49068 (PERTH); Mandurah, *R. A. Saffrey* 875 (PERTH); Alfred Cove, Swan River, *P. G. Wilson* 8698 (PERTH).

The considerable variation in the appearance of this subspecies would suggest that further taxa should be distinguished. The organ which is least responsive to environmental conditions, and therefore most suited for use in discriminating taxa, is the seed; within the subspecies *halocnemoides* can be recognised several seed variants but it has not proved possible to clearly correlate (in a manner which can be described) these variants with other morphological characters (although there is considerable geographical correlation). The problem is increased because only a small minority of the herbarium specimens studied had mature seed and were thus in a suitable state for making critical comparisons. It would seem therefore that for the present it is preferable to apply a broad taxonomic concept to the typical subspecies of *H. halocnemoides*.

In the field subsp. *halocnemoides* may often be readily distinguished from other species by its small size, compact habit and glossy appearance. Some of its variants appear to be able to withstand periods of extreme salinity and it is frequently the only plant present at the innermost zone of vegetation of an inland salt lake; here it may be represented by small non-flowering subshrubs with reddish sub-globular articles.

The type of *H. halocnemoides* was collected near Fremantle in Western Australia; it consists of flowering material with very immature seeds but these do indicate the subspecies group to which it belongs and allow comparison to be made with more recent collections from the same area. The seed has a reddish brown testa with concentric rows of tubercles over the embryo and a slight granulation over the perisperm (Figs. 40–41); this agrees with the seed of some recent collections from near Fremantle (e.g. *Saffrey* 875) while other collections (e.g. *Wilson* 8698) have practically no tubercles (Figs. 38–39), or are intermediate in character.

In Victoria and in the southern part of South Australia the seed is ovate and similar in ornamentation throughout the area although the plants themselves vary considerably in vegetative morphology. They agree fairly closely with plants from the type locality (Swan River, W.A.). Plants from the Eremaean region of South Australia, while having similar seed to those from coastal situations, have a fruiting perianth which is firm, translucent, and deltoid in outline, whereas in plants from more equable climatic regions the perianth shrivels at maturity. The variation in texture of the fruiting perianth is probably an environmental response and not due to a genetic difference since there is some inconsistency in plants collected from the same area but in different years.

The fertile articles in subsp. *halocnemoides* are slightly laterally compressed which, due to the decussate arrangement of the bracts, causes the spike to have an uneven appearance. This character is most pronounced in specimens coming from the more southern region of its distribution and helps to distinguish this subspecies from subsp. *tenuis* and subsp. *longispicata*.

Hybridization between *H. halocnemoides* and *H. pergranulata* probably occurs since in areas where the two species grow together may be found plants intermediate in habit and with somewhat deformed flowers. The immature seed which is sometimes found in these 'intermediate' plants appears to be developing characters of the testa which cannot clearly be attributed to either species.

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1b. subsp. **caudata** P. G. Wilson, subsp. nov.

Articuli doleiformes vel obovoidi, ca. 3 mm longi et lati, opaci, papillosi; lobi caudati denticulati. *Spicae* 5–10 mm longae apicem versus angustatae; bracteae caudatae, denticulatae. *Semen* late ovatum, lateribus laevibus.

Type: 9 mi S of Pingrup, Western Australia; salt loam; plant 12" to 18" high, dull green; 23 Nov. 1969, *K. Newbey* 3075 (holo: PERTH, iso: CANB, K).

Subshrub ca. 0·3 m high; densely branched. *Articles* doleiform to obovoid, ca. 3 mm long and wide, dull green, papillose; lobes caudate, denticulate. *Spikes* 5–10 mm long, ca. 3·5 mm diam., narrowing towards the apex, circular in cross-section; articles deeply concave over cymules, caudate, denticulate. *Seed* broadly ovate, 1·0 mm long, strongly tuberculate over embryo, smooth on sides over perisperm.

Habitat: Margins of inland salt-lakes.

Distribution: Lake Grace-Norseman area of Western Australia Map 8.

Western Australia: Lake King, *A. S. George* 9357 (PERTH); Lake King, 22 Sept. 1976, *R. Hnatiuk* (PERTH); Lake Cobham, *K. Newbey* 3315 (PERTH); Lake Grace, *P. G. Wilson* 8273, 8276 (PERTH); 93 km N of Esperance, *P. G. Wilson* 10125 (PERTH); 6 km N of Lake Grace township, *P. G. Wilson* 10241 (PERTH).

This subspecies may be recognised by its dull appearance and by the caudate and denticulate margins of its articles. Material intermediate between subspecies *caudata* and the typical subspecies has been collected in two areas where the two subspecies are found growing together. The intermediate collections are as follows: Lake Cobham, *K. Newbey* 3313, 3314, 3316 (PERTH); 9 mi S of Pingrup, *K. Newbey* 3077 (PERTH).

A plant very similar in appearance to subsp. *caudata* has been collected at Lake Miranda (ca. 130 km S of Wiluna, Western Australia); it differs, however, in its seed which is noticeably granular over the perisperm. For the present this must be considered as one of the indefinite members of the *H. halocnemoides* complex.

1c. subsp. **longispicata** P. G. Wilson, subsp. nov.

Salicornia tenuis [non Benth.] Benth., Fl. Austral. 5: 204 (1870) p.pte., not as to lectotype.

Articuli doleiformes ca. 5 mm longi, 2·5 mm diam., apicem leviter rotunde lobati. *Spicae* tenues, aequatae, anguste cylindraceae, 2–8 cm longae, 3 mm diam.; bracteae leviter rotunde lobatae. *Fructiculi:* perianthium chartaceum, firmum, spiceum transverse oblongum. *Semen* semicirculare, pallido brunneum, supra embryonem tuberculatum aliter laeve.

Type: Finke River near Junction with Palm Creek, 24°06′S, 132°52′E, Northern Territory; on shingle of river bed; stems semi-prostrate; 24 Aug. 1967, *B. G. Briggs* 1257 (holo: NSW).

Subshrub ca. 0·3 m high. *Articles* barrel-shaped, ca. 5 mm long, 2·5 mm diam., apex slightly and obtusely lobed, entire. *Spike* slender, even and cylindrical, 2–8 cm long, 3 mm diam., bracts very slightly lobed. *Fruitlets:* perianth chartaceous but firm when mature, transversely oblong at apex (central fruitlet). *Seed* semi-circular, 1·0 mm long, pale brown, tuberculate over embryo, smooth on sides.

Habitat: Poorly drained somewhat saline situations.

Distribution: Central Australia. Map 7.

Queensland: Pulchera Waterhole, 30 mi WNW of Sandringham, *P. K. Latz* 519 (PERTH).

New South Wales: "Western interior of New South Wales", 1880 *C. Moore* (MEL 71387).

South Australia: Coward Springs, 31 Dec. 1926, *J. B. Cleland* (AD); Beresford, 25 Apr. 1950, *J. B. Cleland* (AD); Moolawatana Bore, *R. H. Kuchel* 2672 (AD); N.W. interior of South Australia, *J. McDouall Stuart* (K, MEL 71379); Dalhousie Springs, *S. A. White* 117 (AD).

Northern Territory: Erldunda Stn., *T. S. Henshall* 55 (NT); Napperby Stn., *T. S. Henshall* 1015 (NT); Finke River, ex herb, F. Mueller (AD 97543201 p.pte.).

The collection *Henshall* 1015 cited above differs from the others in having shorter and thicker fruiting spikes; in seed characters it closely resembles the type.

A plant which is very similar to, and possibly sympatric with, subsp. *longispicata* should probably be included under that subspecies. In the dried state the only obvious differences between the two are found in the seed which in the variant is reddish brown and broadly ovate. From the few ecological notes accompanying the specimens it would appear that this variant is found in very saline situations. The following specimens have been seen:

Northern Territory: Napperby Salt Lake, *C. Dunlop* 2353 (PERTH); Lake Bennet, *C. Dunlop* 2435 (PERTH); 6 mi S of Mongrel Downs, *J. R. Maconochie* 952 (PERTH); 1 mi W of Central Mt. Wedge, *A. O. Nicholls* 819 (PERTH); near MacDonnell Ras., 1889, *Schwarz* (MEL).

A variant of *H. halocnemoides* subsp. *tenuis* has been collected in the same localities as subsp. *longispicata*. They differ from each other in habit (subsp. *tenuis* is a small open plant with divaricate branches and thick articles) and in seed (circular with granular sides in subsp. *tenuis*). The few collections seen do not indicate whether there is hybridization between the two subspecies.

Herbarium material of subsp. *longispicata* is, at the flowering stage, very similar to that of *H. pergranulata* subsp. *elongata*. The two may be readily distinguished by their perianths; in *H. pergranulata* the perianth has a large semi-circular outer lower (abaxial) lobe while in subsp. *longispicata* it has a small inner lower lobe. In the fresh state they are easily recognisable since *H. pergranulata* is bluish-green and glaucous in colour while *H. halocnemoides* subsp. *longispicata* is glossy green (or red). In seed characters, the two plants are very different.

The syntype material of *Salicornia tenuis* Benth. includes representatives of four different species. The name was lectotypified by J. M. Black (1919) on a Howitt collection which is now referred to *Sclerostegia tenuis* (Benth.) P. G. Wilson. One of the specimens among those syntypes of *S. tenuis* collected on J. McDouall Stuart's expedition (1859–1862) is of *H. halocnemoides* subsp. *longispicata;* duplicates are in Herb. K and MEL.

In the vicinity of Port Pirie, South Australia, is found a plant which in the dried state somewhat resembles subsp. *longispicata* and should possibly be included in it. The plant at Port Pirie is found in tidal marshes, conditions very different to those found in Central Australia, and this may account for some of the morphological variation; in seed characters the maritime and inland forms show close similarities.

1d. subsp. **catenulata** P. G. Wilson, subsp. nov. Fig. 19C–D.

Articuli nitidi (vel glauci), doleiformes, 2–3 mm longi, 3 mm diam., ad nodos constricti, margine integro, truncati vel leviter undulati. *Spicae* tenues, 5–10 mm longae, apicem versus leviter angustatae. *Semen* ovatum, lateribus laevibus.

Type: 6 km S of Lake Barlee HS., 29°10′S, 119°6′E, 26 Aug. 1970, *P. G. Wilson* 8849 (holo: PERTH).

Compact *subshrub* to 0·5 m high. *Branchlets* slender, articles glossy (or glaucous), doleiform, 2–3 mm long, 3 mm diam., constricted at the nodes, margin entire, undulate or truncate. *Spike* terminal to short branchlets, slender with a smooth outline, narrowing slightly towards the apex, 5–10 mm long, of ca. 6 articles. *Seed* ovate, 1 mm long, reddish brown, smooth on sides over perisperm.

Habitat: in heavy soil, not strongly saline.

Distribution: Mt. Magnet-Meekatharra (south to Lake King, glaucous variant); Map 7.

Western Australia: Yandil, Sept. 1939, *W. E. Blackall* (PERTH); Lake View Stn., *C. A. Gardner* 7811 (PERTH); 15 mi SW of Nannine, *N. H. Speck* 729 (CANB, PERTH); 48 km N of Mt. Magnet, *P. G. Wilson* 8564 (PERTH); 12 km N of Glen Stn., *P. G. Wilson* 8584, 8585 (PERTH); 1 km S of Yuin H S, *P. G. Wilson* 9951 (PERTH).

This subspecies may be recognised by its slender branchlets (whose articles retain a barrel-shaped appearance even in the dried state), by the slender, smooth spikes, and by the ovate seeds with smooth sides.

The typical variant of subsp. *catenulata* is glossy; however a similar but strongly glaucous plant has been collected at Lake Barlee and Lake King. This variant represents the only case in *H. halocnemoides* where the plant is glaucous; in all other variants of this species the articles are either glossy or merely dull. The flowers and seed of both typical subsp. *catenulata* and the glaucous variant appear to be nearly identical. The following three collections are of this variant:

Western Australia: S side of Mollerin Lake, *B. G. Muir* 550 (PERTH); Lake King, east bank near Causeway, *P. G. Wilson* 9991 (PERTH); southern margin of Lake Barlee, *P. G. Wilson* 8814 (PERTH).

The herbarium material of the glaucous variant of subsp. *catenulata* cited above has a distinctive appearance. Other collections, however, suggest that this plant integrades with other variants of *H. halocnemoides* which are also found in the Lake King district of Western Australia.

The subspecific epithet refers to the resemblance of the articles to the links of a chain.

1e. subsp. **tenuis** P. G. Wilson, subsp. nov. Fig. 19E–F.

Articuli anguste doleiformes, ca. 5 x 2 mm, opaci vel nitidi, apicem, leviter lobati interdum apiculati, margine integro. *Spicae* fere cylindraceae 10–25 (70) mm longae, 2–3 mm diam., apicem rotundatae vel obtusae; bracteae leviter undulatae, super cymulas profunde concavae, margine integro. *Fructiculi*: perianthium firme chartaceum, leviter exsertum. *Semen* sub-orbiculare, porphyreum, lateribus granularibus.

Type: Near aerodrome, Wyndham Township, Western Australia; salt flat; spreading succulent plant 9" high; 20 July 1949; *R. A. Perry* 2558 (holo: CANB, iso: AD, BRI, NSW, NT, PERTH).

Compact to open *subshrub* ca. 0·3 m high. *Branchlets* slender, spreading; articles narrowly barrel-shaped, ca. 5 x 2 mm, dull green (not glaucous) to glossy, apex slightly lobed, margin entire. *Spikes* almost cylindrical, 10–25 (-70) mm long, 2–3 mm diam., apex rounded or obtuse, bracts slightly undulate, deeply concave over cymules, margin entire. *Florets* slightly protruding beyond bracts. *Fruiting perianth* firmly chartaceous outside, pithy within, slightly protruding from between bracts. *Seed* suborbicular with prominent radicle, 0·8–1 mm long, finely tuberculate over embryo, granular on the sides, reddish brown.

Habitat: Coastal or near coastal, frequently on tidal flats, (the central Australia variant on "semi-saline flats" and around salt springs).

Distribution: Coastal region of tropical Australia from Carnarvon (Western Australia) north and east to Wide Bay district (Queensland); also (Central Australian variant) northern South Australia and southern portion of the Northern Territory. Map 8.

Queensland: Alligator Creek near Townsville, *W. Macuae* 12.1 (BRI); Shell Ridge, 'Wernadinga', *S. Jacobs* 1386, 1387 (NSW); Elliott Heads, *L. S. Smith* 489 (BRI); Karumba, *G. Trapnell* 199 (BRI).

Western Australia: Broome, *A. C. Beauglehole* 48207 p.p. (PERTH); Nobbys Well, *W. V. Fitzgerald* (NSW); Derby, *R. D. Royce* 3335 (PERTH); Wyndham, *C. A. Gardner* 7316 (PERTH).

Northern Territory: 10 mi NE of Leguna Stn., Victoria R., *R. A. Perry* 2590 (AD, BRI, CANB, MEL).

Central Australian Variant

South Australia: Cootanoorina, 5 May 1891, *R. Helms* (AD, MEL).

Northern Territory: Tanami Desert, *A. C. Beauglehole* 50927 (PERTH); Tanami Sanctuary, *T. S. Heushall* 1232 (PERTH); 1 mi W of Central Mt. Wedge, *A. O. Nicholls* 821, 823 (PERTH).

This subspecies is most distinct in north-eastern Queensland where it is a sprawling subshrub of coastal mud-flats. There it has terete branches and slender spikes 2–3 cm long; the seed is sub-orbicular and is ornamented with small tubercles over the embryo which grade into the granulations on the sides. The plant found in the coastal swamps of the Northern Territory and at Wyndham in north-east Western Australia is very similar to the Queensland plant but further south along the Western Australian coast, e.g. at Derby

and Broome, the position becomes complicated by the presence of plants which are evidently the northern variant of subsp. *halocnemoides*. In this region of overlap the two subspecies are sympatric and, in fact, grow intermixed in the same tidal mudflats (Fig. 28). They have different (but overlapping) flowering times (that of subsp. *tenuis* being earlier in the winter than that of subsp. *halocnemoides*) but plants have been collected which are intermediate between the two subspecies in habit, vegetative morphology, and seed characters, so that it would appear likely that hybridization does occur.

H. halocnemoides subsp. *tenuis* is the only member of this species recorded from eastern and northern Queensland, the northern half of the Northern Territory, and from the north-east Kimberley area of Western Australia; no variability between the different populations has been observed in plants from these areas, nor is it likely to occur since they are isolated from the other subspecies.

A plant having an open divaricate habit, similar to that of the type variant of subsp. *tenuis*, is found in Central Australia. It has similar seed to the coastal plant and differs principally in having thicker articles. This Central Australian variant is here included within subsp. *tenuis* but further work may show that it should be recognised as a distinct taxon.

Many of the specimens of this subspecies which come from the north coast of Western Australia bear spherical galls made up of numerous separate flower-like segments. This structure has not been observed on any other species, or on any of the other subspecies of *H. halocnemoides;* when present it therefore enables one to recognise ssp. *tenuis* even when only vegetative material is available.

2. Halosarcia fimbriata P. G. Wilson, sp. nov. Fig. 20A–C.

Fruticulosus ad 1 m altus. *Articuli* late obovoidei, ca. 3 mm longi, valde lobati, lobis acuminatis saepe caudatis, margine fimbriato. *Spicae* breves, in ambito undulatae, 5–10 mm longe; articuli profunde lobati fimbriati. *Flores* ad apice expositi ad vicinas liberi, dorsiventraliter applanati truncati fimbriati. *Perianthium* tenue; lobus abaxialis parvus, lobi laterales prominentes lobos abaxiali superpositus. *Spica* fructifera sicca, bracteis tenuibus, floribus occultis; perianthium tenue, debile; pericarpium membranaceum ad perianthium coalescens. *Semen* late ovatum ca. 1 mm longum; testa tenuiter chartacea, porphyrea, super radiculam, tuberculata aliter laevis.

Type: 5 km S of Morawa, Western Australia. 4 Sept. 1970, *P. G. Wilson* 9968 (holo: PERTH, iso: CANB, K).

Subshrub to 1 m high with ascending branches. *Articles* dull pale green or glossy, broadly obovoid ca. 3 mm long, deeply lobed, the lobes triangular, acuminate and usually shortly caudate; margin prominently fimbriate. *Spikes* short and in outline prominently undulate due to the lateral compression of the articles, 5–10 mm long with 2–6 articles, at first terminal but usually becoming intercalary; fertile articles (bracts) deeply lobed and fimbriate, becoming dry and thin as fruit matures, completely obscuring flowers. *Flowers* ascending, to 1·5 mm long, free from each other but coalescent to upper bract near axis. *Perianth* thin, apex dorsiventrally flattened and fimbriate, with a pair of large lateral lobes on abaxial face and a small inner medial abaxial lobe. *Ovary* membranous. *Fruitlets* enclosed within bracts, free from each other and from bracts, eventually tearing away from axis exposing seed at their base; perianth thin, weak: pericarp membranous and coalescent to perianth. *Seed* broadly ovate, 1 mm long; testa thinly chartaceous, reddish brown, concentrically tuberculate over embryo otherwise smooth; embryo curved; endosperm lateral. *Seed* released on breakdown of perianth and pericarp at spike axis.

Habitat: Margin of salt lakes, either of common salt or gypsum.

Distribution: Lake Annean south-west to Three Springs, Western Australia. Map 5.

Western Australia: N side of Lake Austin, *A. S. George* 793 (PERTH); S side of Lake Austin, *A. S. George* 769 (PERTH); Lake Annean, *R. Hnatiuk* s.n. (PERTH); 1 km S of Three Springs, *D. Lowry* (PERTH); 3 mi S of Three Springs, *B. R. Maslin* 735 (PERTH); Carnamah, *A. Morrison* 16135 (K); Yarra Yarra Lakes, *M. D. Tindale* 1292 (NSW, PERTH); 23 km W of Wubin, *P. G. Wilson* 6480 (PERTH); 6 km S of Damboring, *P. G. Wilson* 6492 (PERTH).

The flowering spikes of this species soon become intercalary due to vegetative growth at their apex. On the maturation of the seed the bracts, perianth, and pericarp become dry and thin; eventually the fruitlets tear away from the spike axis to expose the seed which is released. The vegetative and fertile articles have a noticeably fimbriate margin from which character the specific epithet is derived.

While *H. fimbriata* in its typical state has a very distinctive appearance, two collections, that of *Maslin* 735 and *Wilson* 6492, are intermediate in morphology between this species and *H. halocnemoides* suggesting that introgression does occur between the two taxa.

Of those species of *Halosarcia* in which the perianth 'tears' away from the axis, *H. fimbriata* is probably most closely related to *H. halocnemoides*, for their seeds are very similar; in addition, in both species the perianth has a small inner abaxial lobe; however, the apex of the perianth in *H. halocnemoides* is truncate whereas in *H. fimbriata* it is dorsiventrally flattened.

3. **Halosarcia nitida** P. G. Wilson, sp. nov.

Fruticulus ca. 0·5 m altus. *Articuli* nitida ca. 5 mm longi, margine integro vel liveter crenulato, lobis breviter acuminatis. *Spicae* terminales, anguste cylindracei; bracteae cupuliformes, truncatae, margine integro vel leviter crenulato, lobis breviter acuminatis. *Flores* liberi, valde adscendentes, parte distali dorsiventraliter applanatus. *Perianthium* tenue, margo terminali rotundato vel acuminato, lobis duo, lateralibus, conduplicatis, imbricatis. *Fructiculi* demum secedentes semine exposo; perianthium tenue, nec induratum; pericarpium chartaceum, ad basim membranaceum; stylus ad basim durus. *Semen* ovoideum, 1 mm longum; testa valde tenuis pallido fusca supra embryo concentrico granularis aliter laevis.

Type: South Australia, between Lake Torrens and Lake Gairdner; at the channel at the south-eastern end of Pernatty Lagoon; 23 Oct. 1966, *Hj. Eichler* 18855 (AD96650459).

Shrub ca. 0·5 m high. *Branches* erect, articles glossy, ca. 5 mm long, margin entire to slightly crenulate, lobes shortly acuminate. *Spikes* terminal; bract pairs resembling the vegetative articles but shorter, ca. 4 mm long, becoming cup-shaped with age. *Flowers* hermaphrodite, free from each other and from bracts, ca. 3 mm long, steeply ascending, distal half dorsiventrally compressed and slightly winged, apex just exposed. *Perianth* thin (at least when dry), terminal margin rounded to acuminate; lobes two, lateral and conduplicate, imbricate, thin and soft in fruit. *Utricle* ellipsoidal, papery, membranous towards the axis; style with hard base. *Seed* ovoid, 1·0 mm long; testa very thin, pale brown, concentrically granular over embryo otherwise smooth. Fruitlets eventually tearing away from axis at base.

Habitat: Strongly saline or gypseous soil.

Distribution: North-western Victoria, central South Australia. Map 19.

Victoria: Nowingi, NW Victoria, 30 Nov. 1949, *A. M. O'Neill* (MEL 70631).

South Australia: SE corner of Lake Gairdner, *J. Pickard* 2468, 2469 (NSW); between Lake View Dam and Lake Frome, Frome Downs, *D. E. Symon* 8030 (ADW, PERTH); S shore of L. Frome, 18 Sept., 1972, *D. A. Webb* (CANB).

The nature of the perianth in *H. nitida* is interesting in that it is intermediate in structure between the type found in *H. undulata* and that found in *H. halocnemoides*. In the material included in this species may be found flowers with only a pair of terminal conduplicate lobes, ranging to flowers with imbricate lobes covering the orifice on the abaxial rounded surface but extending to the adaxial; in the latter case a small inner abaxial lobe is present. In those specimens with the conduplicate lobes the imbrication is of the type found in *H. undulata* (the lateral florets having the lobe nearest to the central floret overlapping the farthest away), while in those specimens with the imbricate lobes the imbrication is of the type found in *H. halocnemoides* (the lateral florets having the lobe nearest the central floret underlapped by that farthest away). Some specimens, as might be expected, have an indefinite imbrication.

In spite of the variability of the perianth structure I am treating the specimens as being representatives of a distinct species because I am unable to suggest from which taxon (apart from *H. halocnemoides*), *H. nitida* could be derived. In addition, the field notes suggest that sizeable populations of the taxon were present at two of the sites.

The manner in which the perianth is attached to the spike axis is similar to that found in *H. halocnemoides* but the seeds of the two species are quite different, those of *H. nitida* being almost identical to the seeds of *H. syncarpa*.

The specific epithet alludes to the glossy appearance of the plant when fresh.

4. Halosarcia fontinalis P. G. Wilson, sp. nov. Fig. 24C–E, 66.

Fruticulus at 70 cm altus. *Ramuli* tenues; articuli opaci vel glauci, margine obtuse lobato, integro. *Spicae* tenues, attenuatae, 3–8 cm longae, ca. 3·5 mm diam; articuli breviter doleiformes, margine undulato integro. *Flores* ad vicinas et bracteas liberi, leviter adscendentes, apice rotundato. *Perianthium* succulentum trilobatum: lobi laterales breves; lobus medius abaxialis prominens, semicircularis, lobos laterales superpositus. *Fructus:* perianthium medullosum (vel interdum chartaceum?), basim versus membranaceum; pericarpium membranaceum ad perianthium connatus. *Semen* obtuse ovatum, ca. 1 mm longus; testa crustacea, atroporphyrea, super radicula cum costis concentricis prominentibus porcatis ornata, aliter laevis. *Fructiculi* integri, semene includenti ad pericarpium adhaerenti secedentes.

Type: South Australia, Dalhousie Springs, 24 Sept. 1974, *D. E. Symon* 9302 (holo: ADW 47816, iso: PERTH).

Subshrub to 70 cm high. *Branchlets* slender; articles dull to glaucous, margin bluntly lobed, entire. *Spikes* terminal to main and lateral branchlets, erect, slender, attenuate, 3–8 cm long, ca. 3·5 mm diameter; articles shortly barrel-shaped, margin undulate, entire. *Flowers* hermaphrodite, free from each other and from bracts, somewhat ascending; apex rounded, 3-lobed, 2 short lateral and a semicircular outer abaxial medial lobe; perianth and ovary succulent. *Fruiting perianth* shrivelled, pithy (or sometimes firm and chartaceous?) at apex, membranous towards axis, fused to the membranous pericarp. *Seed* bluntly ovate, ca. 1 mm long; testa crustaceous, porcately ribbed over embryo, smooth on sides, dark reddish brown. Fruitlets shed entire; seed enclosed by and adherent to pericarp.

Habitat: All collections seen refer to the plant as growing around springs, presumably saline.

Distribution: northern area of South Australia. Map 9.

South Australia: Nilpena, 2 May 1891, *R. Helms* (AD, MEL, NSW); Dalhousie Springs, *P. K. Latz* 4792 (NT); ibid., Sept. 1974, Mines Dept. (ADW); 50 mi NE of William Creek, 25 Aug. 1969, *A. C. Robinson* (AD).

This species resembles *H. pergranulata* subsp. *elongata* but when in fruit may be readily distinguished by its distinctive seed. The fruiting perianth is, in the material seen, always shrivelled in the dry state but it appears likely that, as with *H. pergranulata*, under the right conditions it becomes firm and chartaceous on the outside. The perianth when ripe falls entire; it does not tear away from the spike to expose the seed as does the perianth in both *H. halocnemoides* and *H. pergranulata*.

The specific epithet refers to the association of this plant with springs.

5. Halosarcia pluriflora P. G. Wilson, sp. nov. Fig. 67.

Fruticulus ca. 1 m altus. *Rami* graciles; articuli opaci vel glauci, lobis aliquantum acutis, margine denticulato. *Spicae* graciles; articuli breviter doliiformi, lobis aliquantum acutis, margine denticulato. *Cymulae* 3–5 (7)-florae; flores ad vicinas et bracteas liberi. *Perianthium* versus apicem succulentum (sed lato abaxiali tenui); apex rotundatus, lobis 3, irregularibus, denticulatis; ovarium membranaceum. *Fructiculi:* perianthium medullosum vel chartaceum; pericarpium membranaceum ad periantbium conjunctum. *Semen* semi-circulare, 1 mm longum; testa atroporphyrea cum costis concentricis porcatis supra radiculam ornata.

Type: South Australia, Lake Eyre, May 1951, *C. W. Bouython* 1194 (holo: ADW).

Subshrub ca. 1 m high. *Branches* slender; articles dull to glaucous, lobes somewhat acute, margin denticulate. *Spikes* slender, terminal to branches and short lateral branchlets, erect; articles shortly doleiform, lobes somewhat acute, margin denticulate. *Flowers*

androdioecious, 3–5 (7) in each of the opposite bracts (when more than 3 the lateral ones reduced in size), somewhat ascending, free from each other and from bracts; perianth prominently fleshy towards apex on upper (adaxial) and lateral margins, thin below (abaxially) and towards base; apex rounded, lobes 3 at apex, irregular, denticulate, the abaxial one small and usually within the lateral lobes; male flower with small pistillode, the stigmas exerted but minute (ca. 0·2 mm long); hermaphrodite flower with linear stigmas ca. 1 mm long, ovary thin, eventually fused to the perianth. *Fruitlets* with pithy or chartaceous perianth; pericarp membranous and fused to perianth. *Seed* semi-circular, ca. 1 mm long, porcately ribbed over embryo, smooth on sides, dark reddish brown. Mature fruitlets eventually breaking away from spike axis to expose seed at their base.

Habitat: Around inland salt lakes and salt springs.

Distribution: Central and northern South Australia; north-eastern New South Wales. Map 10.

New South Wales: Warroo, via Bourke, 25 Oct. 1936, *K. I. Morriss* 4 (BRI).

South Australia: Moolawatana Bore, *R. M. Kuchel* 2669 (AD); Dalhousie Springs, *P. K. Latz* 4793 (NT); ibid., *D. E. Symon* 3254 (ADW, CANB); ibid., *D. E. Symon* 9312 (ADW, PERTH); S of Scrubby Peak, Lake Hart, May 1919, *G. Taylor* 19 (AD); Gawler Range, *P. G. Wilson* 541 (AD).

Halosarcia pluriflora is closely related to *H. fontinalis* as is evidenced by its flower structure and seed. It is peculiar in frequently having more than three flowers in each axillary cymule and in the irregularity of the perianth. This species may be distinguished from all others by a combination of characters involving its seed, its free florets, and the denticulate margin to the leaf-lobes and bracts.

One of the specimens examined (*Symon* 9312) was of a male plant with vestigial ovaries, but in those other specimens in which the anthers and ovaries could be observed these appeared to be functional.

The method of separation of the fruitlets from the spike is the same as that found in *H. halocnemoides*, *H. pergranulata*, and *H. pterygosperma*. The chartaceous perianth retains its shape and tears away from the axis due to an abscission zone between the axial septa and the fruitlet; the seed is exposed at the ruptured base.

The *Taylor* specimen from Lake Hart, which is cited above, is one of the several syntypes of *Arthrocnemum halocnemoides* var. *pergranulatum* J. M. Black.

The specific epithet refers to the presence of up to 7 flowers in a bract axil.

6. Halosarcia pergranulata (J. M. Black) P. G. Wilson, sp. et stat. nov.

Arthrocnemum halocnemoides var. *pergranulatum* J. M. Black, Trans. Roy. Soc. S. Austral. 43: 359, t.33 (1919).

Lectotype: Railway bridge between Pt. Elliot and Victor Harbour, 12 Feb. 1919, *H. W. Andrew* (holo: AD 97614357), lecto. nov.

Subshrub, erect or spreading (sometimes decumbent), ca. 50 cm high. *Articles* cylindrical, barrel-shaped, or obovoid; lobes short, rounded or obtuse; margin entire, dull green or glaucous (never glossy). *Spikes* terminal to main or lateral branchlets (rarely intercalary) to 4 cm long; articles cylindrical, barrel-shaped, or obovoid, frequently laterally compressed, the bract-pairs united, entire; triads of flowers included within bracts or their apices exposed. *Flowers* hermaphrodite (or in some variants only female flowers present), free from each other and from upper bract or fused to a varying extent; abaxial surface ascending; apex curved, and ± continuous with abaxial surface, to truncate; perianth succulent, lobes 3, 2 lateral and one lower rounded (abaxial) lobe which is either inside or outside the laterals; pericarp succulent, style slender. *Fruitlets* free from each other and from upper bract or ± united; perianth fleshy, spongy, or firmly chartaceous on the surface with pithy interior; pericarp fused to and similar in texture to perianth. *Seed* broadly ovate to circular, ca. 1 mm diameter; testa crustaceous, dark reddish-brown

to black, concentrically ribbed and porcate all over (in one variant not ribbed in centre); embryo curved. Perianth and pericarp eventually either breaking down near base, thus releasing the separate fruitlets from which the seed protrudes, or remaining attached to upper bract and spike axis.

As circumscribed in this revision *H. pergranulata* encompasses numerous variants some of which are so distinct in habit, in floral morphology, and in gross morphological appearance, as to appear deserving of recognition as distinct species. Linking all these variants together is one constant and readily observable organ, the seed, which in shape and ornamentation is so distinct as to allow one to discriminate this taxon from all others (except for the closely related species *H. doleiformis*). The variants which make up the species *H. pergranulata* appear to form an intergrading complex and the subspecies as here delimited merely represent those that are more clearly definable.

Comparison between different specimens is not always easy since the flowers and fruit change considerably in shape and texture with development, while local conditions and methods of preservation add to the morphological diversity. A number of variants have not been collected in flower, or not retained in a condition where the flower structure has been adequately preserved for critical examination, for this reason the descriptions of the subspecies do not always permit close comparison. In particular the extent of fusion between the flowers and the upper bract, the shape and position of the perianth lobes, and the shape and texture of the mature fruitlets, are not known for each of the taxa.

The imbrication of the perianth lobes is (basically) constant throughout a subspecies and provides an easy way of distinguishing subsp. *pergranulata* (the most common and widespread of the subspecies) from *H. halocnemoides*. In the western variant of subspecies *pergranulata* the abaxial lobe is large, rounded, and overlaps the lateral lobes, whereas in *H. halocnemoides* the lower lobe is small and is within the laterals. The imbrication of the lateral lobes, in relation to each other, is apparently consistent throughout the species; the lateral florets of a triad have the lobe nearest to the central floret overlapped by the outer one while in the central floret itself the imbrication can be of either type.

Lectotypification: The lectotypification of *A. halocnemoides* var. *pergranulatum* is critical since J. M. Black cited numerous collections of which four appear to have been used in the production of the illustrations accompanying his description. The collection here designated as lectotype represents the most widespread of the four subspecies recognised in *H. pergranulata* and it is also the one which best fits the original description. Of the other syntypes, one (from Cootanoorina, leg. *R. Helms*) is here referred to *H. pergranulata* subsp. *elongata*, a second (from Lake Hart, leg. *G. Taylor*) belongs to *H. pluriflora*, a third (from River Frome, leg. *J. M. Black*) is of *H. pergranulata* subsp. *divaricata*, and a fourth (from Port Alma, leg. *L. Hassell*) is of *H. pergranulata* subsp. *queenslandica*. The selection of lectotype has not been made from those syntypes collected near Adelaide (Grange and Birkenhead) since, as mentioned elsewhere, in this area subsp. *pergranulata* differs slightly from the bulk of the material included in this taxon.

Key to Subspecies

1. Flowers free from each other and from upper bract; lower perianth lobe obvious 2
1*. Flowers ± fused to each other and to upper bract; lower perianth lobe very small or absent 3
2. Spikes undulate in outline; articles somewhat laterally compressed; lower lobe of perianth prominent, usually overlapping lateral lobes a. subsp. **pergranulata**
2*. Spikes slender, terete, lower lobes of perianth shallow and scarcely overlapping lateral lobes b. subsp. **elongata**
3. Plant sprawling or decumbent; spikes slender, erect (coastal plant) c. subsp. **queenslandica**
3*. Plant erect; spikes spreading (inland plant) d. subsp. **divaricata**

6a. subsp. **pergranulata** Figs. 21, 22A–C, 42, 43.

Erect *subshrub* ca. 0·5 m high. *Articles* obovoid, dull green or glaucous; lobes short and rounded. *Spikes* terminal to branches or on lateral ascending branchlets, 3–4 mm diameter; articles barrel-shaped to shortly obovoid, either circular in cross section or laterally compressed, bract-apices convex. *Flowers* free from each other and from bracts, predominantly hermaphrodite, ascending; apex curved, lobes 3 with the large semi-circular abaxial lobe outside (in Western Australia) or inside the lateral lobes.

Habitat: Coastal swamps, brackish swamps, and margins of salt lakes.

Distribution: Western New South Wales, Western Victoria, South Australia, south Western Australia. Map 15.

New South Wales: Lake Victoria Stn., 17 Mar. 1959, *L. A. S. Johnson & E. F. Constable* (NSW 48435); Wentworth, *T. M. Whaite* 1809 (NSW).

Victoria: NW of Lake Albacutya, Sept. 1887, *C. French* (MEL); 16 mi SE of Swan Hill, *C. W. E. Moore* 3613 (CANB); Nhill, *A. C. Beauglehole* 19975 (PERTH); Tooradin, Oct. 1921, *H. B. Williamson* (CANB).

South Australia: Wallaroo, *B. J. Blaylock* 382 (AD); Redcliff, *R. J. Chinnock* 2119 (AD); near Swan Reach, *J. B. Cleland* 37 (NSW); South Pearson Island, 6 Jan. 1923, *T. G. B. Osborn* (NSW).

Western Australia: 24 mi N of Karonie, *K. M. Allan* 292 (AD); Lake Grace, *S. L. Everist* 9080 (BRI); near Dundas Rock, *B. R. Maslin* 2469 (PERTH); 1 km S of Three Springs, *R. A. Saffrey* 1568 (PERTH).

Northern Territory: "Near the MacDonnall ranges", 1889, *Rev. Schwartz* (MEL 71544).

This is the most widespread of the different subspecies of *H. pergranulata*. It can usually be recognised by its dull green or glaucous appearance and by the uneven margin of the spike; on drying it frequently takes on a dark grey colour.

There is considerable regional variation in the floral morphology and in the general appearance of this subspecies. In Western Australia the lower perianth lobe is large and obvious, both in the fresh and dried condition; in South Australia it is relatively small (about one third the width of the perianth) and thin, its position being sometimes within and sometimes outside the lateral lobes, while in the dry state it may not be immediately apparent and with age appears to become fused with the underlying perianth tissue. Around Adelaide is found a variant in which the seed is ovate (rather than circular) with the central region of either side un-ribbed. This variant ranges eastwards into Victoria and grades locally into the typical variant; it is also found in Yorke Peninsula. In New South Wales is found a variant with slender branches and spikes; this is similar to a plant found in Yorke Peninsula and in both cases looks different to the typical variant which is found in the same general area.

The subspecies *pergranulata* grades northwards in South Australia into both subsp. *elougata* and subsp. *divaricata*, although the latter two subspecies appear sometimes to retain their distinctive appearance even when growing in areas where the two occur. In coastal New South Wales it appears to grade northwards into subsp. *queenslandica*.

Plants which are evidently hybrids between *H. halocnemoides* subsp. *halocnemoides* and *H. pergranulata* subsp. *pergranulata* have been collected at various localities throughout the overlapping ranges of these two taxa. These putative hybrid plants frequently exhibit deformities and sterility of flowers—the ovules either not developing or the seed never reaching maturity.

Plants which are probably hybrids between *H. pergranulata* and *Sclerostegia arbuscula* have been collected in Port Phillip Bay. For further comment see under the latter species.

On the north coast of Western Australia is found a variant in which the flowers are adherent to each other and to the upper bract. It is an erect plant quite different in appearance from subsp. *queenslandica* which grows in a similar habitat on the Queensland coast. In the flowering state it is very similar to *H. indica* subsp. *leiostachya* and in fact the two may be found growing together on the coastal mudflats. Possibly for this reason it has been very seldom collected. The two collections seen of this north-coast variant are as follows:

Western Australia: Wyndham, *A. S. George* 14544 (PERTH); Sir Graham Moore Is., *P. G. Wilson* 11268 bis. (PERTH).

A single collection from central Queensland (Bowen Downs, MEL 70611) has slender branchlets, short terete spikes, and flowers fused to the upper bract; the orifice of the perianth is deltoid in shape, quite different from that found in subsp. *queenslandica*. For the present this plant and the collections made along the north coast of Western Australia, can only be treated broadly as being members of the species *H. pergranulata*.

The only collection of subsp. *pergranulata* from the Northern Territory (MacDonnell Ranges) comes from a locality well north of the otherwise recorded range of the subspecies. The specimen is typical of the southern South Australian populations and for this reason it seems likely that a confusion of labels has occurred.

In Western Australia the typical subspecies usually bears flowers in which the stamen is vestigial and obviously not functional; they are also often cleistogamous. In southern South Australia and Victoria the flowers are frequently hermaphrodite with apparently fertile anthers.

6b. subsp. **elongata** P. G. Wilson, subsp. nov. Fig. 22C–E.

Spicae erectae, graciles, cylindraceae, ad 6 cm longae, ca. 2·5 mm diam., bracteis fere truncatis. *Flores* libri. *Perianthium* ad apicem exposum; lobi tres, subaequales, lobo abaxiali semiorbiculari, lobos laterales leviter superposito.

Type: 7 mi SE of Rabbit Flat, 130 E, 20 15′S, Northern Territory; salt pan; 26 May 1970, *J. R. Maconochie* 1032 (holo: PERTH, ex NT 27274, iso: CANB).

Herbaceous to somewhat woody, erect to decumbent short-lived perennial, to 25 cm high. *Articles* on branchlets short cylindrical to doleiform, 3–5 mm long, ca. 2·5 mm diam., obtusely lobed, glaucous. *Spikes* terminal to branches or pedunculate on lateral ascending branchlets, slender, cylindrical, to 6 cm long, equal to branchlets in diameter; bracts similar to vegetative articles but shorter, slightly lobed, the lower margin deeply concave over the triads. *Flowers* hermaphrodite (in some specimens only female seen), free from each other and from bracts, at first ascending but eventually ± vertical to spike axis. *Perianth:* apex sub-truncate and exposed with 3 large almost equal lobes, the lower (abaxial) lobe semi-orbicular and in bud slightly overlapping the lateral lobes.

Habitat: This subspecies appears to be restricted to the strongly saline areas around salt lakes.

Distribution: Central Australia. Map 16.

?*Queensland:* E shore of Lake Buchanan, 10 mi N of Bowie Stn., *L. Adams* 1168 (BRI, CANB, NSW)—specimen in flower only.

South Australia: Curdimurka, *A. C. Beauglehole* 20885 (AD); Cootanoorina Creek, 5 May 1891, *R. Helms* (AD).

Northern Territory: Napperby Salt Lake, *C. Dunlop* 2352 (PERTH); Erldunda Stn., *T. S. Henshall* 53, 81 (NT); Napperby Stn., *T. S. Henshall* 1011, 1021 (NT); 10 mi WSW of Stuart Ras, *G. F. Hill* 227 (NSW); Mt. Dare Stn., *P. K. Latz* 4787 (NT); Lake White, *J. R. Maconochie* 934 (PERTH); 7 mi SE of Rabbit Flat, *J. R. Maconochie* 1032 (PERTH).

This subspecies is, in the dried state, similar in appearance to both *H. halocnemoides* subsp. *longispicata* and *H. fontinalis*. From the former it may be distinguished by its glaucous colour, by its circular seed which is concentrically ribbed and porcate all over, and by the lobing of the perianth (large outer lower lobe as against a small inner lower lobe). From *H. fontinalis* it is principally distinguished by its seed.

At King Sound, on the north coast of Western Australia, is found a plant which, in the dried state, is very similar in appearance to specimens of subsp. *elongata* from Central Australia. At King Sound it grows in mud on the landward edge of mangrove swamps and has a sprawling habit. It seems inappropriate at present to give this coastal plant a

distinct formal status, and yet from its habit and locality it seems incorrect to refer it to the same subspecies as the Central Australian plant. The following is the only collection seen of the coastal variant:

Western Australia: Derby, 20 Aug. 1975, *V. Semenink* 24 (PERTH).

At Lake Buchanan in north-east Queensland has been collected a flowering plant which is similar to the Central Australian specimens of subsp. *elongata*; however, fruiting material is required to permit positive identification.

6c. subsp. **queenslandica** P. G. Wilson, subsp. nov.

Spicae erectae, anguste cylindraceae, 2–3 mm diam., bracteis undulatis. *Flores* exposi, ad bracteas superus conjuncti vel partibus distalibus liberis, ad vicinas liberi vel conjuncti. *Perianthium* lobi laterales sinui; lobus abaxialis ut videtur absens.

Type: Townsville Common, Queensland, coastal mudflats, 24 Feb. 1977, *P. G. Wilson* s.n., (holo: PERTH, iso: BRI, CANB, K, NSW).

Open straggly, often decumbent *subshrub* to 25 cm high; branches slender. *Articles* cylindrical to barrel-shaped, ca. 5 mm long on branchlets, dull to glaucous, apex very shortly and bluntly lobed. *Spikes* narrowly cylindrical, 1–3 cm long, 2–3 mm diameter, bract pairs with undulate margin. *Flowers* either totally fused to upper bract or free at distal edge, either free from or fused to each other. Lower perianth lobe not observed; lateral lobes sinuous.

Habitat: Coastal mud-flats.

Distribution: Queensland coast at least from Burketown east and south to Brisbane.

Queensland: Cooktown, *S. T. Blake* 21876 (BRI); Serpentine Ck., *L. Durrington* 593 (BRI); Whyte Is., *L. Durrington* 1337 (BRI); Marmon, Mar. 1920, *W. D. Francis* (BRI); 48 km N of Burketown, *T. J. Hall* 590 (BRI); Port Alma, Oct. 1919, *L. Hassell* (AD, BRI); Townsville, *W. Macnae* 12.3 p.p. (BRI); Curtis Is., 21 Apr. 1962, *W. Macnae* (BRI); Nudgee Beach, 6 July 1940, *L. S. Smith* (BRI); Cribbe Is., *Van Royen* 9365 (BRI).

This subspecies appears to contain three variants but these, with further collecting, may be shown to be representatives of a continuous cline running around the east and north-east coast of Australia. The variants differ in the degree of fusion of the flowers with each other and with the upper bract: in the variant found near Townsville (which includes the type) the flowers are free from each other and, at their distal margin, from the upper bract (at least when young); in the southern variant (Brisbane to Rockhampton), the flowers are totally fused to the upper bract (the epidermis being continuous over both organs) and to each other in the distal half. A single collection from Burketown in the Gulf of Carpentaria has spikes similar to the southern variant but with the flowers totally fused together. Plants from all localities occupy a similar habitat (coastal mudflats or mangrove swamps) and have a virtually identical vegetative appearance and habit; for this reason it does not seem profitable to make formal taxonomic divisions within this subspecies.

There is no indication that subsp. *queenslandica* grades into the inland subspecies nor does it appear to hybridize with other *Halosarcia* species which occur in the same area and habitat, but it may form a clinal relationship with the coastal variant of subsp. *pergranulatum* which occurs in southern New South Wales, a supposition that again can only be confirmed or otherwise by further collecting. It may also grade westwards along the north coast of Australia into the variant of subspecies *pergranulata* found on the north coast of Western Australia; here the plants are erect, with the florets somewhat adnate (but not fused) to each other and the upper bract.

In none of the collections examined have any fertile stamens been seen and, in fact, a study of material which is at a stage, or in a condition, suited to investigation has in all cases shown that the flowers bear a staminode which consists of a minute vestige about 0·1 mm long. In some flowers the stigmas become exserted but in others they remain

within the perianth and in either case seed is formed. It would appear that the plants are parthenogenic and it is interesting that the variant of *H. indica* subsp. *indica* which also grows on coastal mudflats likewise has only female flowers. The adoption of an apomictic mode of reproduction could in these cases, be related to the habitat which is subject to tidal inundation; however, in other instances (e.g. in *H. leptoclada*) this mode of reproduction is obviously not related to a tidal situation.

The precise morphology of the perianth in this subspecies is uncertain; no lower (abaxial) lobe has been observed although it is possible that this lobe is present but diaphanous and that at an early stage it becomes fused with the underlying perianth tissue; the lateral lobes are long and sinuous. Fresh material at an early stage of anthesis should be studied to determine the situation.

The two subspecies, *queenslandica* and *divaricata*, are evidently closely related but their distinct appearance suggests that, apart from other characters, they should be recognised as separate taxa.

6d. subsp. **divaricata** P. G. Wilson, subsp. nov.

Spicae divaricatae, cylindraceae, 1–3 cm longae, ca. 3·5 mm diam., bracteis undulatis. *Flores* exposi, ad vicinas et bracteas superas conjuncti, apicem truncati. *Perianthii* lobi laterales late imbricati, grandes; lobus abaxialis semi-circularis, membranaceus lobos laterales superpositus.

Type: Goyders Lagoon, 8 km S of Koonchera Waterhole, 26°46′S, 139°31′E, South Australia; sand dunes; 14 Aug. 1975, *J. Z. Weber* 4497 (holo: AD).

Dense erect *shrub* to 1 m high. *Articles* on branchlets cylindrical to obovoid, greyish green, apex bluntly lobed. *Spikes* divaricate, usually on very short lateral branchlets, cylindrical 1–3 cm long, ca. 3·5 mm diam., with up to 20 articles: bract pairs undulate, ± circular in cross-section. *Flowers* either female or hermaphrodite, exposed at apex, fused to each other and to upper bract; apex truncate with the centre slightly raised.

Perianth: lateral lobes broadly imbricate, the outer one prominent, semi-circular, extending length of apex, lower (abaxial) lobe membranous, semi-circular, either outside or inside the lateral lobes. *Seed* as in subsp. *pergranulata*. Fruiting perianth remaining attached to spike and together eventually breaking down to release seed.

Habitat: Inland claypans; apparently not in strongly saline soils.

Distribution: South-western Queensland, western New South Wales, north-western Victoria, north-eastern South Australia. Map 16.

Queensland: Nockatunga, 5 Jan. 1935, *A. C. Boyle* (BRI); Mulligan River, Feb. 1904, *H. Clarke* (NSW); S of Eulo, 31 July 1962, anon. (BRI); Birdsville-Betoota Rd., 9 Aug. 1964, *A. Rodd* (NSW).

New South Wales: Delalah Downs, *G. M. Cunningham* 516 (NSW); Fort Bourke, Oct. 1919, *T. Waddell* (NSW).

Victoria: 17 km NW of Kerang, *A. C. Beauglehole* 57137 (PERTH).

South Australia: 24 km S of William Ck., *A. C. Beauglehole* 2081 (AD); Mt. Dare Stn., *P. K. Latz* (NT); Oaken Hills, *B. J. Murray* 503/2 (AD).

This subspecies is strictly an inland plant of eremaean situations. It may be recognized by its short cylindrical spikes which are strongly spreading and are borne on short lateral branchlets. The flowers are intimately fused to the upper bract and to other members of the cymule; in fact the epidermis is continuous over both bract and flowers. The lower (abaxial) perianth lobe is probably always present but being very delicate soon becomes indistinguishable from the underlying perianth tissue into which it appears to merge with the development of the fruit.

The subspecies *divaricata* grades to the south into the typical subspecies; plants intermediate in location have a depression between the flowers and the bract; in plants even further to the south this depression develops into an absence of cohesion between the two organs. There is no suggestion of introgression of subsp. *divaricata* with subsp. *elongata* even though the two subspecies are to some extent parapatric.

7. Halosarcia doleiformis P. G. Wilson, sp. nov. Fig. 22F–G.

Salicornia leiostachya Benth., Fl. Austral. 5: 204 (1870) p.pte., as to "Drummond, (Herb. F. Mueller)", not as to lectotype.

Fruticulosus ad 0·5 m altus. *Articuli* glaucescentes, doleiformes, ca. 5 mm longi, in statu sicco medullosi, apice leviter lobato, margine ciliolato. *Spicae* terminales, anguste cylindraceae, attenuatae, ad 15 mm longae, laeves et medullosae; bracteae confertim imbricatae (segmentis undulatis), rotundatae, ad vicinas coalescentes; facies abaxialis valde adscendens. *Perianthium* versus apicem succulentum, margine adaxiali ciliolato; lobos laterales superpositus. *Spica fructifera* grisea, laevis; bracteae siccae, medullosae, confertim imbricatae, floribus occultis; perianthium medullosum; pericarpium tenue, molle, ad perianthium adhaerens. *Semen* fere circulare, ca. 1 mm diam.; testa crustacea atroporphyrea, cum costis concentricis prominentibus porcatis ornata.

Type: Murchison River, ca. 8 km E of Mt. Narryer, 26°30′S, 116°20′E, rounded shrub 0·3–0·6 m high, 2 Sept. 1970, *P. G. Wilson* 9914 (holo: PERTH, iso: CANB, K, NSW).

Low spreading rounded *subshrub* to 0·5 m high. *Articles* dull green, doleiform, ca. 5 mm long, pithy when dry; apex slightly lobed; margin ciliolate. *Spikes* terminal to branches, narrowly cylindrical and attenuate, to 15 mm long, grey, smooth, and pithy when mature; bracts closely sheathing, the opposite members connate and forming an undulate segment, margin ciliolate. *Flowers* hermaphrodite, in disjunct triads, steeply ascending, coalescent to each other laterally and frequently to upper bract, apex rounded, somewhat exposed. *Perianth* succulent towards apex with its upper (adaxial) edge forming a thin ciliolate border; lower (abaxial) lobe prominent, semi-orbicular, ciliolate, overlapping the large lateral lobes; anther ca. 1 mm long; ovary membranous, free from perianth; stigmas slender. *Fruiting spike* grey and smooth in outline, the bracts dry, pithy, closely sheathing so as to obscure the fruitlets; perianth pithy; pericarp thin and soft, adherent to the perianth. *Seed* flat, almost circular, ca. 1 mm diameter; testa crustaceous, very dark reddish brown, concentrically ribbed all over, the ribs with porcate sculpturing; embryo slightly curved; perisperm lateral. *Seed* released on decay of spike.

Distribution: South-western Western Australia from Shark Bay south to Northam and south-east to the Norseman district. Map 3.

Western Australia: Lake Ninan, *T. E. H. Aplin* 731 (PERTH); Western Australia, *J. Drummond* s.n. (K, MEL, NSW—syntype of *Salicornia leiostachya*); Dirk Hartog Is., *A. S. George* 11609 (PERTH); 16 km S of Mt. Jackson, *K. F. Kenneally* 4741 (PERTH); 145 km E of Norseman, *P. G. Wilson* 10116 (PERTH); 93 km N of Esperance, *P. G. Wilson* 10129 (PERTH).

Halosarcia doleiformis is closely related to, and in some situations sympatric with, *H. pergranulata*. It may be readily distinguished from the latter species by its barrel-shaped articles which become pithy with age and retain their form, by its smooth attenuate spikes, and by the ciliolate margin to the articles and bracts. In the mature fruitlets of *H. pergranulata* the perianth either remains fleshy and eventually shrivels or it becomes firmly chartaceous on the outside and retains its deltoid outline (from above), in either case the fruitlets fall away from the spike axis. In *H. doleiformis* the perianth becomes dry and pithy, similar to the bracts in texture, the whole spike being brittle and readily fragmenting between the articles. The seeds of the two species are virtually identical.

Specimens which are intermediate in form between *H. doleiformis* and *H. pergranulata* have been collected; examples are as follows: Goomalling, *T. E. H. Aplin* 714; 8 km S of Coorow, *A. S. George* 2310; 15 km E of Wagin, *P. G. Wilson* 8270 (all herb. PERTH).

The specific epithet refers to the barrel-shaped appearance of the dry articles.

The flower of *H. doleiformis* resembles the southern Western Australian variant of *H. pergranulata* (i.e. in having a large rounded outer abaxial lobe), and therefore, considering the virtual identity of the seeds of the two species, it seems likely that the two plants have arisen in this region from a common ancestor in Western Australia. As is noted elsewhere in the text, the form taken by the flower of *H. pergranulata* in other areas of Australia differs considerably from that found in *H. doleiformis*.

8. Halosarcia lepidosperma P. G. Wilson, sp. nov. Fig. 23D–F, 44, 45.

Fruticulosus ad 1 m altus, ramis erectis. *Articuli* obovoidei vel doliiformes vel cylindracei 5–10 mm longi leviter glauci. *Spicae* graciles, aequaliter cylindraceae, ad 50 mm longae 3·5–5 mm diam.; bracteae truncatae. *Flores* fere liberi leviter adscendentes, apice truncato. *Perianthium* succulentum; lobus medius abaxialis prominens, semi-circularis, integer, lobos laterales superpositus. Perianthium in fructo succulentum, demum spongiosum; pericarpium membranaceum, ad perianthium connatum. *Fructiculi* demum secedentes semine exposo. *Semen* sub-orbiculare, ca. 1·5 mm longum, album; testa in costis prominentibus squamiformibus ornata; embryo semi-circularis.

Type: Western Australia, Baandee townsite W of Merredin; light brown soil on edge of salt lake; 21 June 1969, *R. A. Saffrey* 621b (holo: PERTH, iso: CANB).

Subshrub to 1 m high; branches slender, erect. Articles obovoid to barrel-shaped or cylindrical, 5–10 mm long, yellowish green to dull green, slightly glaucous. *Spikes* slender, terminal to branches or sub-sessile, evenly cylindrical to 50 mm long, 3·5–5 mm diam., apex ± rounded; bracts truncate, the opposite pairs united; cymules disjunct, prominently exposed at apex. *Flowers* almost free from each other, slightly ascending (upper and lower sides ± parallel), apex truncate and broadly oblong (central flower), or triangular (lateral flowers); perianth succulent, 3-lobed in centre of apex, the lower (abaxial) lobe large semi-circular, and overlapping the pair of lateral lobes; ovary membranous. *Fruitlets* not or scarcely exceeding bracts; perianth succulent, eventually spongy and becoming shrivelled on drying, or firm and chartaceous on outside; pericarp membranous, fused with perianth which eventually falls from the spike with the seed which is exposed at the torn perianth base. *Seed* sub-orbicular, ca. 1·5 mm long, white or pale fawn when dry; outer testa raised on the margin to form 5–7 concentric scale-like ribs with transverse corrugations (sides of seed smooth); embryo semi-circular; perisperm lateral (somewhat enclosed).

Habitat: Growing in moderately or only slightly saline soil.

Distribution: South-western Western Australia and south-western South Australia. Map 1.

South Australia: Stenhouse Bay, Yorke Peninsula, *D. Symon* 9641B (ADW); Lake Pillie, 10 km S of Pt. Lincoln, *P. G. Wilson* 2678 (AD).

Western Australia: 8 km W of Tammin, *K. M. Allan* 1 (PERTH); 2 mi W of Waeel, *T. E. H. Aplin* 670 (PERTH); 18 mi S of Wagin, *E. M. Bennett* 3070 (PERTH); Point Pedder, Hardy Inlet, *Congdon & McComb* 74032b (PERTH); Oldfield River, *Hj. Eichler* 20240 (PERTH); Stokes Inlet, *Hj. Eichler* 20319 (PERTH); Lake Wagin, *Miss Cronin* (MEL); 3 mi E of Newdegate, *A. S. George* 7338 (PERTH); 4 mi N of Pt. Malcolm, *R. Hnatiuk* 761200 (PERTH); Burswood Is., Swan R., 14 Apr. 1900, *A. Morrison* (BRI, CANB, PERTH); N of Stirling Ra., Oct. 1867, *F. Mueller* (MEL 71463); ibid., 1869, *F. Mueller* (K); 1 mi N of Ongerup, *K. Newbey* 3067 (PERTH); between Miling and Pithara, *P. G. Wilson* 9979 (PERTH).

Halosarcia lepidosperma may be readily recognised by its long evenly cylindrical spikes and by its seeds which are white with smooth concentric scale-like ribs over the embryo. In the field it is usually of a more yellowish green (tending towards chlorotic in appearance) than other *Halosarcia* species growing in the same area. In herbaria it has been confused with *H. pterygosperma* which also has white seeds; the latter species may be readily distinguished by its short spikes with undulate outline and by the seed in which the ribs are rough and cover the entire surface of the testa (Fig. 46). The seed of *H. lepidosperma* is almost identical to that of *Tegicornia uniflora* but in other respects the two species have little in common.

Halosarcia lepidosperma is one of the most common samphire species in the south-west of Western Australia. It is an early invader of the newly created saline areas which follow the clearing of woodland and is frequently present along roadside drainage channels in salt-affected country. Only two collections made prior to 1900 have been seen ("Margin of salt lakes north of Stirling Range, Oct. 1867, *F. Mueller*", which was included under *Salicornia bidens* by Bentham, and Lake Wagin, leg. *Miss Crouin*). This suggests that the plant was far less common in the nineteenth century. The localities of the few collections made in South Australia are such as to suggest that it is a recent introduction to that State.

This species exhibits no apparent regional variation and does not appear to hybridise with any other member of the genus.

The specific epithet is derived from the Greek words *lepidos* (scale) and *sperma* (seed); referring to the scale-like ribs on the seed.

9. Halosarcia pterygosperma (J. M. Black) P. G. Wilson, comb. et stat. nov.

Arthrocnemum halocnemoides var. *pterygospermum* J. M. Black, Trans. Roy. Soc. S. Austral. 60: 166 (1936).

Type: Mount Victor Station, 24 May 1936, *C. M. Eardley* (holo: AD 97614361, iso: MEL 70586).

Spreading *subshrub* to 0·5 m high, with slender divaricate branches. *Articles* narrowly to broadly obovoid, ca. 5 mm long, dull green or somewhat glaucous. *Spikes* terminal to main and lateral branches, cylindrical to ellipsoidal, to 30 mm long and 5 mm diam., with up to 15 articles; bract pairs united or apparently free, ± deeply concave over cymules; opposite cymules contiguous. *Flowers* free, or adherent to each other and to bracts at least towards axis, arranged vertical to axis, deltoid in shape from above with both adaxial and abaxial sides horizontal; apex truncate, quadrate to transversely oblong, 1·5 mm long and wide, 1·2 mm high; perianth succulent; lobes 3 in centre of apex, entire or denticulate, the lower lobe semi-circular and overlapping the pair of curved lateral lobes; anther ca. 1 mm long. *Fruiting spikelets* with thin shrivelled bracts forming septa-like plates between the disjunct whorls of fruitlets. *Fruitlets* deltoid from above, to 2·5 mm long, considerably exceeding bracts and readily shed when mature (the seed totally enclosed), perianth chartaceous, glossy, hollow (somewhat mucilaginous around seed when immature); pericarp membranous or apparently absent. *Seed* thick, ovoid, ca. 1·5 mm long, pale fawn to cream coloured; outer testa raised into corrugated scale-like ribs over whole of seed (or the cells of the ribs ± separate and forming curved to uncinate hairs); embryo slightly curved; perisperm lateral.

This species is distinctive because of its fruiting spikes in which the fruitlets are arranged in prominent whorls considerably exceeding the bracts. The perianth of the fruitlet is papery and glossy, which, with the white ovoid seeds with prominent uneven ribs, clearly distinguishes *H. pterygosperma* from other species.

The distinction between the two subspecies noted below is not sharp for in collections of subsp. *pterygosperma* which come from areas towards the western end of its range the articles are ciliolate and the ornamentation of the testa is somewhat intermediate between the typical variants of the two subspecies.

Key to subspecies

1. Vegetative articles with rounded to obtuse lobes; testa raised into scale-like ribs ..... a. subsp. **pterygosperma**

1*. Vegetative articles with acuminate or apiculate lobes; testa covered with rows of uncinate hairs which may be united towards their base ..... b. subsp. **denticulata**

9a. subsp. **pterygosperma**. Fig. 46, 47.

Articles with rounded to obtuse lobes, margins entire to ciliolate. *Spikes* ± cylindrical; fertile articles undulate. *Perianth:* lower lobe entire. *Seed:* testa raised into scale-like ribs.

Habitat: Margin of salt lakes.

Distribution: Western New South Wales and Victoria, central and south-western South Australia, south-central and south-eastern Western Australia (from Shark Bay eastwards). Map 17.

New South Wales: Donsandel (Broken Hill), 10 Oct. 1974, *L. Richley* (NSW).

Victoria: 30 mi S of Mildura, *J. Cullimore* 9 (AD, BRI, NSW, PERTH); 8 mi SSE of Ouyen, *J. Cullimore* 49 (AD, NSW); Lake Wahpool, *N. Macfarlane* 852 (PERTH); Cowongie, 29 Aug. 1955, *J. H. Willis* (MEL).

South Australia: Fowlers Bay, Bay III, 29 Jan. 1802, *R. Brown* (BM); Koonamore, *Hj. Eichler* 12433 (AD); Yalata Swamp, *A. E. Orchard* 3214 (AD).

Western Australia: Quelquelling Wells, *T. E. H. Aplin* 708, 2217 (PERTH); 5 km NE of Norseman, *A. C. Beauglehole* 49380 (PERTH); Nanga Stn., *A. Devitt* 71 (PERTH); Dirk Hartog Is., *A. S. George* 11454a (PERTH); Lake Anneen, 28 Mar. 1976, *R. Huatiuk* (PERTH); Mundrabilla Stn., *C. V. Malcolm* 652 (PERTH); Nullarbor H.S., *A. E. Orchard* (PERTH); S end of Hamelin Pool, *P. G. Wilson* 8229 (PERTH); 305 km N of Geraldton, *P. G. Wilson* 8331 (PERTH); 21 km N of Mt. Ragged, *P. G. Wilson* 10100 (PERTH).

9b. subsp. **denticulata** P. G. Wilson, subsp. nov. Fig. 24A–E.

Lobis articularum acuminatis vel apiculatis, margine ciliolato. *Spicae* ellipsoideae; bracteae ad apicem liberae vel fere liberae, facie exteriori transverse triangulari. *Perianthium* lobo medio abaxiali denticulato. *Testa* chartacea, pilis uncinatis seriatis ornatis.

Type: Western Australia, 6 mi SW of Yardie Creek H.S., North-West Cape; shrub 20 cm, ± bright green; open saline flat, 6 Sept. 1970, *A. S. George* 10311 (holo: PERTH).

Articles with acuminate or apiculate lobes, margins ciliolate. *Spikes* ellipsoidal with rounded apices; bracts either united and markedly concave above triads or ± distinct distally with the outer surface transversely triangular in outline. *Perianth:* lower lobe denticulate. *Seed:* testa covered with rows of uncinate hairs which are sometimes united towards their base.

Habitat: Coastal (or near coastal), in tidal flats, along tidal creeks, and margins of salt lakes.

Distribution: Lake Macleod north-east to the Eighty Mile Beach, Western Australia. Map 17.

Western Australia: 9 mi N of Yardie Ck., *K. Allan* 454 (PERTH); Wooroo Ck., Eighty Mile Beach, *N. T. Burbidge* 1307 (PERTH); Lake Macleod, *A. S. George* 10196 (PERTH); Cape Keraudren, *A. S. George* 14823 (PERTH); ibid., 26 June 1974, R. E. Johnstone (PERTH).

10. Halosareia lylei (Ewart et White) P. G. Wilson, comb. nov. Fig. 23A–C, 48, 49.

Salicornia lylei Ewart et White, J. Roy. Soc. N.S. Wales 42: 195, t.34 (1909). *Arthrocnemum lylei* (Ewart et White) J. M. Black, Trans. Roy. Soc. S. Austral. 43:359, t.34 (1919).

Lectotype: Cowcowing, near salt lakes, Sept. 1904, *M. Koch* 1051 (holo: MEL, ?iso: NSW), cf. J. M. Black, op cit. 360.

Erect woody *perennial* to 1 m high, frequently with several fastigiate stems arising from the rootstock. *Branchlets* very slender, evenly and narrowly cylindrical; articles ca. 3 mm long, not swollen, dull green, margin truncate, eciliate, leaf-lobes apiculate. *Spikes* terminal, slender, to 20 mm long, 3·5–4·5 mm diameter. *Bracts* short, the opposite pairs united, lobes deltoid, freely exposing the flowers. Cymules contiguous. *Flowers* perpendicular to spike axis, free from each other and from bracts; apex quadrate, truncate. *Perianth* fleshy, orifice triangular in centre of apex, abaxial lobe overlapped by the pair of lateral lobes. Anther ca. 1 mm long. Ovary at first membranous and free from perianth; style very short and thickened at base; stigmas narrowly triangular ca. 0·5 mm long. *Fruitlets* extending beyond bract, 1·5–2 mm long, firm and pithy (not indurated); pericarp convex and protruding slightly from perianth giving it a mammillate appearance, crustaceous at apex where fused to perianth, membranous below; style base persistent, hard. *Seed* broadly elliptical, reddish brown, 1–1·5 mm long; testa crustaceous, concentrically granular over embryo, otherwise ± smooth; embryo curved; perisperm lateral. Fruitlets shed with enclosed pericarp and seed.

Habitat: Usually around salt lakes but also in poorly drained inland localities.

Distribution: Western Victoria, south-western South Australia, south-western Western Australia. Map 12.

Victoria: Landrook Lake, *A. C. Beauglehole* 19814 (PERTH); Tyrrell Ck., 5 Sept. 1965, *J. H. Willis* (MEL); 8 mi W of Nowingi, 1936, *W. J. Zimmer* (MEL).

South Australia: S of Lake Bring, *D. E. Symon* 3391 (ADW, CANB, K); near Maralinga, *S. Warne* 20103 (AD).

Western Australia: 2 mi W of Waeel, *T. E. H. Aplin* 665 (PERTH); between Dundas Hills and Lake Lefroy, *J. D. Batt* (MEL); Lake Lefroy, 7 Nov. 1891, *R. Helms* (AD, MEL, NSW); Cowcowing, July 1904, *M. Koch* 1051 (NSW, syntype); ibid., Aug. 1904, *M. Koch* 1051 (NSW, syntype); ibid., Dec. 1904, *M. Koch* 1051 (K, syntype); Lake Biddy, 22 Sept. 1971, *C. V. Malcolm* (PERTH).

Halosarcia lylei may be readily identified because of its slender branches, which are similar to the branches of *Casuarina;* in addition, the mammilliform appearance of the fruitlets clearly distinguishes it from all other species. The fruitlets are similar in structure to those of *H. halocnemoides* and, as in that species, the seed is shed with the perianth; however, in *H. lylei* the seed is almost totally enclosed by that structure since the fruitlets are only slightly embedded in the spike axis, whereas in *H. halocnemoides* the prominent interfloral radial septa of the axis are fused to the proximal portion of the perianth, and an abscission zone forms well above the base of the flower causing the seed to be exposed on the release of the fruitlets.

The plant found in South Australia has thicker inflorescences than does material from Victoria and Western Australia, and in South Australia the seed is 1·5 mm long whereas in Western Australia it is only 1 mm.

11. Halosarcia leptoclada P. G. Wilson, sp. nov.

Fruticulus parvus, diffusus ad 30 cm altus. *Rami* graciles; articuli teres, doliiformes vel anguste obovoidei, apice breviter et obscure lobato, integro. *Spicae* anguste ellipsoideae, ad 10 mm longae; bracteae confertim imbricatae, ± truncatae. *Flores* occulti, initio ad vicinas coalescentum, basim versus membranaceum; apice ± truncatus, lobis lateralibus prominentibus, lobo medio abaxiali interno; stamen sterile vel absens; ovarium membranaceum. *Fructiculi* libri, semine inclusum; perianthum crustaceum, extra muricatum, apice truncato late ovato; pericarpium tenue, basim versus absens. *Semen* ovatum, ca 0·8 mm longum; testa membranacea, straminea, laevis.

Type: Western Australia: Mt. Sandiman Stn., north-east of Carnarvon; on saline stony uplands, Aug. 1969, *D. G. Wilcox* 53 (holo; PERTH).

Small divaricately branched delicate *subshrub* ca. 30 cm high. *Branches* slender; articles terete to doleiform or obovoid, 5–8 mm long, dull to glaucous; apex with small, rounded, and entire lobes. *Spikes* terminal to main and lateral branches, narrowly ellipsoidal, of 4–10 articles, to 10 mm long; bracts closely imbricate, the opposite pair united with ± horizontal margin. *Flowers* in ± contiguous triads, obscured by bracts, abaxial surface ascending, at first adherent laterally to neighbouring florets, to upper bract (except towards apex), and in proximal third to lower bract, ca. 1 mm long. *Perianth* succulent at apex, thin towards base; apex ± truncate with a pair of prominent lateral lobes and a small inner abaxial lobe. Stamen absent, or present and sterile. Ovary membranous. *Fruiting spike:* bracts shrivelling on drying and eventually falling as plate-like rings from the slender spike axis. *Fruitlets* free from each other and from bracts, standing vertical to spike axis, broadly ovoid in lateral view, ca. 1·5 mm long, completely enclosing the seed; perianth forming a thin crustaceous inner layer which is smooth within but areolate-muricate on outside, apex ± truncate, broad-oval in outline and slightly conical in centre due to projecting lateral lobes; pericarp thin, membranous or absent towards the base. *Seed* ovate, ca. 0·8 mm long; testa membranous, very pale fawn coloured, smooth or with very fine longitudinal lines over embryo; embryo somewhat curved; perisperm lateral, prominent.

The epithet *leptoclada* is derived from the two Greek words '*leptos*' slender, and '*clados*' branch; it refers to the slender branches.

The species consists of two variants which are morphologically very distinct and geographically disjunct. Due to their having almost identical fruit I am treating them as subspecies since I consider it probable that further collecting will indicate that they are clinally related to each other.

Key to subspecies

Articles cylindrical to barrel-shaped; perianth (in flower) dorsiventrally flattened towards apex ..... 11a. subsp. **leptoclada**
Articles narrowly obovoid; perianth (in flower) rounded to truncate at apex ..... 11b. subsp. **inclusa**

11a. subsp. **leptoclada.** Fig. 25D–E.

Branchlets slender and terete, or the articles doleiform. *Flowers* with perianth lobes thin and forming a beak-like ascending conical apex; stamen sterile, the anther ca. 0·6 mm long; stigmas exserted, slender. *Fruitlets* with truncate broadly elliptic apex, the perianth lobes projecting in centre.

Habitat: Stony areas, frequently saline.

Distribution: Gascoyne River area of Western Australia. Map 18.

Western Australia: Wanna, *J. S. Beard* 6064 (NSW, PERTH); Mt. Vernon, *A. Mitchell* 221 (PERTH); Jimba Jimba Stn., *D. G. Wilcox* 10 (PERTH); Dalgety Downs Stn., *D. G. Wilcox* 137 (PERTH).

11b. subsp. **inclusa** P. G. Wilson, subsp. nov. Fig. 25F–I, 60.

Articuli obovoidei vel anguste obovoidei; perianthium (in flore) ad apicem rotundatum vel truncatum.

Type: 3 km E of Meckering on Mortlock R. flats, Western Australia; sandy saline soil; open subshrub 20 cm high, articles dull green; 4 Nov. 1977; *P. G. Wilson* 11692 (holo: PERTH, iso: CANB, K, MEL).

Branchlets slender; articles narrowly obovoid. *Perianth* ± truncate at apex in flower, the lateral lobes eventually prominent in fruit as a vertical beak. *Style* frequently remaining within the perianth.

Habitat: Sandy or loamy saline areas.

Distribution: South-western Western Australia. Map 18.

Western Australia: 34 km N of Westonia, *K. M. Allan* (PERTH); 5 mi W of Pingaring, *A. S. George* 9361 (PERTH); One Mile Rocks Reserve, *A. S. George* 10505 (PERTH); 2 km N of Mt. Stirling, *B. R. Maslin* 182 (PERTH); 1 mi S of King Rocks, *K. Newbey* 3244 (PERTH); Hines Hill, *R. A. Saffrey* 619 (PERTH); 2 mi W of Ravenswood, *A. S. Weston* 7404 (PERTH); 4 km S of Three Springs, *T. & J. Whaite* 4227 (PERTH); 25 km S of Perenjori, *P. G. Wilson* 8253 (PERTH).

The subspecific epithet refers to the fact that the stigmas frequently remain enclosed within the perianth.

The species *Halosarcia leptoclada* is peculiar in having prominent lateral perianth lobes which in fruit protrude as a short beak (in the flower, at least in subsp. *inclusa*, they are flush with the perianth apex). In neither subspecies have fertile anthers been observed although in subsp. *leptoclada* a well-formed (but sterile) anther ca. 0·6 mm long is present. The staminode in subsp. *inclusa* is minute (ca. 0·2 mm long) and has no recognisable antherode; in this subspecies the stigma does not always emerge, in fact it normally remains folded within the perianth. This is the situation as it has been observed in the field in a population near Meckering and in herbarium material from near Lake King. It is likely that in other localities the plant is normally hermaphrodite since a collection from near Pingaring (*A. S. George* 9361) bears flowers with a fertile stamen and ovary; it is more robust than the other collections of subsp. *inclusa* and the spikes frequently become intercalary. From the material available it is not possible to say whether it is a hybrid, or whether it should be recognised as a distinct taxon.

A collection made by Cecil Andrews at Canning Plains (near Perth) in October 1902 has the general appearance of *H. leptoclada* subsp. *inclusa*, but the material (which is in bud) has been badly preserved and it is not possible to be certain of its identity; the flowers have fertile anthers. Duplicates of this collection are present in the herbaria BM, K and PERTH.

Halosarcia leptoclada subsp. **inclusa** x **H. pruinosa**?

A plant which is intermediate in appearance between *H. leptoclada* ssp. *inclusa* and *H. pruinosa* has been collected near Three Springs and at Ajana, Western Australia. A description of the putative hybrid follows:

Small much-branched *shrub* to 50 cm high. *Branchlets* thin. Vegetative *articles* doleiform to obovoid, 3–8 mm long, dull to glaucous, with shallow broadly rounded lobes; margin broad and scarious, entire. *Spikes* terminal to branchlets, short, of 3–6 articles, the bracts similar to but shorter than the vegetative articles, circular in cross-section and somewhat swollen to give the spike an uneven appearance, ca. 3·5 mm diam. *Flowers* obscured by bracts (the triads contiguous), free from each other and from bracts; abaxial side steeply ascending; perianth beaker-shaped, lower half with fleshy lateral walls, upper (distal) part membranous and somewhat dorsiventrally compressed, apex wide, open and truncate, in bud consisting of a pair of lateral equitant lobes which are not apparent at anthesis. *Fruiting spike:* bracts thin and shrivelled; perianth ± horizontal with ascending strongly dorsiventrally flattened tongue-like apex, walls thin and soft, deeply honeycombed outside, smooth and glossy within; pericarp membranous, absent towards base. *Seed* ovoid, ca. 1 mm long; testa thin, very pale brown, smooth; embryo slightly curved; perisperm lateral.

Distribution: Ajana and Three Springs. S.E. of Ajana, 6 Aug. 1976, *R. Hnatiuk* s.n. (PERTH); 5 km S of Three Springs, by salt lake, 2 Oct. 1976, *T. & J. Whaite* 4225 and 4226 (PERTH).

12. Halosarcia flabelliformis P. G. Wilson, sp. nov. Fig. 8, 24F–H, 50, 51.

Fruticulosus ad 20 cm altus. *Articuli* anguste obovoidei vel doleiformi, ca. 5 x 2·5 mm, margine fere truncato integro. *Spicae* cylindraceae vel aliquantum attenuatae, 20–40 mm longae, ca. 5 mm diam., in ambito laevi, apice obtuso vel rotundato. *Bracteae* oppositae, librae, flabelliformes, facie exteriori trapezoidea. *Flores* ad axem spicae verticales, ad vicinas et bracteas liberi, apice truncato, trapezoidea. *Perianthium* succulentum, parietibus lateralibus et apice crasso, pariete adaxiali tenui; lobis laterali duo, magni; lobus abaxialis minutus, internus. *Ovarium* tenue. *Spica fructifera* demum in parte discreta secedens; perianthium in dimidiis translucidis secedens; pericarpium membranaceum, librum. *Semen* applanatum, late ellipticum ca. 1·8 mm longum; testa tenuis, transluceda, super radiculam tuberculata, aliter laevis.

Type: Just behind Webb Beach (34°27′S, 138°16′E), South Australia; 30 Jan. 1977; *R. J. Chinnock* 3368 (holo: AD, iso: K, MEL, NSW, NY, PERTH).

Woody *perennial* to 20 cm high. *Branches* ascending; articles dull to glossy green, narrowly obovoid to barrel-shaped, ca. 5 x 2·5 mm, margin almost truncate, entire. *Spikes* terminal to main and lateral branchlets (not sessile) cylindrical or somewhat attenuate, 20–40 mm long, ca. 5 mm diameter, outline smooth, apex obtuse to rounded. Opposite bracts free from each other, flabelliform (from above), trapezoid on outer surface, not obscuring the flowers. *Flowers* vertical to spike axis, free from each other and from upper and lower bracts; perianth succulent, translucent; sides and apex thick; adaxial surface very thin in medial position, apex truncate, trapezoid in shape, with two thick lateral lobes which occupy most of the surface and a very small triangular inner abaxial medial lobe, anther 1 mm long; ovary thin and weak, with a pair of short weak stigmas. *Fruiting spike* eventually disarticulating into separate bracts, perianth halves, and pericarps with enclosed seed; perianth translucent, pericarp membranous. *Seed* flat, broadly elliptical, ca. 1·8 mm long; testa thin, translucent, with several rows of small tubercles over the embryo, otherwise smooth.

Habitat: Coastal: "Samphire association, forming a band below the *Arthrocnemum-Salicornia* zone on wet blue-grey fine silty muds" (fide R. Chinnock in sched.); "Centre of gypsum swamp" (fide T.G.B. Osborn in sched.).

Distribution: Only known from the coast north of Adelaide, and from Flinders Is., off the west coast of Eyre Peninsula, South Australia. Map 11.

South Australia: Port Parham, *R. J. Chinnock* 2984, 3363, 3364, 3365, 3366 (AD); Webb Beach, *R. J. Chinnock* 3371 (AD); Port Prime, *R. J. Chinnock* 3375 (AD); St. Kilda swamps, 23 Mar. 1923, *J. B. Cleland* (AD); Flinders Is., 8 Jan. 1924, *T. G. B. Osborn* (AD, NSW); St. Kilda (13 km N of Adelaide), 7 April 1924, *A. B. Black* (AD).

Figure 8. *Halosarcia flabelliformis;* in samphire flat at Webb Beach, South Australia. Photo by R. J. Chinnock.

This species is interesting in that it is intermediate in morphology between the genera *Halosarcia* and *Tecticornia*. It could, in fact, equally well be placed in either genus. The characters which suggest its affinities to *Tecticornia* are :(1) its free flabelliform bracts; (2) a perianth which divides readily into two lateral halves; (3) the membranous pericarp; and (4) a similar seed to that found in *T. australasica* (Fig. 64, 65). None of these features is restricted to the genus *Tecticornia*, and other characters, such as the perennial habit and the presence of an abaxial perianth lobe, are more indicative of a relationship with the genus *Halosarcia*.

The specific epithet refers to the fan-shaped appearance of the bracts.

13. Halosarcia peltata P. G. Wilson, sp. nov. Fig. 26, 52.

Fruticulus ad 1 m altus. *Articuli* sordido viridi, obovoidei, 2–5 mm longi, leviter lobati, plerumque apiculati, marginem integri, granulares. *Spicae* late cylindraceae, 5–10 mm longae, 5 mm diam., apicem rotundatae; bracteae discretae, nec imbricatae, facei exteriore semicirculari, margine late scarioso. *Flores* ad axem spicae verticales, ad vicinas et bracteam superam perfecte conjuncti. *Perianthium* succulentum; lobi laterales grandes ab apice truncato protrudentes; lobus medius abaxialis parvus, internus. *Perianthium* in fructo succulentum demum medullosum, lobis lateralibus prominente protrudentibus; pericarpium tenue medullosum, lateraliter compressum, ad perianthium conjunctum. *Semen* ovatum, ca. 1·3 mm longum; testa tenuis, pallido brunnea, laevis. *Spica fructifera* demum a ramo secedens.

Type: 5·5 km S of Morawa, Western Australia; growing on salt pan; plant 0·5 m high, dull green; 4 Sept. 1970; *P. G. Wilson* 9969 (holo: PERTH, iso: CANB, K, MEL, NSW).

Much branched *subshrub* to 1 m high. *Articles* dull pale green, papillose, obovoid, 3–5 mm long; apex somewhat lobed and frequently apiculate; margin granular (especially when dry). *Spikes* terminal to short branchlets, broadly cylindrical and of up to 9 articles, 5–10 mm long, 5 mm diam. (when fresh), apex rounded; bracts free (or almost free) from

each other, not imbricate, sub-orbicular on surface, with broad scarious entire margin; cymules well separated from each other. *Flowers* hermaphrodite, compact, aligned at right angles to spike axis, fused along entire length to each other and to lateral and upper bracts (but distinguishable by slight indentation in surface of spike), and along proximal half to lower bract. *Perianth* succulent; apex truncate; lobes 3, lateral lobes large and vertical, protruding from spike, overlapping the small inner hemispherical medial abaxial lobe. *Anther* ca. 2·5 mm long. *Ovary* membranous; style arms delicate. *Fruiting perianth* fleshy (pithy crustaceous when dry) with prominently exserted vertical (lateral) lobes; pericarp thin, pithy, laterally compressed, fused to and scarcely distinguishable from perianth. *Seed* ovate, ca. 1·3 mm long; testa thin, pale brown, smooth; embryo curved; perisperm lateral. Release of seed by separation and eventual decay of perianths in the spike which breaks away from the branch.

Habitat: Margin of salt lakes.

Distribution: Western Australia, from Lake Macleod south to Northam and east to Kalgoorlie. Map 11.

Western Australia: Lake Annean, Aug. 1971, *H. G. Baker* (PERTH); S of Hamelin Pool, *E. M. Bennett* 3319 (PERTH); Nanga Stn., *A. Devitt* 20 (PERTH); Lake Macleod, *A. S. George* 10193 (PERTH); Dirk Hartog Is., *A. S. George* 11430 (PERTH); Comet Vale, *J. T. Jutson* 195 (PERTH); Jibberding, M. Koch 1373 (MEL); 4 km ENE Yelma H.S., 12 Sept. 1970, *J. Lowry* (PERTH); 16 km S of Widgiemooltha, *R. A. Saffrey* 1576 (PERTH); Mongers Lake, *T. & J. Whaite* 4129 (PERTH); 2½ mi S of Three Springs, *T. & J. Whaite* 4227 (PERTH); Waeel, *P. G. Wilson* 6402 (PERTH); Lake Raeside, *P. G. Wilson* 7558 (PERTH).

The specific epithet refers to the peltate appearance of the bracts.

In *H. peltata* the perianths are intimately fused with the upper and lateral bracts, and in their proximal half with the lower bracts. This condition continues to the fruiting stage; when mature, the spikes eventually fall entire from the branches. The lateral lobes of the perianth prominently protrude from the mature spike like a duck's beak (vertically positioned); this gives it a characteristic warty appearance.

The flowers and fruit of this species resemble those found in *H. leptoclada* to which it is probably closely related.

14. Halosarcia pruinosa (Paulsen) P. G. Wilson, comb. nov. Fig. 27D–F, 53.

Arthrocnemum pruinosum Paulsen, Dansk Bot. Ark. 2 (8): 63, Fig. 25 and pl.6f.3 (1918).

Type: Carnarvon, 31 Oct. 1914, *C. H. Ostenfeld* 349 (iso: K).

Much branched *sub-shrub* to 1 m high. *Articles* obovoid, 3–8 mm long, often greyish green; lobes rounded, entire. *Spikes* terminal to branches or to short lateral branchlets (rarely sessile), narrowly cylindrical, 1·5–3·5 (10) cm long, 3–5 mm diameter, occasionally continuing growth vegetatively. *Bracts* shortly barrel-shaped, closely overlapping, margin slightly undulate, entire. *Flowers* fertile or with either the stamen or ovary sterile, coalescent to each other and fused to upper bract in proximal half, entirely concealed by bracts; adaxial side ± horizontal, abaxial side steeply ascending, extreme apex dorsiventrally compressed, acute. *Perianth* fleshy but rather thin with a pair of large conduplicate lateral lobes and a smaller oblong to deltoid inner abaxial lobe. *Ovary* thin, free from perianth; style slender. *Fruiting bracts* spongy, remaining shortly cylindrical or cup-shaped and imbricate. *Fruitlets* totally enclosed within the bracts, eventually free from each other and from bracts; perianth brittle, areolate, muricate on the outside but with a firm crustaceous inner layer; pericarp free from perianth, thinly crustaceous at apex, membranous or absent below. *Seed* ovoid, ca. 1 mm long; testa membranous pale brown, faintly concentrically granular over embryo, otherwise smooth; embryo slightly curved; perisperm prominent and forming a lateral bulge. Bracts and fruitlets eventually separating from each other and from the slender axis; perianth splitting in medial sagittal plane to release seed.

Habitat: Moderately saline situations both coastal and inland.

Distribution: Western Victoria, South Australia, Western Australia south of 24° latitude, south-western portion of the Northern Territory. Map 10.

Victoria: Hattah Lakes Nat. Park, *A. C. Beauglehole* 19817 (PERTH); L. Wahpool, Waitchie, *N. Macfarlane* 851, 854 (PERTH).

South Australia: Lake Meramangyne, *N. Forde* 546 (CANB); 150 km E of Cheeseman Peak, *R. B. Major* 102 (AD); St. Francis Is., *N. M. Wace* 103 (AD); Pt. Paterson to Red Cliff Point, *D. J. E. Whibley* 5461 (AD); Pt. Pirie, *P. G. Wilson* 10254 (PERTH).

Western Australia: Boulder, *W. D. Campbell* 185 (K); Lake Throssell, *A. S. George* 2994 (PERTH); 1·5 km W of Windarra, 29 July 1973, *H. Hukin* (PERTH); Hamelin Pool, Sept. 1976, *G.* & *M. Perry* (PERTH).

Northern Territory: SE corner of Lake Amadeus, *G. Chippendale* (NT 6376); Lake Neale, *P. K. Latz* 4256 (PERTH).

Most collections studied appear to have flowers with a fertile ovary and a vestigial stamen, or a fertile stamen and an apparently non-functional ovary. However, some collections had fully fertile flowers and in others it was not clear whether the ovary was functional but matured considerably later than the stamen.

Halosarcia pruinosa is somewhat variable in morphology as may be expected from a plant with such a wide distribution. It may be recognised by its fruiting spikes which retain their shape (the bracts do not shrivel) and by the fruitlets which separate from each other and have a firm crustaceous perianth that is muricate on the outside. The relationships of this species are to *H. undulata*, from which it may be distinguished by the firm shortly cylindrical fruiting bracts and the steeply ascending florets.

The perianth in *H. pruinosa* is similar to that in *H. auriculata* and in the flowering condition the two are difficult to distinguish. In both the lateral lobes are conduplicate, that is they are dorsiventrally compressed; on the orifice (which is at the acute apex) on the abaxial (lower) side they are separated by a medial abaxial lobe. In *H. auriculata* the abaxial lobe is large and broad and the lateral lobes overlap it only on its margins; in *H. pruinosa* the abaxial lobe is much smaller and becomes inwardly folded, while the lateral lobes are large and overlap each other so as to obscure the medial lobe. In *H. auriculata* the florets are fused to each other and the seed is released by the sagittal splitting of the fruitlets.

Between Marree and Mt. Lyndhurst in South Australia has been collected a plant which is very similar in fruiting structure to *H. pruinosa* and may, in fact, intergrade with that species. It differs from *H. pruinosa* in having minutely papillose, acutely lobed, ciliolate articles and in the fruiting spikes taking on a pale straw colour (rather than dark brown). The following collections represent this taxon (all PERTH): 14 km NW of Lyndhurst, *M. Lazarides* 8259; 27 km SE of Marree, *M. Lazarides* 8379, 8780. Further collections are required before it can be determined whether it should be recognized as a distinct species.

15. Halosarcia auriculata P. G. Wilson, sp. nov. Fig. 27A–C, 54, 55.

Fruticulus divaricatus ad 0·5 m altus. *Articuli* doliiformes glauci, margine ± truncato, integro. *Spicae* terminales, erucaeformes, 1–2 cm longae, ca. 4 mm diam.; bracteae firmae aliquantum tumidae, interdum demum suberosae. *Flores* bracteis occulti, vicinas et bracteas superas coalescentes, parti proximali cum bractea infera conjuncti; facies abaxialis valde adscendens. *Perianthium* apicem dorsi-ventraliter applanatum, parietibus lateralibus crassis, aliter tenue; facie abaxiale cum lobo medio grandis, lobis lateralis auriculatis superpositis. *Perianthium* in fructo crustaceum, in plano sagittali secedens. *Pericarpium* membranaceum vel ad apicem crustaceum. *Semen* applanato ellipsoideum, ca. 1 mm longum; testa tenuis.

Type: 13 km N of Sandfire Roadhouse, approximately midway between Pt. Hedland and Broome; blue colour evident, 25–30 cm high; 30 July 1973: *R. A. Saffrey* 1707 (holo: PERTH).

Much-branched spreading *shrub* to 0·5 m high. *Articles* doleiform, glaucous; margin ± truncate, entire. *Spikes* terminal to branches, eruciform, 1–2 cm long, ca. 4 mm diameter; bracts firm, somewhat swollen, sometimes corky when mature. *Flowers* in ± contiguous triads, completely obscured by bracts, steeply ascending on abaxial side,

coalescent to each other and to upper bract, fused to lower bract in proximal half. *Perianth* strongly dorsiventrally flattened at apex, thin above and below in medial position but with thick lateral walls, at first succulent but soon becoming crustaceous; abaxial face of flattened apex with a large rounded medial lobe which is overlapped on either side by smaller auriculate lobes, these being continuous with the flat adaxial margin; anther ca 1·2 mm long; style short and firm with two short stigmatic lobes. *Fruitlets* obscured by bracts, firmly fused laterally to each other, adaxial margin vertical to spike axis, abaxial margin steeply ascending, apex strongly dorsiventrally flattened; perianth crustaceous, thin in medial position and readily splitting in sagittal plane, lateral walls firm; pericarp laterally compressed, membranous and hyaline apart from the thickened apex, free from perianth. *Seed* ovate, 1 mm long, adherent to the pericarp; testa thin, pale brown, concentrically granular over embryo; embryo curved. Seed with pericarp released by the decay of the spike and the sagittal splitting of the perianth.

Habitat: Saline clay pans.

Distribution: North-western Western Australia, predominantly in near coastal situations. Map 13.

Western Australia: 6·5 km from Beagle Bay road on Willie Creek road, *A. C. Beauglehole* 48198 (PERTH); 43 km S of Lagrange Mission turnoff, *A. C. Beauglehole* 48279 (PERTH); 16 mi S of Vlaming Head, *A. S. George* 6623 (PERTH); Lake Macleod, May 1977, *M. Lewis* (PERTH); 13 mi E of Broome, *M. Lazarides* 6578 (AD, CANB, K, PERTH); 2 mi NW of Well 24, Canning Stock Route, *B. R. Maslin* 2252 (PERTH); 50 km SW of Onslow, *A. A. Mitchell* 515a (PERTH); Pt. Hedland, 13.v.1971, *G. I. Parlerliet* (PERTH).

Halosarcia auriculata is closely related to *H. syncarpa;* they have similarly shaped flowers, (which are fused together), and virtually identical seed. It differs most obviously in having the spikes terminating the branches, and in the lobing of the perianth; the fruiting and flowering spikes look very different as do the general habits of the two species for in *H. auriculata* the articles are barrel-shaped and of a bluish glaucous colour whereas in *H. syncarpa* they are obovoid and green.

Halosarcia pruinosa, has a similar appearance to *H. auriculata* but differs in the shape of its spikes, the lobing of the perianth (no abaxial lobe or only a very small one) and in having free fruitlets with muricate lateral walls to the perianths.

All the collections studied of *H. auriculata* have a bluish glaucous appearance, a character which appears to persist throughout the life of the plant.

In *H. auriculata* the flowers are fused to the lower bract in their proximal half; this is unusual in the genus where normally fusion only occurs with the upper bract (if at all). Because of this fusion the fruitlets remain attached to the lower bract when the spike is broken whereas in other species they preferentially adhere to the upper bract.

The specific epithet refers to the small ear-like perianth lobes which are positioned on either side of the large rounded abaxial lobe.

16. Halosarcia syncarpa P. G. Wilson, sp. nov. Fig. 29E–G.

Fruticulosus decumbens vel erectus, 0·2–1 m altus. *Articuli* late obovoidei, ca. 5 mm longi et lati, apiculati, margine denticulato vel integro. *Spicae* primum terminales, jam intercalares. *Flores* ± obtecti, vicinas coalescentes, facie abaxiale valde adscendente. *Perianthium* praeter latos laterales tenue, apicem dorsiventraliter applanatum; lobi duo, laterales conduplicati, imbricati. *Spica* fructifera intercalaris; bracteae demum tenues, siccae (vel interdum medullosae), fructiculis obtectis (vel interdum demum expositis); perianthium crustaceum vel coriaceum (in medio tenui) ad vicinas conjunctum; pericarpium liberum, lateraliter compressum, spongiosum vel crustaceum, ad apiceum durum. *Semen* ovoideum, ca. 1·2 mm longus, ad pericarpium ± adhaerens; testa membranacea, pallido brunnea, supra embryo concentrico granularis. Perianthium fructiferum demum in plano sagitali fissum, seminibius et pericarpio liberatum.

Type: Western Australia, Lake Grace, by main Tarin Rock—Lake Grace Road, 33°7′S, 118°27′E, bright green sub-shrub 0·5 m high, on edge of salt pan, 7 May 1969, *P. G. Wilson* 8277 (holo; PERTH, iso; CANB, K, NSW).

Decumbent to erect *sub-shrub* 0·2–1 m high. *Articles* broadly obovoid, ca. 5 mm long and wide, glossy or dull, bluntly to acutely lobed, apiculate, margin entire or denticulate. *Spikes* sessile, or terminal to short lateral branchlets, soon becoming intercalary through vegetative development of apex, of 1–10 articles, the bracts similar at anthesis to the vegetative articles. *Flowers* in triads, ± obscured by bracts but with apex protruding at anthesis, coalescent to each other and in proximal half to upper bract, free from lower; abaxial surface steeply ascending. *Perianth* thin at anthesis except for the thickened lateral walls, deltoid in shape, apex strongly dorsiventrally flattened; lobes 2, lateral, conduplicate and imbricate (with sometimes a small inner abaxial lobe); style short and firm with a pair of ligulate stigmas which are thickened at their base. *Fruiting spike:* bracts eventually becoming thin, dry or sometimes pithy (in one variant becoming firm) ± totally enclosing the fruitlets or shrivelling to expose them; perianths with leathery to crustaceous lateral walls which are fused to the neighbouring perianth, thin or torn in medial position; pericarp laterally compressed, spongy to crustaceous (often hardened at apex), free from perianth. *Seed* ovoid, ca. 1·2 mm long, ± adherent to pericarp; testa membranous, pale brown with distinct concentric granulation over embryo; embryo curved; perisperm lateral. Seed released with pericarp through decay of bracts and the splitting of perianth in sagittal plane.

Habitat: Principally on margin of salt lakes under strongly saline conditions but also coastal.

Distribution: Western Victoria, southern South Australia, and southern Western Australia. Map 13.

Victoria: Near Dimboola, *Reader* 20 (MEL); Lowan, 15 Aug. 1897, *Reader* (MEL); Wimmera, *anon.* (MEL).

South Australia: Browns Beach, Yorke Peninsula, *C. R. Alcock* 4967 (AD); 5 mi SE of Wellington, *F. M. Hilton* 1536 (ADW); Stamford Hill, *P. G. Wilson* 2667 (AD).

Western Australia: Israelite Bay, 1885, *S. Brooke* (MEL); 30 km NNE of Stokes Inlet, *Hj. Eichler* 20320 (AD, PERTH); 9 mi S of Pingrup, *K. Newbey* 3074 (PERTH); 13 mi N of Norseman, *B. L. Turner* 5278 (PERTH); 3 km E of Meckering, *P. G. Wilson* 8678 (PERTH).

Halosarcia syncarpa—Sclerostegia arbuscula ?

South Australia: Browns Beach, Southern Yorke Peninsula, *C. R. Alcock* 4964, 4965 (AD); Lower end of Coorong, *D. E. Symon* 10484 (ADW, PERTH).

Halosarcia syncarpa—H. undulata

Western Australia: Meckering, *P. G. Wilson* 8669, 11623 (PERTH).

The description provided by G. Bentham (1870) for *Salicornia arbuscula* consisted of a combination of characters derived chiefly from *Sclerostegia arbuscula* and *Halosarcia halocnemoides*. The material he cited, however, included specimens of additional species; three of the specimens were of *H. syncarpa*, these are as follows (all MEL): "Wimmera, *Dallachy*" p.pte., "Sandflats N of Stirling range, *F. Mueller*", and "Swan river, *Drummond*, 1 st coll."

Halosarcia syncarpa may be readily distinguished from related species by the perianths which are fused laterally to the neighbouring members of the cymule. The medial portion of each perianth is membranous (or absent) allowing the fruitlets to split along the sagittal plane to release the pericarp with its enclosed seed. The spikes vary considerably in size; in the typical form they consist of only 1–3 articles but in other forms the spikes may contain as many as 7; in all cases their apices continue growth vegetatively so that the fruiting spike is always intercalary.

The great variability exhibited by this species suggests that more than one taxon is involved. Hybridization with *H. undulata* and *H. pruinosa* appears to occur in Western Australia, and with *Sclerostegia arbuscula* in South Australia. This obviously increases the difficulty in distinguishing the constituent taxa within the complex. In South Australia and Victoria the perianths have a small but obvious inner abaxial lobe while in Western

Australia this is absent (or is extremely minute). In Western Australia plants of *H. syncarpa* with very different aspect but with the same fruit type can be found growing together without any apparent sign of introgression, whereas plants gathered from the total area of its distribution so vary as to cover the entire morphological spectrum. Much critical field work is needed before the '*syncarpa*' complex can be understood.

The specific epithet refers to the lateral union of the fruitlets.

17. Halosarcia undulata P. G. Wilson, sp. nov. Figs. 29A–D, 56.

Fruticulosus ramosus. *Articuli* opaci vel glauci, late doliiformes ca. 7 mm longi; lobi rotundati (interdum acuminati), integri. *Spicae* conicae vel cylindraceae, 10–30 (50) mm longae, 3–5 (9) mm diam., ambito undulato; bracteae breves, arcte imbricatae, convexae, margine valde undulato, integro. *Flores* obtecti parte proximali ad vicinas et bracteas coalescenti, aliter liberi, facies abaxialis plana, leviter vel valde adscendens, parte distali valde dorsiventraliter applanata; lobi duo, laterales, conduplicati, imbricati. *Fructiculi* demum libri; perianthium spongiosum vel crustaceum, nitidum; pericarpium membranaceum (vel ad apice crustaceum); stylus ad basim durus, acicularis. *Semen* ovoideum ca. 1 mm longum; testa tenuis, brunnea, fere laevis. Bracteae in statu fructifero demum ab axe secedentes; fructiculi in statu integro cadenti.

Type: 1 km W of Meckering, Western Australia, Mortlock River bed; plant 0·2 m high; 23 Nov. 1967, *P. G. Wilson* 6404 (holo: PERTH, iso: CANB, K).

Much-branched *sub-shrub*. Vegetative *articles* dull to slightly glaucous, broadly barrel-shaped, ca. 7 mm long; lobes rounded (sometimes acuminate), entire. *Spikes* terminal and lateral (when usually sessile by a broad base, the lowest bract pair being very short), conical to cylindrical, 10–35 (50) mm long, 3–5 (9) mm diameter, outline very undulate when fresh, the apex sometimes continuing growth as a short vegetative branchlet; bract-pairs short, closely imbricate, fleshy, outer face prominently convex, margin markedly undulate (face very thin in inter-bracteal position), entire. *Flowers* totally enclosed, united in proximal half to each other and to upper bract; abaxial (lower) surface flat, slightly to steeply ascending; adaxial (upper) surface ascending to ± horizontal, distal half strongly dorsiventrally flattened, apex acute; perianth at first fleshy at sides, thin at apex, soon becoming brittle, ca. 2 mm long; lobes 2 lateral, conduplicate (each sharply folded due to dorsiventral compression of flower), imbricate, extending ± half way along abaxial surface; anther 1·5–2 mm long (frequently vestigial); style linear, thickened towards base; stigmas slender. *Fruitlets* separating from each other (sometimes tardily), apex dorsiventrally flattened; perianth thin, firm and spongy to crustaceous (especially within), glossy; pericarp laterally flattened, membranous (or crustaceous at apex), usually absent towards axis or, if sterile, then often entirely crustaceous, style base firm and acicular. *Seed* ovoid, ca. 1 mm long; testa thin, pale to dark brown, practically smooth (minutely granular over embryo); embryo slightly curved; perisperm lateral. Bract-pairs eventually separating from spike axis, the fruitlets falling entire.

Habitat: Saline or gypseous soil.

Distribution: Northern portion of South Australia, southern half of Western Australia, and southern portion of the Northern Territory. Map 19.

South Australia: Dalhousie Springs, *P. K. Latz* 4795 (NT).

Western Australia: Cundeelee, *P. Boswell* J21 (PERTH); 2–3 mi E of Carnegie HS., *A. S. George* 5545a (PERTH); Lake Annean, *R. Hnatiuk* (PERTH); Hamersley estuary, *K. Newbey* 4900 (PERTH); Lake Hinds, *P. G. Wilson* 11649 (PERTH).

Northern Territory: Erldunda Stn., *T. S. Henshall* 54 (NT).

Halosarcia undulata may be recognised by its sessile, broadly based, lateral spikes and their short markedly undulate bracts. It is probably most closely related to *H. syncarpa* which may be distinguished by its predominantly intercalary fruiting spikes and by the lateral fusion of its fruitlets (free in *H. undulata*). The fruitlets of *H. undulata* are usually very strongly dorsiventrally flattened towards the apex but in some variants they are more obtuse, in which case they are similar in shape to those found in *H. pruinosa*. In the latter species, however, the perianth is muricate on the outside. Another difference

between the two species, but one not easily observable, is that in *H. pruinosa* the flower has a medial abaxial perianth lobe within the overlapping lateral lobes; in *H. undulata* there is no abaxial lobe; only the lateral lobes are present and these are prominently dorsiventrally compressed.

Specimens of *H. undulata* from the north-eastern region of its distribution in Western Australia have acuminate articles and bracts whereas in the southern region the plants have shortly apiculate articles. The material from the different regions is itself otherwise far from uniform, but the variation observed could frequently be due to conditions of growth, rather than a reflection of genetic diversity, since spikes on different parts of the same plant, representing growth of different seasons, may vary considerably in both size and shape.

There is only one record of the occurrence of *H. undulata* in the Northern Territory and this specimen differs from those from Western Australia in not having sessile spikes and in the fruitlets adhering to each other. Further work may indicate that the Northern Territory plant should be recognised as a distinct species.

A number of collections appear to be either of a species closely related to *H. undulata*, or of a hybrid between *H. undulata* and another species. These specimens have ovoid to ellipsoidal pedunculate spikes, pithy perianths, and black carbonaceous pericarps. Very few of the flowers set seed, and when they do the seed is adherent to the pericarp and possesses a noticeably papillose testa (almost smooth in *H. undulata*). Examples of this putative hybrid are as follows:

Western Australia: Cue, *J. H. Maiden* (NSW 136567); Lake Austin, *P. G. Wilson* 8569 (PERTH); Mongers Lake, *P. G. Wilson* 8602 (PERTH); Lake Moore, *P. G. Wilson* 8637 (PERTH); Lake Barlee, *P. G. Wilson* 8856 (PERTH); Lake Miranda, *P. G. Wilson* 8924 (PERTH).

18. Halosarcia bulbosa P. G. Wilson, sp. nov. Fig. 30.

Fruticulus effusus ca. 1 m altus. *Articuli* grossi, doliiformes, ca. 15 x 12 mm, truncati, pruinosi. *Spicae* laterales, breviter pedunculatae, cylindrico-fusiformes, 15–20 mm longae, saepe demum intercalares; bracteae undulatae, imbricatae. *Flores* hermaphroditi, in parte proximali ad vicinas et bracteas coalescentes, in parte distali acuminati, dorsi-ventraliter applanati. *Perianthium* ad apicem profunde bilobatum. *Spicae* in statu fructiferis: bracteae cupulatae, leviter undulatae, coriaceae; fructiculi libri, ascendentes; perianthium crustaceum, nigrum, profunde areolatum, apice truncato prominente rostrato; pericarpium ad apicem crustaceum, aliter membranaceum. *Semen* ovatum ca. 1·3 mm longum; testa membranacea, laevis, pallido brunnea.

Type: Western Australia, 10 km E of Morawa, 29 April 1979, *P. G. Wilson* 11702 (holo: PERTH, iso: CANB, K).

Sprawling *shrub* ca. 1 m high and 2–3 m diameter. *Branches* spreading; articles barrel-shaped, ca. 15 x 12 mm, truncate with only a very narrow scarious rim, bluish green and pruinose when fresh. *Spikes* lateral, sub-sessile, fusiform-cylindrical, 15–20 mm long, often becoming intercalary with age; bract-pairs closely imbricate, undulate; triads completely enclosed. *Flowers* hermaphrodite, united in proximal half to bracts and to each other, ascending, acuminate and dorsiventrally flattened in distal half. *Perianth* with lateral walls succulent, otherwise thin, the distal (acuminate) half deeply divided into two lateral lobes, a small abaxial lobe sometimes present; anther ca. 1·7 mm long; ovary ellipsoidal; style arms ligulate. *Fruiting spike* persistent, dark-brown (when dry); bracts imbricate, cup-shaped, leathery, with an abaxial flange which partially covers apex of flowers. *Fruitlets* ascending, free from each other and from bracts; perianth crustaceous, black, deeply areolate where previously united to lateral fruitlets and bracts, apex oblong and smooth with a beak-like apiculum; pericarp thinly crustaceous at apex, membranous below, free from perianth. *Seed* ovate, ca. 1·3 mm long; testa membranous, smooth, pale brown.

Habitat: Open *Melaleuca* shrubland on slightly saline reddish-brown loam (Soil pH 8·7, NaCl 3·4%).

Distribution: Known only from one locality between Morawa and Koolanooka Hills ca. 150 km SE of Geraldton, Western Australia. Map 8.

Western Australia: 10 km E of Morawa, 1977, *H. Demarz* (PERTH).

This species is noticeable because of its large pruinose articles which exceed those of any other species of *Halosarcia*. It is evidently most closely related to *H. pruinosa* and *H. undulata* as is suggested by the similar fruits.

The old spikes appear to remain attached to the plant for several years and presumably fall only with the decay of the dead branches. The fruitlets are tightly enclosed within the cup-shaped bracts and are securely held in place by a flange on the underside of the bracts. Evidently, therefore, the seed is released only after the decay of the bracts and perianth.

The size of the articles in *H. bulbosa* may be partly a response to the particular soil in which the plant grows for when transplanted to non-saline sandy loam it develops narrower branchlets. However, the other *Halosarcia* species found with *H. bulbosa* had articles of normal size; these species were *H. halocnemoides* subsp. *halocnemoides*, *H. pergranulata* subsp. *pergranulata*, and *H. pruinosa*.

19. Halosarcia entrichoma P. G. Wilson, sp. nov. Fig. 31A–D.

Fruticulosus decumbens. *Articuli* opaci vel glauci, late obovoidei, lobis rotundatis, margine cilialato. *Spicae* terminales, ovoideae, ambito undulato; bracteae tumidae, profunde undulatae, margine ciliolato. *Flores* bracteis occulti, liberi; facies abaxialis valde adscendens. *Perianthium* tenuiter coriaceum, lateraliter compressum, apicem dorsi-ventraliter applanatum, orificio terminali; lobi laterales super faciem abaxialem inserti, imbricati, denticulati; lobus medius abaxialis parvus, semi-circularis, internus. *Fructiculi* liberi, ab axim facile secedentes, integri; perianthium tenuiter cartilagineum; pericarpium ad apicem crustaceum, basim versus membranaceum. *Semen* ovoideum ca. 2 mm longum; testa membranacea, laevis, straminea.

Type: Frank Hann National Park, 79·2 km E of Lake King township, 32°52′S, 120°25′E, Western Australia, 15 Oct. 1978, *D. Monk* 482 (holo: PERTH, iso: CANB, K, MEL, NSW).

Dwarf semi-decumbent *shrub*. *Articles* dull green to glaucous, broadly obovoid, ca. 10 mm long, 5 mm broad; lobes rounded, margin cililate. *Spikes* terminal to branches, ovoid, ca. 20 mm long, 8 mm broad, outline uneven; bract pairs deeply undulate, swollen, margin ciliolate. *Flowers* hermaphrodite, obscured by bracts, adaxial face ± horizontal, abaxial face steeply ascending. *Perianth* thinly coriaceous, laterally compressed; apex dorsiventrally flattened with orifice at terminal edge; lateral lobes imbricate on abaxial face, denticulate; medial abaxial lobe semi-circular, small, overlapped by lateral lobes. *Fruitlets* free from each other and from bracts, readily separating from axis, entire (not tearing at base); perianth cartilaginous; pericarp crustaceous at apex, membranous towards base. *Seed* laterally flattened, ellipsoidal, ca. 2 mm long; testa membranous, smooth, pale fawn in colour.

Habitat: Margin of slightly brackish lakes in clay soil.

Distribution: Only known from the type locality near Lake King township, Western Australia. Map 10.

Western Australia: Frank Hann National Park, 32 53′S, 120 26′E, around lake (fresh in winter), *D. N. Butcher* 336 (PERTH).

Halosarcia entrichoma is readily recognisable on account of its large obovoid articles which are ciliolate on their margin; these, with the free fruitlets and cartilaginous perianths, clearly demarcate it from other species.

The lake around which the collections have been made is relatively fresh in winter and only becomes brackish in summer; this situation is unusual in inland Western Australia and may account for the apparent rarity of the species. An analysis of the soil after the lake had dried up indicated an NaCl content of 0·24% in the top 10 cm and 1·05% at a depth of 30–40 cm.

The specific epithet is a Greek word for eyelash and alludes to the ciliolate margin of the bracts and leaf-lobes.

20. Halosarcia chartacea P. G. Wilson, sp. nov. Fig. 20D–F, 57.

Fruticulus ad 1 m altus. *Articuli* anguste obovoidei, ca. 10 mm longi, margine truncato, integro. *Spicae* terminales cylindraceae, 20–40 mm longae, 4–6 mm diam.; bracteae confertim imbricatae truncatae, margine integro. *Flores* fere occulti, ad vicinas et bracteam superum coalescentes. *Perianthium* tenue, apicem dorsiventraliter applanatum; lobi 2, laterales, conduplicati. *Ovarium* membranaceum, ad basim perianthii affixum; stylus tenuis. *Perianthium in fructo* librum integrum, aliquantum urceolatum, ad 4 mm longum, chartaceum, lateribus reticulatis, semine incluso; pericarpium diaphanum. *Semen* late ellipsoideum ca. 2 mm longum; testa diaphana, laevis.

Type: 5 km S of Warren Bore, ca. 115 km ENE of Bandya HS, Western Australia; flooded clay pan, plant 1 m high; 28 Aug. 1968, *P. G. Wilson* 7446 (holo: PERTH, iso: AD 96947008, NSW).

Erect dwarf *shrub* to 1 m high. Vegetative *articles* narrowly obovoid, ca. 10 mm long, apices with a scarious truncate margin, entire. *Spikes* terminal to short lateral branchlets (often of one internode) but apparently not to main branches, cylindrical, 20–40 mm long, 4–6 mm diam.; bracts closely imbricate (becoming separated on drying), margin ± truncate, entire. *Flowers* with the opposite triads contiguous, steeply ascending, almost entirely included with bracts, adherent to each other and at first to upper bract; perianth thin (not succulent), the apex obtuse, dorsiventrally flattened with terminal orifice; lobes 2, lateral and conduplicate anther ca. 2 mm long; ovary membranous, attached to base of perianth, style and stigmas tenuous. *Fruitlets* eventually free, somewhat urceolate, to 4 mm long; perianth chartaceous, reticulate where formerly adherent to bract, completely enclosing seed; pericarp diaphanous (somewhat thicker at apex) closely enfolding seed. *Seed* broadly ellipsoidal; perisperm copious along length of embryo.

Habitat: On only slightly saline clay pans.

Distribution: Central Western Australia. Map 12.

Western Australia: Lake Yindarlgooda 70 km E of Kalgoorlie, *Jane Elkington* 628 (PERTH); Ilgarari Mine, 120 km S of Mt. Newman, *A. Mitchell* 318 (PERTH).

This species is distinctive in having fruitlets which readily fall away from the dry spike, a papery perianth, and a diaphanous pericarp and testa. It evidently occurs only on clay pans and in these situations it may form a mono-specific community.

The specific epithet refers to the papery consistency of the perianth in fruit.

21. Halosarcia cupuliformis P. G. Wilson, sp. nov. Fig. 32.

Fruticulosus ca. 25 cm altus. *Ramuli* tenues; articuli anguste cylindracei ca. 10 mm longi, lobis rotundatis breviter acuminatis. *Spicae* terminales anguste cylindraceae, ad 8 cm longae, 4 mm diam.; bracteae cupuliformes ca. 2·5 mm altae, breviter acuminatae, in sicco laxe imbricatae. *Flores* omnino occulti, ad vicina et bracteam superam coalescentes, facie abaxiali valde adscendente. *Perianthium* succulentum, 2 mm longum in plana sagittali fere divisum in dimidiis succulentis, apicem dorsi-ventraliter applanatum; stylus tenuis. *Perianthium* in fructo liberum, integrum, leviter medullosum, in dimidiis lateralibus secedens; pericarpium membranaceum (in parte proximali abscens). *Semen* ovatum ca. 1·2 mm longum; testa pallido fusca, super radiculam minute tuberculata.

Type: Pulchera Waterhole 30 mi WNW of Sandringham Stn., Queensland; rare on edge of waterhole in white clay soil; 21 Jan. 1970: *P. K. Latz* 518 (holo: PERTH, iso: CANB, NT 26711 (n.v.)).

Sub-shrub ca. 25 cm high. *Branches* slender; articles dull or glaucous, narrowly cylindrical, ca. 10 mm long, apex with rounded shortly acuminate lobes. *Spikes* terminal, narrowly cylindrical, to 8 cm long, 4 mm diameter; bracts cupuliform, ca. 2·5 mm high, loosely imbricate in dried state, obtuse and shortly acuminate, with a prominent scarious margin; triads completely hidden, contiguous. *Flowers* adherent to each other and to upper bract throughout their length, abaxial surface steeply ascending; perianth succulent, 2 mm long, divided on abaxial surface in sagittal plain to form two succulent lateral halves, apex obtuse and dorsiventrally compressed; anther ca. 1 mm long; style and stigmas

long and slender. *Fruiting spike* not seen in mature state; fruitlets (perianth with enclosed pericarp and seed) eventually free from each other and from bracts; perianth weakly pithy, separating into two lateral halves; pericarp membranous (absent in proximal half). *Seed* ovate ca. 1·2 mm long; testa pale brown, minutely tuberculate over embryo; embryo almost straight; perisperm lateral.

Habitat: Only known from the description accompanying the type specimen.

Distribution: South-west Queensland and north-east South Australia. Map 2.

Queensland: Pulchera Waterhole. 30 mi WNW of Sandringham, *P. K. Latz* 518 (CANB, NT, PERTH).

South Australia: Eyre Creek, 26° S, 1889, *A. Henry* (MEL). Note: 26° latitude delineates the Queensland-South Australia border.

Halosarcia cupuliformis may be recognised by its distinctive spikes in which the abruptly acuminately lobed bracts form cup-like rings around the axis. In flower structure it is similar to *H. pruinosa* but the perianth is much thinner and does not harden with age.

The specific epithet refers to the cup-shaped appearance of the bracts when dry.

22. Halosarcia calyptrata P. G. Wilson, sp. nov. Fig. 25A–C, 58, 59.

Fruticulosus ad 0·8 m altus. *Ramuli* tenues; articuli doleiformes vel obovoidei ca. 6 mm longi, 3 mm diam., margine leviter lobato; integro. *Spicae* anguste cylindraceae 10–20 (40) mm longae, 3 mm diam.; bracteae breviter doleiformes, ca. 3 mm altae, ± truncatae, confertim imbricatae, integrae. *Flores* bracteis occulti ad vicinas et bracteas superas parti proximali conjuncti. *Perianthium* apicem dorsi-ventraliter applanatum, parietibus latcralibus crassis, lobis lateralis imbricatis (lobo abaxali absenti?). *Spica fructifera* persistens; bractea et perianthium crustaceum; pericarpium ad apicem crassum, crustaceum, operculatum, ad basim membranaceum; stylus ad basim durus, persistens. *Semen* ovoideum, ca. 1 mm longum; testa membranacea, super radiculam granulata.

Type: 18 km S of Wiluna, Western Australia; claypan; sub-shrub 0·3 m high, articles dull pale green; 28 Aug. 1970; *P. G. Wilson* 8939 (holo: PERTH, iso: CANB, K).

Divaricately branched *sub-shrub* to 0·8 m high; branches slender. *Articles* doleiform to obovoid, ca. 6 mm long, 3 mm diam., dull to slightly glaucous; margin broad and scarious, lobes very short and rounded. *Spikes* narrowly cylindrical, 10–20 (40) mm long, 3 mm diam., terminal (frequently becoming intercalary) or sessile and lateral; axis thick and woody; bracts shortly doleiform, ca. 3 mm high, almost truncate, closely imbricate thick and woody; bracts shortly doleiform, ca. 3 mm high, almost truncate, closely imbricate, entire; triads ± contiguous. *Flowers* completely obscured by bracts, fused laterally to each other and (sometimes?) in proximal half to upper bract; perianth succulent on lateral margins, otherwise thin, deltoid-acuminate in lateral view, ± vertical to spike axis (abaxial side ascending and adaxial descending), orifice at the acute apex; lateral lobes imbricate and conduplicate (no abaxial lobe observed), the perianth ± splitting at anthesis into two lateral halves; anther ca. 1·3 mm long; ovary deltoid, fixed along vertical length of flower to spike axis; style and stigmas slender. *Fruiting spike* persisting on dead branchlets or, if intercalary, around living branch; bracts and perianth usually crustaceous; pericarp thick and crustaceous at apex forming an ellipsoidal cymbiform cap to seed, membranous towards axis; style base hard and persistent frequently forming a small conical projection in centre of fruitlet. *Seed* ovoid to narrowly ellipsoidal, 1 mm long; testa thin, pale brown, granulate in longitudinal lines over radicle; embryo straight.

Habitat: Margin of gypseous salt lakes (Northern Territory) and on slightly saline clay pans (Western Australia).

Distribution: Central Australia and north central Western Australia. Map 22.

Northern Territory: Lake Amadeus, 26 June 1959, *G. Chippendale* (NT 6377, AD); Lake Mackay, 17 June 1957, *G. Chippendale* (NT 3401, AD, BRI, CANB, NSW, PERTH); Lake Amadeus, *T. S. Henshall* 748 (NT).

Western Australia: Mininer to Mt. Vernon Stn., *A. S. Mitchell* 76/189 (PERTH); Jigalong, *R. D. Royce* 1557 (PERTH); 49 km N of Mt. Magnet, *P. G. Wilson* 8563 (PERTH); 34 km W of Wiluna, *P. G. Wilson* 8963 (PERTH); 25 km NE of Balfour Downs H.S., *P. G. Wilson* 10371 (PERTH); Rudall River, *P. G. Wilson* 10578 (PERTH).

The plant as found in the Northern Terrtiory has terminal inflorescences while in Western Australia these are usually lateral and sessile. Further collecting may indicate that two species are involved which would then account for the apparent differences in habitat.

A distinguishing feature of this species is its thick cap-shaped pericarp; the plant is also interesting in having a hard fruiting spike due to the indurated bracts, perianth, and pericarp, and to the thick lignified axis. In those cases where the spike-axis dies the spike may persist for some time (a year or more) as a short lateral branchlet; these fruiting spikes eventually break up into separate segments composed of the opposite triads with the surrounding pair of bracts. In other cases the spike axis continues growth vegetatively and the fruitlets persist on the branch for some years until they are eventually sloughed off in a similar manner to that of the bark.

Collections from near Wiluna (including the type) frequently have two spikes arising from a leaf axil (that is, four spikes to a node), or one of the spikes may be replaced by a branchlet. No anatomical investigation has been made of this phenomenon.

The specific epithet refers to the cap-like covering to the seed formed from the hardened apical portion of the pericarp.

23. Halosarcia indica (Willd.) P. G. Wilson, comb. nov.

Salicornia indica Willd., Ges. Naturf. Fr. Neue Schr. 2: 111 t.4 f.2 (1799).—*Arthrocnemum indicum* (Willd.) Moq., Chenop. Enum. 113 (1840), p.p.; Moq. in DC., Prod. 13 (2): 151 (1849), p.p.; Ungern-Sternberg, Versuch Syst. Salicornieen 69 (1866); Ungern-Sternberg, D. Atti del Cong. Int. Bot. Firenze 1874: 282 (1876); J. D. Hooker, Fl. Brit. India 5:12 (1886); Brenan in Turrill et Milne-Redhead, Fl. Trop. E. Africa—Chenopodiaceae 18 (1954); Tölken, Bothalia 9:276 f3/3 (1967).—*Sarcathria indica* (Willd.) Rafinesque ex D. Jackson, Ind. Kew. 2:803 (1895).

Type: Tranquebar, India, *J. G. Klein* (B).

Decumbent to erect *perennial*, frequently glaucous. *Articles* of branchlets slender or thick, cylindrical and truncate to somewhat flattened, obovoid and deeply lobed, margin entire or ciliolate. *Spikes* terminal to main and lateral branchlets, smooth and cylindrical and up to 4 cm long or ovoid and up to 2 cm long. Opposite bracts united, the bract-pair truncate to deeply lobed, entire or ciliolate, the cymules completely disjunct. *Flowers* coalescent to each other and to upper bract or free except near axis, completely enclosed or the apex exposed; upper face horizontal, lower (abaxial) face ascending; apex rounded or obtuse. *Perianth* soon becoming fleshy (especially the lateral walls); lobes 3, the two lateral thin, large, ± valvate to deeply imbricate, (the outer one frequently fimbriate); lower (abaxial) medial lobe within, triangular and small to semi-circular and then equal in size to lateral lobes (sometimes apparently absent). *Fruiting spike* broadly ovoid (subsp. *bidens*) to cylindrical; bracts leathery, corky, or spongy. *Fruitlets* ± obscured by bracts (except in subsp. *julacea*), laterally compressed, triangular in side view, 1·2–2 mm high, apex rounded; perianth soft and spongy or pithy and firm, sometimes crustaceous within, pericarp hard and horny all over, often adherent to perianth, eventually splitting in medial sagittal plane. *Seed* broadly ovate to almost circular; testa membranous, very pale brown, smooth and glossy (faintly reticulate and dull in subsp. *julacea*); embryo curved, perisperm lateral. Spike disarticulating with age and releasing the bract-pairs and fruitlets, the axis often persisting; bracts and perianth in semi-mature spikes frequently swelling when wet (at least in subspp. *bidens* and *leiostachya*).

Halosarcia indica, as here circumscribed, exhibits considerable variability and an attempt has been made to provide infra-specific names for the more prominent of these variants. The typical sub-species is almost prostrate in habit and inhabits the tropical coasts of east Africa and of India where it is very uniform in appearance. A plant apparently identical to the type is also found on the north coast of Australia; here, however, it grades imperceptibly into subsp. *leiostachya*.

In Malaysia is found a plant which differs sharply from that of India and Africa; it has an erect habit, slender branches, and narrow cylindrical spikes. The articles (both vegetative and fertile) are noticeably ciliolate. This plant was referred by Backer in Flora Malesiana 4: 104 (1949) to *Arthrocnemum indicum*. Brenan, however, in Flora of Tropical East Africa—Chenopodiaceae 20 (1954), considered the Malaysian plant to represent a distinct species. The plant found in Malaysia was described by Ungern-Sternberg as *A. ciliolatum*, which name was based on material collected in Timor and Sumbawa (Indonesia). On the north coast of Australia may be found plants which closely match those of Indonesia and which again appear to grade into the common Eremaean taxon which is here referred to *Halosarcia indica* subsp. *leiostachya*.

In southern temperate Australia is found a variant with markedly lobed articles and a robust habit. This plant was described as *A. bidens*, but again there is no clear separation between it and the Eremaean taxon.

Halosarcia indica (as *Salicornia indica*) was first recorded for Australia by Robert Brown (1810). Brown's description was largely based on material of *Sarcocornia quinqueflora* (Ung.-Sternb.) A. J. Scott but his species concept was broad and in this case encompassed a number of taxa including *H. indica* sensu lato.

Halosarcia indica (as *Arthrocnemum indicum*) was again recorded for Australia (without validation) by Moquin (1840). This record was probably based on Robert Brown's treatment for in a later revision Moquin (1849) omitted any reference to Australia but tentatively (and incorrectly) referred Brown's misapplication of the name to *Halocnemum australasicum*. C. E. Moss (1954) also recorded *H. indica* for Australia and from his text it would appear that he had seen material of plants here referred to the sub-species *bidens* and *leiostachya*.

In related species important characters can be found in the lobes of the perianth, but these are usually difficult to distinguish in *Halosarcia indica*. They consist basically of a pair of large semi-circular lateral lobes extending downwards from the upper margin of the apex of the flower. These lobes extensively overlap one another and are usually somewhat erose or ciliolate: the inner of the lateral lobes may (at least initially) be infolded. Similarly the lower (abaxial and innermost) lobe may not be observable, but although it varies considerably in size its apparent absence is frequently due to it also being infolded. In the sub-species *julacea* the abaxial side of the perianth is extremely thin and soon ruptures with the development of the anther; the lateral lobes scarcely (or do not) overlap and the abaxial lobe is either minute or absent. In some variants of subsp. *leiostachya* the abaxial margin is also extremely thin and the lobe very small.

The variation in perianth structure would probably form the basis of a sound infra-specific classification, however, this structure is only decipherable in young flowers in a good state of preservation (preferably either fresh or in a fluid preservative) and since only a few collections are suitable for detailed analysis it is not possible to make much use of this character.

The texture of the perianth is also extremely variable. In many collections the flowers when young have a thin soft perianth and may persist in this state even when seed formation is well advanced. Normally the perianth rapidly becomes succulent and changes to a dry and spongy texture as the fruitlets mature. The factors which influence the various conditions are not clear but generally speaking the fruiting spikes do not fragment until a year after anthesis and in desert situations they may remain attached to the branches for several years.

As has been mentioned earlier, *Halosarcia indica* differs markedly in its anatomy from all other species of the genus and, in fact, from all other members of the *Salicornieae*. The palisade layer consists of a single row of cells which is made up of groups of chlorenchyma cells (situated beneath the stomata) and groups of colourless cells (that may form a reticulate pattern between the chlorenchyma clusters). Beneath the palisade layer is a single layer of small close-fitting thick-walled isodiametric chlorenchymous cells and this forms a continuous sheath between the aqueous and palisade tissues. The walls of these isodiametric cells often become lignified with age. The nature of the chlorenchyma

and associated tissues provides a means of identifying *H. indica* when dealing with vegetative material, for the distinctive anatomy may be readily observed in fresh specimens with a hand lens, or in dry specimens with a microscope (Fig. 1).

Key to subspecies

1. Pericarp horny all over; testa smooth and glossy; fruitlets ± obscured by bracts 2
1*. Pericarp crustaceous at apex, membranous below; testa faintly reticulate, dull; fruitlets not obscured by bracts ... 23d. subsp. **julacea**
2. Plant decumbent or prostrate; articles of branches corky with age, ± truncate entire (tropical coastal) ... 23a. subsp. **indica**
2*. Plants ± erect; cortical tissue of articles shrivelling with age, often lobed, ± ciliolate 3
3. Spike cylindrical or ellipsoidal, lowest ring of bracts small; vegetative articles truncate or shallowly lobed ... 23b. subsp. **leiostachya**
3*. Spike ovoid, lowest ring of bracts large and deeply lobed; vegetative articles deeply lobed ... 23c. subsp. **bidens**

23a. subsp. **indica.** Fig. 61.

Decumbent *perennial* forming mats ca. 1 m diameter. *Articles* cylindrical to barrel-shaped, to 10 mm long, 4–6 mm diameter, becoming corky with age. *Spikes* cylindrical to 2 cm long, grey with age; bracts closely overlapping, eciliate, the lowest pair ± equal in size to (or smaller than) those above it. *Flowers* fused to upper bract and to each other, predominantly (always?) female. *Fruitlets:* perianth spongy; pericarp hard, horny all over. *Seed* ovate; testa smooth and glossy.

Habitat: Tidal mudflats.

Distribution: North coast of Australia; the tropical coasts of the Indian Ocean; according to Tölken, l.c., also occasionally on the west coast of Africa. Map 9.

Queensland: Curtis Is. 21 Apr. 1962, *W. Macnae* (BRI); Mouth of Settlement Ck., *R. A. Perry* 1250 (BRI, CANB, NSW); Karumba, *G. W. Trapnell* 197 (BRI); Townsville Common, 24 Feb. 1977, *P. G. Wilson* (PERTH).

Northern Territory: Roper River near mouth, *N. Byrnes* 1616 (NT); Bing Bong Stn., *E. Paine* (NT 8513).

India: Peninsula In. Orientalis, ex Herb. *Wight* (NSW 136656).

Tanzania: Kunduchi, *A. McCusker* 242 (NSW).

This is the most widespread of the sub-species of *H. indica* and shows very little variability throughout its range, although in Australia it grades into the local variants of subsp. *leiostachya*. In its typical form it is found in Australia only along the north and north-east coasts of Queensland and the east coast of the Northern Territory. Rather similar plants, however, have been collected elsewhere on the Northern Territory coast and on the north coast of Western Australia. Brenan, l.c., assumed the species to be dioecious since he failed to find any stamens in the flowers he examined. Similar comments have appeared on some herbarium sheets, but in all cases I have examined the supposedly male plants have turned out to belong to a quite different species. Tölken, l.c., observed stamens in fresh material from Mozambique and found the flowers to be normally hermaphrodite. I have been unable to find stamens in any plants from Africa or in plants of the typical variant in Australia. At Townsville subsp. *indica* was observed in the field, and again only female plants were seen although seed-set was occurring. It would appear probable that this sub-species is normally apomictic. (See also comments on parthenogenesis in *H. pergranulata* subsp. *queenslandica*).

The mature spikes in subsp. *indica* break down through the separation of the bract-pairs which fall away as distinct articles from the slender axis. The triads of fruitlets at first remain attached to a bract-pair (usually the upper) which are buoyant in water.

This sub-species differs from subsp. *leiostachya* in habit and in gross morphology; it may also be distinguished by the eciliate margin of the leaves and bracts. Some Australian material, however, probably as a result of introgression with subsp. *leiostachya*, is minutely and irregularly ciliolate.

23b. subsp. **leiostachya** (Benth.) P. G. Wilson, stat. et comb. nov. Fig. 9.

Salicornia leiostachya Benth., Fl. Austral. 5: 203 (1870).—*Arthrocnemum leiostachya* (Benth.) Paulsen, Dansk Bot. Ark. 2 (8): 61 (1918); J. M. Black, Trans. Roy. Soc. S. Austral. 43: 360 (1919).

Lectotype: Kyejeron Creek, *J. P. Murray* (holo: K, iso: MEL 70595 and 70596, "A. W. Howitt"), lecto. nov.

? *A. ciliolatum* Bunge ex Ung.-Sternb., Versuch Syst. Salicornieen 69 (1866); Ung.-Sternb., D. Atti del Cong. Int. Bot. Firenze 1874: 283 (1876). *Type:* From Timor and Sumbawa, n.v.

S. ciliolatum Bunge, Linnaea 28: 573 (1856), nomen.

A. benthamii Paulsen, Dansk Bot. Ark. 2 (8): 62, pl.6 f.2 (1918). *Lectotype:* Point Samson (Cossacks), *C. H. Ostenfeld* 1143 (iso: NSW), lecto. nov.

A. brachystachyum Paulsen, op. cit. 64, pl.6 f.4. *Type:* Carnarvon, 31 Oct. 1914, *C. H. Osteufeld* 352 (iso: K, MEL, NSW).

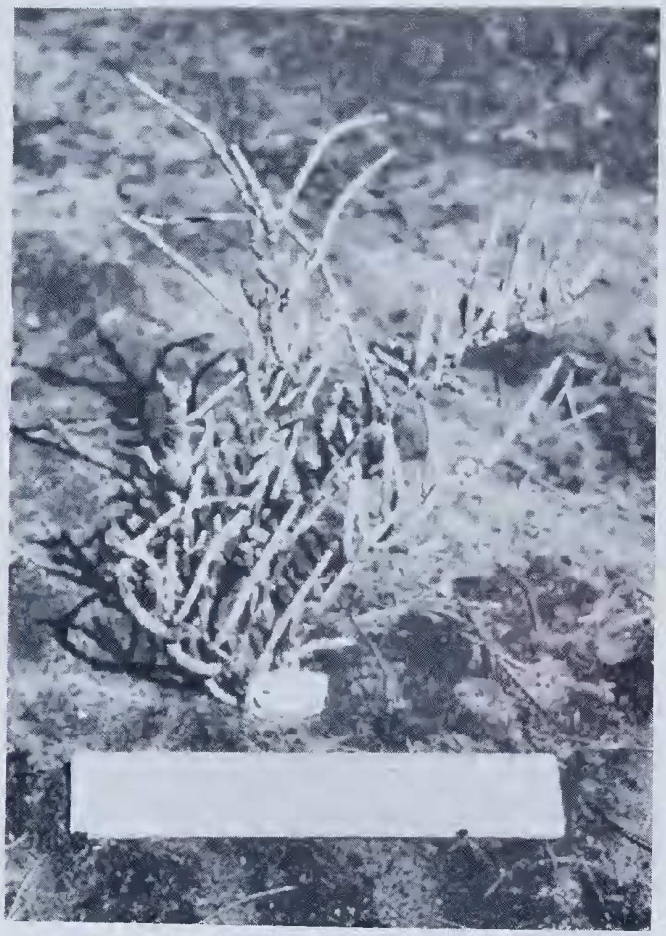

Figure 9. *Halosarcia indica* subsp. *leiostachya;* from Derby, Western Australia.

Decumbent to erect *sub-shrub*. *Articles* thick, cylindrical to obovoid, to 10 mm long, slightly lobed, ciliolate. *Spikes* ellipsoidal to cylindrical 5–40 mm long, with smooth outline when mature, bracts closely overlapping, the lowest pair smaller than, or equal in size to, those above it. *Flowers* initially fused to upper bract and to each other, normally hermaphrodite. *Fruiting spikes* leathery to corky; perianth soft and spongy; pericarp hard and horny all over. *Seed* ovate; testa smooth and glossy.

Habitat: Tropical coast and inland around salt lakes.

Distribution: Widespread in Australia; Malaysia. Map 14.

Queensland: Lake Galilee, *Adams* 1233 (BRI, CANB); 15 mi N of Brisbane, *L. A. S. Johnson* (NSW 16079); Waroo, *K. I. Morris* 5 (BRI).

New South Wales: Onepar Stn., *E. G. Cuthbertson* (CANB); Broken Hill, *Haviland* (NSW).

Victoria: 25 km NW of Kerang, *A. C. Beauglehole* 55720 (PERTH); 12 km N of Manangatang, *A. C. Beauglehole* 55989 (PERTH).

South Australia: Andamooka, 4 Nov. 1929, *J. B. Cleland* (AD); Lake Eyre North, *G. C. Cornwall* 5 (AD); Leigh Creek, *T. R. N. Lothian* 3028 (AD); Oakden Hills, *B. J. Murray* 512 (AD).

Western Australia: Lake Macleod, *A. S. George* 10192 (PERTH); West Is., Lacepede Islands, *R. Johnson* (PERTH); 13 mi E of Broome, *M. Lazarides* 6579 (BRI, CANB).

Northern Territory: Wessel Islands, *P. K. Latz* 3503 (CANB); Mulga Park Stn., *P. K. Latz* 5036 (NT); 5·6 mi S of Mt. Wedge HS., *D. J. Nelson* 104 (AD, NSW, NT).

Java: Bungil, April 1934, *Altmann* (K); Sumarang, Herb. *Otto Kuntze* no. 5476 (K); Japore, leg. *Teysmann* (K).

Sumba Is.: Waingapu, *Iboet* 23 (B, K).

Madura Is.: Sampang, *C. A. Backer* 19607 (K).

Timor: Bena-Panite, *Sauveneur* (?) 150 (K).

Sub-species *leiostachya* exhibits a multiplicity of forms and this explains to some extent the several names which have been applied to it. Part of this plasticity is obviously due to environmental factors since in different seasons the same plant may produce both branches and spikes which are very different in morphology. Part of the variation is certainly due to genetic differences since in cultivation some variants retain a distinctive appearance. Normally only one variant is present in any locality but occasionally, due to introgression with subsp. *bidens* or subsp. *indica*, a range of forms may be found.

The Malaysian plant, which was named *A. ciliolatum* by Ungern-Sternberg, has slender branches and slender, evenly cylindrical spikes; the leaf-lobes and bracts are distinctly ciliolate. When dry it usually assumes a brown colour, unlike the grey or fawn colour of typical *H. indica* ssp. *leiostachya*. The bracts when mature are more leathery than corky and do not enlarge with age. In Malaysia this plant is invariable and, in fact, is the only member of the genus present. A plant very similar to the Malaysian has been collected on the north coast of Australia but here it obviously introgresses with subsp. *leiostachya*. I have therefore referred all material of this complex to this sub-species but realise that from the point of view of Malaysian botanists it would be more informative to recognise this plant as a species distinct from *H. indica*.

The lectotype of *A. leiostachya* (from Kyejeron Creek) was stated by Bentham (1870) to have been collected on M'Douall Stuart's Expedition; it was, however, evidently collected by J. P. Murray (whose name is on the herbarium label), probably in 1862 on a Victoria Exploring Expedition relief party led by A. W. Howitt (see J. H. Willis, 1962). I have chosen this collection as the lectotype since it is typical of the eremaean variant of the sub-species; of the other collections cited by Bentham, those from Providence Hill and McAdam Range represent the north coast variant (approaching *A. ciliolatum*) while the Drummond collection cited is a vegetative specimen of *H. doleiformis*.

23c. subsp. **bidens** (Nees) P. G. Wilson, stat. et comb. nov. Fig. 10, 31E–F.

Arthrocnemum bidens Nees in Lehm., Pl. Preiss. 1: 632 (1845); Moq. in DC., Prod. 13 (2): 151 (1849); Ungern-Sternberg, Versuch Syst. Salicornieen 71 (1866).—*Salicornia bidens* (Nees) Benth., Fl. Austral. 5: 204 (1870).

Type: Swan River, *Preiss* 1261 (iso: K, MEL).

Robust *shrub* to 2 m high. *Articles* thick, obovoid, circular in cross-section or somewhat flattened, 5–10 mm long, deeply and often acutely lobed, keeled towards apex, usually ciliolate. *Spikes* ovoid, pale brown to grey with age, the lowest article at first larger and more deeply lobed than those above. *Flowers* fused to upper bract and to each other. *Fruitlets:* perianth soft and spongy; pericarp hard and horny all over. *Seed* ovate; testa smooth and glossy.

Figure 10. *Halosarcia indica* subsp. *bidens;* near Forest Beach, South West of Capel, Western Australia. Photo by B. R. Maslin.

Habitat: Moderately saline areas both coastal and inland.

Distribution: North western Victoria, southern South Australia, Western Australia south of 26° latitude and west of 123° longitude. Map 14.

Victoria: 10 mi NNW of Underbool, *A. C. Beauglehole* 40385 (PERTH).

South Australia: Grange, 19 Nov. 1926, *J. B. Cleland* (AD); Goolwa Barrage, *Hj. Eichler* 17122 (AD); N of Cowell, *C. R. Alcock* 895 (AD).

Western Australia: Wyola, *T. E. H. Aplin* 694 (PERTH); E of Mullewa, *A. M. Ashby* 2591a (AD); Phillips River, *E. M. Bennett* 3123 (PERTH).

This sub-species is typically a sub-tropical plant and is relatively common in the southern portion of Australia south of 26° latitude. It occasionally occurs in association with subsp. *leiostachya* in more northern localities but here often appears to be a recent arrival since it may be only represented by isolated bushes. Towards the north it grades into subsp. *leiostachya* and with many collections it is not practicable to designate them as belonging to either one sub-species or the other.

Sub-species *bidens* exhibits considerable plasticity of form; in particular the spike may vary greatly in size, shape and texture. The size is much dependent on the environmental conditions which when satisfactory cause the spike to become much longer than normal. The corkiness of the spike increases with age but the texture is obviously also dependent on other factors.

The fully mature fruiting spikes break up in a manner similar to that described under subsp. *indica*, but immature fruiting spikes (those which have not assumed a dull pale fawn appearance) of both subsp. *bidens* and subsp. *leiostachya* will often swell up and disarticulate when placed in water. This reaction is due to the gelatinous nature of the cell contents of the bract tissue and the perianth. A similar reaction has not been observed in any other species.

23d. subsp. **julacea** P. G. Wilson, subsp. nov. Fig. 62, 63.

Perennis decumbens; ramuli graciles. *Articuli* anguste cylindracei, 4–10 mm longi, 2–3 mm diam., margine obtuse lobato, eciliato. *Spicae* cylindraceae; bracteae truncatae, integrae. *Spicae fructificantes* eruciformes; perianthium medullosum, in plano sagittali secedens; pericarpium ad apicem crustaceum basin versus membranaceum. *Semen* sub-circulare, ca. 1·5 mm diam; testa straminea, leviter reticulata.

Type: Near Derby (17 17′S, 123 37′E), Western Australia, July 1975, *V. Semeniuk* 174005 (holo: PERTH, iso: CANB, K).

Decumbent perennial. *Branchlets* slender; articles narrowly cylindrical 4–10 mm long, 2–3 mm diameter, margins shortly and bluntly lobed, eciliate. *Spikes* cylindrical 2–5 cm long, 4–5 mm diameter; bract-pairs truncate, entire. *Flowers* free from each other but adherent to upper bract in proximal half; perianth lobes 2, collateral, not overlapping. *Fruiting spike* eruciform with bulging fruitlets; perianth firm and pithy, eventually separating into two lateral halves; pericarp crustaceous at apex, membranous below. *Seed* sub-circular, ca. 1·5 mm diameter; testa stramineous, irregularly wrinkled, loosely surrounding embryo and perisperm, with faint reticulate ornamentation.

Habitat: Tidal flats in tropics.

Distribution: Coastal tropical Australia. Map 9.

Queensland: Woody Is., *H. Flecker* 8962 (NSW); St. Lawrence, *W. Macnae* (BRI); Townsville Common, 24 Feb. 1977, *P. G. Wilson* (PERTH).

Western Australia: Pt. Wyndham, *A. C. Beauglehole* 47043 (PERTH); near Derby, *V. Semeniuk* 174005–6 (PERTH).

Northern Territory: Darwin Harbour, *Balgooy* 1419 (PERTH); Peron Is., *T. S. Henshall* 855 PERTH); Melville Is., *G. Stocker* 677 (NT).

Around the tropical coast of Australia in regions where either *H. indica* subsp. *indica* or the tropical coastal variant of subsp. *leiostachya* occur, is frequently also found a plant which is similar to each of these sub-species but which differs from both in having the flowers and fruitlets exposed, in having a thin pericarp, and in having a sub-circular seed with faint porcate sculpturing. This plant varies considerably in habit and morphology; it is predominantly associated in the field with one or other of these *H. indica* sub-species and usually occupies an intertidal situation. Three of the collections studied are known to have been growing in association with one of the tropical coastal variants of *H. pergranulata* (as well as with *H. indica*), i.e. near Derby, on Sir Graham Moore Island, and at Townsville. At Derby and at Townsville, where it has been observed by the author, it has the appearance of being a distinct taxon, but in both situations it grades imperceptibly into the local variant of *H. indica*. Some of its organs are intermediate in morphology between *H. indica* ssp. *indica* and *H. pergranulata* (e.g. in texture and ornamentation of testa, texture of pericarp, and shape of articles). This suggests that the plant is a hybrid between the two species. However, in vegetative anatomy (i.e. in the single row of palisade cells and the underlying sheath of small thickened cells) it agrees with *H. indica*. At Derby it occupies a distinct zone in the *Halosarcia* association but at Townsville it is found growing intermixed with ssp. *indica* and *H. pergranulata*, a difference that is due evidently to a noticeable inclination of the mudflat at Derby compared with an almost horizontal tidal flat at Townsville. The mature seed appears to be normal except that the testa is wrinkled, that is, it does not fit closely around the embryo and perisperm as is usual in the genus. I have identified specimens of this complex as *H. indica* subsp. *julacea* but further field work over its whole range is required to understand its true relationship with the other sub-species of *H. indica* and possibly with *H. pergranulata*.

Halosarcia indica subsp. *julacea* differs from subsp. *indica* and *leiostachya* in having slender eciliolate articles, in the texture and lobing of the perianth, the texture of the pericarp (not horny) and in the shape of the seed and ornamentation of the testa. It is probable that eventually a complete range of variability will be found connecting these taxa but where subsp. *julacea* grows adjacent to subsp. *leiostachya* the two do not appear to hybridise.

The specific epithet refers to the resemblance of the spikes to catkins (*julus*, a catkin).

5. Sareocornia A. J. Scott

A. J. Scott, Bot. J. Linn. Soc. 75: 366 (1978).

Salicornia subgenus *Arthrocnemoides* Ung.-Sternb., Versuch einer Systematik der Salicornieen 54 (1866).

Lectotype: Salicornia fruticosa (L.) L., fide A. J. Scott, l.c.

Salicornia sect. *Perennes* Duval-Jouve, Bull. Soc. Bot. France 170 (1868), n.v., Moss, J. Bot. British & Foreign 49: 178 (1911). *Lectotype: Salicornia perennis* Miller, fide A. J. Scott, l.c.

Arthrocnemum subgen. *Gymnanthemum* Moss, J.S. Afr. Bot. 20: 8 (1954).

[*Salicornia* auct. non L. s.str.: J. M. Black, Trans. Roy. Soc. S. Austral. 43: 365 (1919); J. M. Black, Fl. S. Austral. ed. 2, 321 (1948); J. H. Willis, Handb. Pl. Victoria 2: 110 (1972); Beadle, Evans and Carolin, Fl. Sydney Reg. 188 (1972).]

[*Arthrocnemum* auct. non. Moq. s.str.: C. E. Moss, J.S. Afr. Bot. 20: 1 (1954); H. R. Tölken, Bothalia 9: 255 (1967).]

Decumbent to erect perennial *herbs* or *sub-shrubs* often rooting at the nodes. *Inflorescence* a terminal spike-like thyrse consisting of 3–12-flowered cymes sessile in the axils of the bracts. *Bracts* united in opposite pairs, ± shield shaped on outer surface. *Flowers* apparently embedded in the spongy mesophyll of the succulent axis, hermaphrodite or unisexual by abortion (rarely plants dioecious), arranged vertical to spike axis, free distally from bracts and from each other, fused towards base. *Perianth* succulent, gamotepalous; apex (outer surface) truncate, exposed, the orifice a short central vertical slit: lobes 3 or 4, two long lateral lobes and a small semi-circular outer adaxial lobe (sometimes also with a small semi-circular abaxial lobe). *Stamens* 2, one on both the abaxial and adaxial side of pistil. *Ovary* semi-circular to ovoid, succulent; style short; stigmas 2 (3), linear, papillose. *Spike* enlarging in fruit, the axis and bracts not disarticulating at maturity. *Fruiting perianth* becoming dry and spongy; pericarp membranous, ± fused to perianth and both eventually separating from axis just above their base. *Seed* vertical, broadly ovate to orbicular; seed coat membranous of two separate layers, the testa papillose or with slender (sometimes hooked) hairs; embryo hippocrepiform, radicle incumbent, inferior; perisperm absent.

Type species: Sarcocornia perennis (Miller) A. J. Scott (*Salicornia perennis* Miller).

About 16 species throughout the world; three are native to Australia, two of which are endemic.

Origin of name: From the Greek word *sarx*, flesh, and the Latin word *cornu*, horn, referring to the succulent nature of the plants, the shape of the leaves, and with allusion to the genus *Salicornia* (cf. the name *Pachycornia*).

The genus *Sarcocornia* includes species which were referred to *Salicornia* by Ungern-Sternberg (1866, 1876), Volkens (1892), J. M. Black (1919), Ulbrich (1934), and by authors of recent Australian State floras. However, Moss (1954), Tölken (1967), and Ball (1964) treated these species as belonging to the genus *Arthrocnemum*, a move that was accompanied by a misinterpretation of both Standley's (1916) and Ulbrich's (1934) lectotypification of that genus. This lectotypification relates back to Ungern-Sternberg's critical assessments of the genera within the *Salicornieae*. He recognised that Moquin's original description of *Arthrocnemum* encompassed species belonging to disparate genera and he effectively excluded all but three taxa, i.e. *A. fruticosum* var. *macrostachyum* (Moric.) Moq. (= *A. glaucum* (Delile) Ungern-Sternb.), *A. indicum* (Willd.) Moq., and *A. arbuscula* (R.Br.) Moq. (the last species with a query). P. Standley (1914) pointed out the confusion which existed in European floras over the use of the names *Salicornia* and *Arthrocnemum* and later (1916) lectotypified the latter genus on *A. fruticosum* [non (L.) Moq.] Moq. (= *A. glaucum*). This lectotypification was accepted by Ulbrich (1934). Unfortunately both Moss and Tölken apparently misunderstood the intention of the earlier authors and considered the type to be *A. fruticosum* s.str., a move which ran counter to the intentions of Ungern-Sternberg, Standley, and Ulbrich (see also A. J. Scott, 1978). The genera *Salicornia* and *Arthrocnemum* as previously understood together contained five distinct groups which are here recognised as separate genera, the additional ones being *Sarcocornia*, *Sclerostegia* and *Halosarcia*.

The Australian members of the genus *Sarcocornia* can be readily distinguished from those of the related genera by the truncate apex of the perianth in which the orifice is surrounded by a pair of vertical (lateral) lobes and a small semi-circular outer adaxial lobe (there may also be a small abaxial lobe); in no other Australian genus of the *Salicornieae* is this adaxial lobe present. The flowers are also distinctive in having two stamens (one in other Australian genera), and in having a seed in which the embryo is horseshoe-shaped and albumen absent. In their vegetative morphology members of the genus *Sarcocornia* are distinctive in having either plain or spirally thickened sclereids in the palisade tissue of the stem, a character not present in the other Australian members of the *Salicornieae* (fig. 3E, F). Additional characters which readily distinguish the two common species of *Sarcocornia* from all other Australian members of the *Salicornieae* are the number of flowers in a cymule (5 or more) and the decumbent habit with adventitious roots arising at the nodes.

The genus *Salicornia* is similar in its floral morphology to *Sarcocornia* and differs principally in: (1) containing only annual species; (2) all of the branches of the plant terminating in an inflorescence; and (3) the shape of the (normally 3-flowered) axillary cymes in which the lateral flowers are below the central and contiguous, their truncate apices forming the shape of a triangle. This genus is not represented in Australia.

Key to the species of Sarcocornia

1. Decumbent or caespitose woody perennial often rooting at nodes; flowers 5–12 in each axillary cyme 2
1*. Erect sub-shrub, not rooting at nodes; flowers in 3-flowered cymes; seed minutely tuberculate over radicle, otherwise smooth ..... 3. **S. globosa**
2. Flowers of cyme in single row; seed with slender acuminate hairs sometimes hooked at their tips ..... 1. **S. quinqueflora**
2*. Central flowers of cyme often in two rows; seed papillose with short rounded hairs ..... 2. **S. blackiana**

1. Sarcocornia quinqueflora (Bunge ex Ung.-Sternb.) A. J. Scott, Bot. J. Linn. Soc. 75: 368 (1978). Fig. 2A.

Salicornia quinqueflora Bunge ex Ung.-Sternb., Vers. Syst. Salic. 59 (1866); Ung.-Sternb., Atti Cong. Int. Bot. Firenze 1874, 302 (1876).

Syntypes: "Herb. Steetz: Melbourne (gesam. von Hildebrand)! Port-Adelaide (Blondowsky, Ferd. Müller)! Port-Jackson (Rieder)!)". *Lectotype:* Port Adelaide, *F. Mueller* (K, MEL 71432) lecto nov.

S. australis Solander ex Forst.f., Flor. Insul. Austral. Prod. 88 (1786) nomen.

S. australis Solander ex Benth., Fl. Austral. 5: 205 (1870); H. H. Allan, Fl. N. Zealand 1: 232 (1961). *Lectotype:* New Zealand, *Forster* (BM, n.v.), lecto nov.

Arthrocnemum heptiflorum Moss, J.S. African Bot. 20: 18 (1954), nom. illeg. non Moss ex Fourc. (1941). *Type:* New Zealand, leg. *Forster* (BM, n.v.).

[*S. indica* auct. non Willd.: R.Br., Prod. 411 (1810) p.pte.; Richard, Essai Fl. Nouv.-Zel., 162 (1832) (in Dumont d'Urville, Voy. Decouv. l'Astrolabe); Hook.f., Fl. Tasm. 1: 317 (1860); Hook.f., Fl. Nov.-Zel. 216 (1853).]

[*A. australasicum* auct. non (Moq.) Moss: Moss, J.S. African Bot. 20: 19 (1954), as to the New Zealand and New Caledonian specimens cited.]

Decumbent to erect *perennial*, frequently caespitose or, when decumbent, rooting at the nodes, up to 0·5 m high. *Branches* slender; articles cylindrical to narrowly obovoid, 5–15 mm long, minutely to prominently and acutely lobed, sometimes glaucous when young, older articles often retaining shape due to the thick firm spongy mesophyll; uniformly thickened (or sometimes spirally thickened) sclereids frequently present in palisade

tissue. *Spikes* (1) 2–5 cm long, cylindrical or narrowing towards the apex when in flower, 4–5 mm diam. when in fruit; axillary cymules 5–9 flowered in a single row, central floret (quadrate to) oblong or cuneate on outer face. *Perianth* (in fruit) ca. 2 mm high on outer face; adaxial lobe small, semi-circular, outside the lateral pair: abaxial lobe minute, triangular to semi-circular, usually within the lateral pair. Seed circular, covered with short or slender acute hairs, appressed or raised (sometimes uncinate), prominent around the periphery, frequently absent from the sides.

Nomenclatural Notes: The name *Arthrocnemum heptiflorum* Moss (1954) was published posthumously which could account for the confusion with its earlier homonym published by Moss ex Fourcade in 1941, also after Moss's death. Moss (1954) stated that the name *A. heptiflorum* was a 'nom. nov.'; in his synonymy he cited three names, viz. "*S. australis* Sol. ex Forst. Prodr. 88. 1786 (nomen nudum); *S. indica* Hook. Handb. N.Z. Fl. 233. 1864 non. Willd. *S. pachystachya* Black Fl. S. Austral. 2. 208 f.l. 1924. non Bunge ex Ung.-Sternb.". Moss* died in 1930 and the editors of his manuscript were evidently unaware that Ulbrich (1934) had already provided a new name for *S. pachystachya* Black and that Bentham (1870) had validly published the name *S. australis* (based on Solander's manuscript name). Moss, in calling his name a 'nom. nov.', and in citing the type as being the Forster specimen from New Zealand, was evidently intending a nomen novum for *S. australis* Sol. ex Forst.f., though it is unclear why he felt this required a new name. There is the possibility that he was aware of Bentham's '*S. australis*' and assumed it to be based on an Australian plant. He was, therefore, providing a new name for the New Zealand entity. In any case, the name *A. heptiflorum* (1954) is illegitimate being both superfluous and a later homonym. *Salicornia pachystachya* Black is distinct from the New Zealand species and is a nomenclatural synonym of *Sarcocornia blackiana*. In his paper Moss also cited specimens from South and East Africa; these are referred by Tölken (1967) to *A. decumbens* Tölken (= *Sarcocornia decumbens* (Tölken) A. J. Scott).

The name *A. australasicum* was misapplied by Moss (1954) to at least two different species. The New Zealand and New Caledonian specimens cited belong to *S. quinqueflora* while the African specimens belong to *Sarcocornia decumbens* (Tölken) A. J. Scott (see Tölken, 1967). The type of *A. australasicum* was stated by Moss to be a Robert Brown specimen from the East Indies in herb. BM: the type is, however, a specimen of unknown collector in herb. P; the name has been transferred to *Tecticornia* as *T. australasica* (Moq.) P. G. Wilson, a species quite different from those considered by Moss (see Wilson, 1972).

Robert Brown applied the name *Salicornia indica* Willd. to the species considered here and his application was followed by both Richard and J. D. Hooker. Moquin (1849) recognised a misidentification by Brown and considered that the latter's specimens probably belonged to *Halocnemum australasicum* Moq. However, J. D. Hooker (1853, 1860), who evidently discussed the matter with Brown, adhered to a broad (and obviously incorrect) concept of the species. Brown (1810) appears to have based his description of *S. indica* on material of *Sarcocornia ? quinqueflora* from Fowlers Bay, South Australia (cf. his Flora manuscript at the British Museum), but his cited distribution of the plant encompassed specimens or observations of several different species.

Key to subspecies

Plant decumbent (or shrubby); spikes slender; seed with slender often uncinate trichomes ..... 1a. subsp. **quinqueflora**

Plant caespitose; spikes shortly cylindrical; seed with short acute trichomes ..... 1b. subsp. **tasmanica**

* The 1954 paper by C. E. Moss was prepared by his wife and by Prof. R. S. Adamson from notes left by Moss after his death in 1930. These editors added to and altered the original manuscript (including the synonymy citation); many of the contradictory statements evident in this paper could have emanated from these later additions.

1a. subsp. **quinqueflora.** Fig. 33A–B, 68, 69.

S. australis Solander ex Benth., l.c.

S. heptiflorum Moss, l.c.

Decumbent to erect *perennial* rooting at the nodes, to 0·5 m high. *Spikes* 2–5 cm long, narrowly cylindrical; central floret oblong to cuneate on outer face. *Seed* with slender acute (often uncinate) hairs.

Habitat: Moderately saline situations which are frequently inundated, e.g. estuarine localities.

Distribution: Coastal or near coastal situations around the east and south coasts of Australia, and on the west coast as far north as Carnarvon; inland in south-west Western Australia; also found in New Zealand and New Caledonia. Map 20.

Queensland: Sandgate, *S. T. Blake* 2384 (BRI); Hannibal Is., Gt. Barrier Reef, *T. Done* (BRI); Stradroke Is., *C. E. Hubbard* 2376 (BRI).

New South Wales: Narrabeen, *D. O. Cross* (NSW); Bermagui, *W. Dunn* (NSW); Nowra, 7 Feb. 1956, *E. Gauba* (BRI, NSW, PERTH).

Victoria: Port Phillip Bay, *H. I. Aston* 269 (MEL); Wingan Pt., *A. C. Beauglehole* 32662 (PERTH); Williamstown, *R. J. King* 4626 (MEL).

Tasmania: Sorell, Dec. 1908, *R. A. Black* (MEL); Eaglehawk Neck, *N. T. Burbidge* 3221 (HO); King Is., Nov. 1887, *C. French* (MEL).

South Australia: Lake Robe, *J. R. Dodson* 139 (AD); Ethelton, 9 Feb. 1918, *E. H. Ising* (AD); 30 km N of Ardrossan, *A. E. Orchard* 2790 (AD).

Western Australia: Swan River, Perth, May 1902, *W. V. Fitzgerald* (NSW); Lake Coyrecup, *K. Newbey* 3156 (PERTH); Busselton, *A.* & *E. Pries* (MEL).

Morphological Notes. The presence of sclereids in the palisade tissue of the stem has been commented on by a number of workers. Cooke (1912) recorded 'spiral tracheides' in material which presumably came from New Zealand. Moss (1954) commented on them but owing to a taxonomic confusion it is not clear to which species he was referring. Tölken (1967) recorded spiral sclereids in *S. quinqueflora* but in this case it is not clear whether from his own observations or whether he was relying on those of Cooke. I have examined specimens from all Australian States and from New Zealand and have often been able to find sclereids. When present, however, they have been uniformly-thickened except in some specimens from Western Australia and from South Australia where spirally thickened sclereids were found (see Fig. 3E–F). In no plant examined were both types of sclereids present (although when using dried herbarium material they may have been overlooked) and Tölken (1967) found that in the South African species of *Sarcocornia* (which was treated under *Arthrocnemum*) one or other type was typical of a particular species. If this situation is paralleled in Australia it would suggest that more than one species should be recognised within the complex now referred to *S. quinqueflora*. It has not, however, been possible to consistently correlate the presence or absence of spiral sclereids with other characters, nor has it been possible to demonstrate the presence of sclereids in the majority of dried herbarium specimens, therefore at present no attempt has been made to erect additional taxa on this anatomical data. Specimens of *S. quinqueflora* in which spiral sclereids were observed are as follows:

South Australia: S. Neptune Is., Jan. 1923, *T. G. B. Osborn* (NSW); Flinders Is., 7 and 8 Jan. 1924, *T. G. B. Osborn* (NSW); N. Pearson Is., 10 Jan. 1923, *T. G. B. Osborn* (NSW).

Western Australia: Lake Hope, *G. J. Keighery* 1520 (PERTH); W of Moora, 27 Apr. 1969, *J.* & *D. C. Lowry* (PERTH); Shark Bay, 9 Apr. 1972, *G. Stone* (PERTH); Carnarvon, *P. G. Wilson* 8352 (PERTH); New Beach, ca. 30 km S of Carnarvon, *T.* & *J. Whaite* 4188 (PERTH).

Tölken (1967) noted that the abundance of sclereids in the palisade tissue was often related to the salinity of the soil; the greater the salinity the more numerous the tracheids. I have not observed this correlation in the Australian species where relative abundance appears to be determined by geography rather than ecology.

Tölken (1967) recognised that *S. quinqueflora* did not occur in southern Africa, as had been stated by Moss (under *S. australis*) and he described the African segment of the '*australis*' complex as a new species, *Arthrocnemum decumbens*. Tölken compared *A. decumbens* with both *S. quinqueflora* and *S. blackiana* and stated that the latter two species had spiral sclereids whereas in *A. decumbens* they were uniformly thickened. As noted above, spiral sclereids do occur in a variant of *S. quinqueflora*, but this variant has not been recorded from near Adelaide, Melbourne, or Sydney and since plants from these areas tend to be more slender than those in which spiral sclereids occur it is unlikely that such will be found. *S. quinqueflora* was described from material that was collected near these cities and it is therefore probable that none of the syntype specimens have palisade tissue with spirally thickened sclereids.

Collectors have sometimes indicated that specimens were dioecious and Black (1919) found *S. quinqueflora* to be functionally so, the male plants having ovaries which were sterile and smaller than those of the female plant. A study of herbarium material suggests that the plants of some localities are dioecious with the male flowers as described by Black and the female with small staminodes, however, in general specimens bear what appear to be hermaphrodite flowers. It is not clear how this sexuality is related to the plant's distribution or whether it is dependent on environmental factors. (For a general discussion on this phenomenon see J. Heslop-Harrison, 1957, 1972.)

Ecology. The ecological conditions which generally operate in segregating *S. quinqueflora* and *S. blackiana* are not clear. Both species will grow in situations which are periodically inundated, with *S. quinqueflora* generally occurring where the water has a salt content roughly equivalent to or less than that of the sea; *Sarcocornia blackiana*, when allopatric with the former species, often grows in areas which are drier for much of the year or are likely to have a higher salt content; it will also grow in saline loam which is very dry in the summer and here it adopts a bushy rather than decumbent habit. Where the two species grow together they tend to be virtually identical in gross morphology. It is interesting to note that in Western Australia the variant of *S. quinqueflora* which has spiral sclereids is found growing in conditions where water stress is likely to be at times extreme; this anatomical character may therefore be an advantageous adaptation to these situations.

1b. subsp. **tasmanica** P. G. Wilson, subsp. nov. Fig. 33C, 72.

Planta caespitosa ad 20 cm alta; caules graciles dense aggregati; articuli prominente lobati. *Spicae* breviter cylindraceae ca. 15 mm longae 4 mm latae. *Perianthium* in fructo firme spongiosum, apice quadrato ca. 2 mm lato. Semen cum trichomatibus brevibus acutis ornata.

Type: Bond Bay, Port Davey, Tasmania; rocks on sea edge subject to heavy spray at times, 14 March 1954, *M. Davis* 1306 (holo: MEL 71455, iso: HO).

Plant caespitose or with a dense cluster of slender stems to 20 cm high arising from short horizontal stolons. *Branches* slender, the aqueous tissue collapsing with age and soon shed along with the outer tissues. *Articles* prominently lobed, 5–10 mm long. *Spikes* shortly cylindrical ca 15 mm long, 4 mm wide. *Fruiting perianth* firmly spongy; apex quadrate, ca. 2 mm wide. *Seed* orbicular, ca. 1·3 mm diameter, covered with short acute trichomes.

Habitat: Rocky coasts, usually in situations where the plants are subject to sea-spray or to periodic inundation by the sea.

Distribution: Tasmania and probably the south coast of Victoria. Map 21.

Victoria: Mt. Martha, *L. A. S. Johnson* (NSW 136621).

Tasmania: Pt. Davey, 9 Feb. 1937, *C. Davies* (NSW); Blythe River, 3 Jan. 1937, *G. & C. Davies* (NSW); Cape Portland, 1884, *Bandinet* (MEL); Breaksea Is., *M. Davis* 1341 (CANB, HO); Cape Wickham, King Is., March 1885, *Dobson* (MEL); Southport, *S. Jacobs* 2027 (NSW); Bicheno, *V. Jacobs* 7 (MEL); Cape Barren Is., *J. S. Whinray* 422 (MEL).

It is not clear whether the characteristic caespitose form adopted by this subspecies is due to the influence of its preferred habitat (rocky coasts) or whether it would in other situations adopt this habit; however, in Tasmania plants with this habit and with slender stems (from which the soft tissues have been shed) have, if in fruit, always been found to have seeds with short acute trichomes. The subspecies *tasmanica* has often been collected along with a larger decumbent plant which is here recognised as subsp. *quinqueflora* and specimens of this latter subspecies, if in fruit, have usually been found to possess seeds with slender hooked trichomes, although in some cases a variety of seed types has been found in the one inflorescence. It is not clear whether such plants, having seeds of different types, are hybrids or whether the seed indumentum (and perianth shape) is influenced by the environment, although the latter possibility seems unlikely.

Specimens have been collected which appear to be intermediate in gross morphology between the two subspecies but these do not possess fruit so unequivocal identification is not possible. Because of the difficulty in assigning non-fruiting material to one or other taxon I have used the rank of subspecies rather than species, although, in fact, typical members of the two plants appear to differ sufficiently from each other to deserve the higher rank.

Sclereids in the palisade tissue have been observed in one specimen (*V. Jacobs* 7, MEL 71420); they were evenly thickened as is usual for the *S. quinqueflora* complex.

The solitary collection cited of subsp. *tasmanica* from Victoria is not in fruit so the record requires confirmation.

2. Sarcocornia blackiana (Ulbrich) A. J. Scott, Bot. J. Linn. Soc. 75: 369 (1978). Fig. 33D–E, 70, 71.

Salicornia blackiana Ulbrich in Engler et Prantl, Nat. Pflanzenfam. ed. 2. 16c: 552 (1934), based on succeeding.

Salicornia pachystachya J. M. Black, Trans. Roy. Soc. S. Austral. 45: 8, t.2 (1921) nom. illeg. non Ung.-Sternb. (1866).

Lectotype: Patawalonga River, Glenelg, 20 Jan. 1920, *J. M. Black* (holo: AD, ?iso: NSW) lecto. nov.

Arthrocnemum heptiflorum Moss ex Fourcade, Bot. Surv. S. Afr. Mem. no. 20: 19, 115 (1941) nom. illeg. (superfluous name), based on above.

[*A. heptiflorum* auct. non Moss (1954) sensu lectotypica: Moss, J. S. Afr. Bot. 20: 18 (1954) p.pte., as to S. Australian specimen cited.]

Erect or decumbent *perennial*, to 0·8 m high, frequently rooting at nodes. *Articles* to 10 mm long, narrowly obovoid to cylindrical, apex very shortly lobed; leaf-sheath persistent and retaining shape due to the dry spongy mesophyll; palisade tissue with numerous spirally thickened sclereids. *Spikes* 2–5 cm long, cylindrical, ca. 8 mm diam. in fruit; axillary cymules 5–13 flowered, frequently with the central florets in two tiers, central floret wedge-shaped on outer surface (apex). *Perianth* (in fruit) ca. 3 mm high on outer surface; adaxial lobe small, semi-circular, overlapping the lateral lobes; abaxial lobe minute, usually within the lateral lobes. *Seed* circular, testa covered with spreading papilliform hairs (rounded at their tips) which are prominent around the periphery but small on the faces.

Habitat: Swampy or periodically waterlogged moderately saline soils, frequently in estuarine situations. For notes on ecology see under *S. quinqueflora*.

Distribution: Coastal areas of Tasmania, Victoria and South Australia, in Western Australia coastal as far north as Shark Bay, and inland south-western region. Map 22.

Victoria: Altona, Port Phillip Bay, *H. I. Aston* 302 (MEL); The Lakes Nat. Park, *A. C. Beauglehole* 37748; Corner Inlet, Sandy Is., Sept. 1952, *C. I. Skewes* (MEL).

Tasmania: Ralphs Bay, *F. H. Long* 136 (HO); Muddy Plains, *L. Rodway* 660 (HO).

South Australia: 9 km S of Cape Banks, 25 Feb. 1945, *J. B. Cleland* (AD); 3 km N of Elliston, *Hj. Eichler* 19448 (AD); Goolwa, 25 Aug. 1970, *E. H. Ising* (AD).

Western Australia: Middle Doubtful Is., Apr. 1977, *I. Abbot* (PERTH); Garden Is., *T. E. H. Aplin* 646 (PERTH); King George Sound, *R. Brown* (3080) (K); N of Stirling Range, Oct. 1867, *F. Mueller* (MEL); 2 km NW of Pt. Charles, Fitzgerald River, *K. Newbey* 4030 (PERTH).

Nomenclatural Notes. C. E. Moss (1954) cited the collection 'Black 8' from Glenelg, South Australia, as being the type of *Salicornia pachystachya* and he listed this name as a synonym of *Arthrocnemum heptiflorum*. A specimen in herb. AD, collected by J. M. Black on 20 January 1920 at Glenelg probably corresponds to this and has been selected as lectotype. It bears a note in Black's handwriting to say that it was "sent to Paris as no. 3, 30/1/20"; the no. 8 referred to in Moss's paper may be a copying error for a "3" on a specimen in herb. P. For additional notes on *A. heptiflorum* Fourcade (1941) and *A. heptiflorum* Moss (1954) see under *S. quinqueflora*.

Morphological Notes. Sarcocornia blackiana is rather uniform in appearance throughout its geographical range (but it becomes slightly more robust towards the north-western limit). The papillae on the testa of the seeds provide the clearest character for distinguishing it from *S. quinqueflora* and, in fact, from other members of the genus. In Victoria, Tasmania, and South Australia the papillae are short and rounded, whereas in Western Australia, in addition to plants which exhibit this typical form, may be found those in which the papillae are slender and tend towards the shape of the trichomes found on the seed of *S. quinqueflora*.

In all specimens examined the palisade tissue had abundant spirally thickened sclereids (fig. 3F) which, in material from much of its range, are useful in distinguishing this species from *S. quinqueflora* (but see comment under the latter). The central florets of the cymules in *S. blackiana* are frequently in two tiers although the flowers of the lower tier may be vestigial. Old spikes from which the flowers have fallen still bear an indication of the two tiers in the concavities of their axes. In the extreme western limit of its range the single-tier condition is normal.

3. Sarcocornia globosa P. G. Wilson, sp. nov. Fig. 33F–K.

Fruticulus erectus ad 20 cm altus. *Articuli* obovoidei ca. 5 mm longi, apice acuminato, margine integro; textura vallo sclereidis spiralibus numerosis. *Inflorescentiae* terminales, articulis sphaericis; cymulae contiguae, 3-florae. *Perianthium* 3-lobum, lobo adaxiale parvo, hemisphaerico (lobo abaxiale absenti). *Semen* sub-orbiculare, ca. 2 mm diam.; testa super radicula minute tuberculata aliter laevis.

Type: One Mile Rocks Reserve, 33 12′S, 119 46′E, 12 Nov. 1970, *A. S. George* 10502 (holo: PERTH).

Small erect woody *perennial* to 20 cm high. *Articles* obovoid, ca. 5 mm long, apex acuminate, margin entire, palisade tissue with abundant slender spirally thickened sclereids. *Spikes* terminal to branches, of one or two (rarely three) spherical articles ca. 6 mm diameter; bracts with outer face deltoid; axis slender, extending as prominent vertical partitions between the flowers; cymule 3-flowered, contiguous with that of opposite bract. *Flowers* hermaphrodite (stamens not always maturing), vertical to spike axis, free from each other and from bracts but united in proximal half to radial partitions of axis; apex oblong in outline (laterally compressed), surface curved, ca. 5 mm high, 3 mm wide. *Perianth*

succulent, 3-lobed; lateral lobes ± straight, the outer one extending along two-thirds of perianth apex, the inner one for one-quarter length of apex; upper (adaxial) lobe small, semi-circular, overlapping the lateral lobes; abaxial lobe absent; orifice small, in centre of apex. *Ovary* thin walled, translucent; stigmas 2, delicate, sub-plumose. *Fruiting perianth* dry and spongy, readily separating (with seed enclosed in persistent pericarp) from spike axis; pericarp somewhat firmer than, and loosely adherent to, perianth. *Seed* loosely adherent to pericarp, vertical, sub-circular, ca. 2 mm long; testa thinly chartaceous, minutely tuberculate over radicle otherwise smooth, very pale brown; embryo accumbent, cotyledons broad.

Distribution: Inland south-western Western Australia from Meckering east to Lake King district. Map 21.

Western Australia: Mt. Caroline, 1891, *G. Sewell* (MEL 71532); One Mile Rocks Reserve (33 12′S, 119° 46′E), *A. Weston* 7675 (PERTH); 3 km E of Meckering, *P. G. Wilson* 10965 (PERTH).

Sarcocornia globosa may be readily distinguished from all other members of the genus by its spherical (and usually solitary) fertile articles. From the other two species found in Australia it differs in its erect habit and in its seed which is only sparsely tuberculate. The perianth lobes are similar in form to those found in *S. blackiana* and *S. quinqueflora* except that the abaxial lobe (which is small in these two species) is in *S. globosa* totally absent, and the inner of the two lateral lobes is much shorter than the outer. The palisade tissue is of several cells thickness (as is normal for the genus) and contains abundant slender sclereids which are spirally thickened; these sclereids extend from the epidermis to the water tissue.

Whereas both *S. blackiana* and *S. quinqueflora* are predominantly species of saline waterlogged situations (they even flourish in water), *S. globosa* grows in drier situations in company with such species as *Halosarcia pergranulata* and *H. lylei*. Its preferred habitat is reflected in its habit, for whereas the other two species have the main branches decumbent and rooting at the nodes, *S. globosa* is an erect dwarf shrub.

Sarcocornia globosa is almost certainly more widespread than is apparent from the few collections seen, but it is a small plant and easily overlooked in a samphire shrubland. However, it is not common, and at the salt-lakes near Meckering (one of the three collection sites) only one plant has been found even though the area has been extensively investigated on several occasions.

Acknowledgements

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The illustrations have been prepared by Margaret A. Menadue and Bryony V. Wilson, to both of whom I extend my thanks for the long and detailed study they made of the plants.

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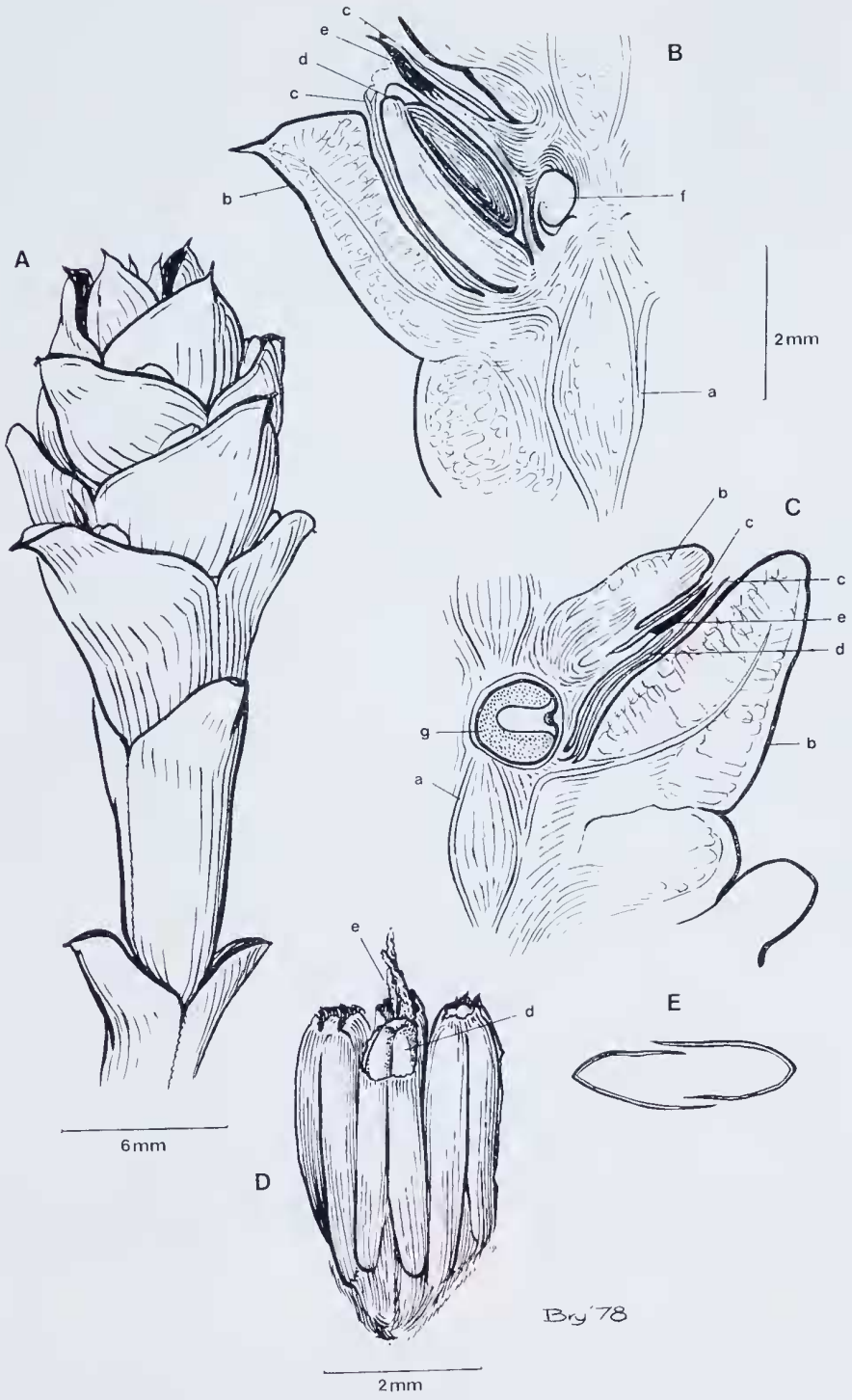
Figure 11. *Pachycornia triandra:* A—Inflorescence; B—L.S. central hermaphrodite flower; C—L.S. fruit; D—Triad of young flowers, lateral male, central hermaphrodite; E—T.S. perianth apex (a—stele, b—bract, c—perianth, d—stamen, e—style, f—ovule, g—seed). From J. Verschuer, 27 Aug. 1971.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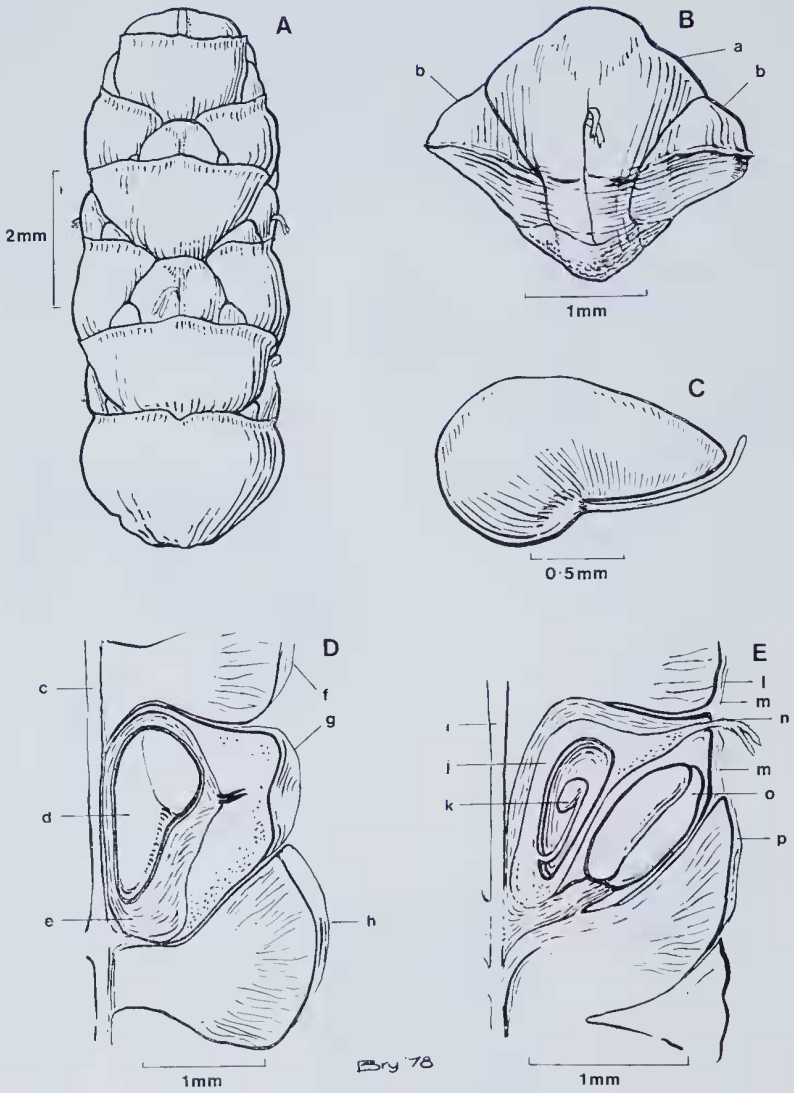

Figure 12. *Sclerostegia disarticulata:* A—Inflorescence; B—Triad of flowers (a—central hermaphrodite, b—lateral male); C—Seed; D—L.S. (radial) of fruitlet (c—stele, d—seed, e—thick pericarp, f—upper bract, g—perianth, h—lower bract); E—L.S. of central flower (i—stele, j—fleshy ovary wall, k—ovule, l—upper bract, m—perienth, n—style, o—anther, p—lower bract). A—D from P. G. Wilson 8603; E from P. G. Wilson 8850.

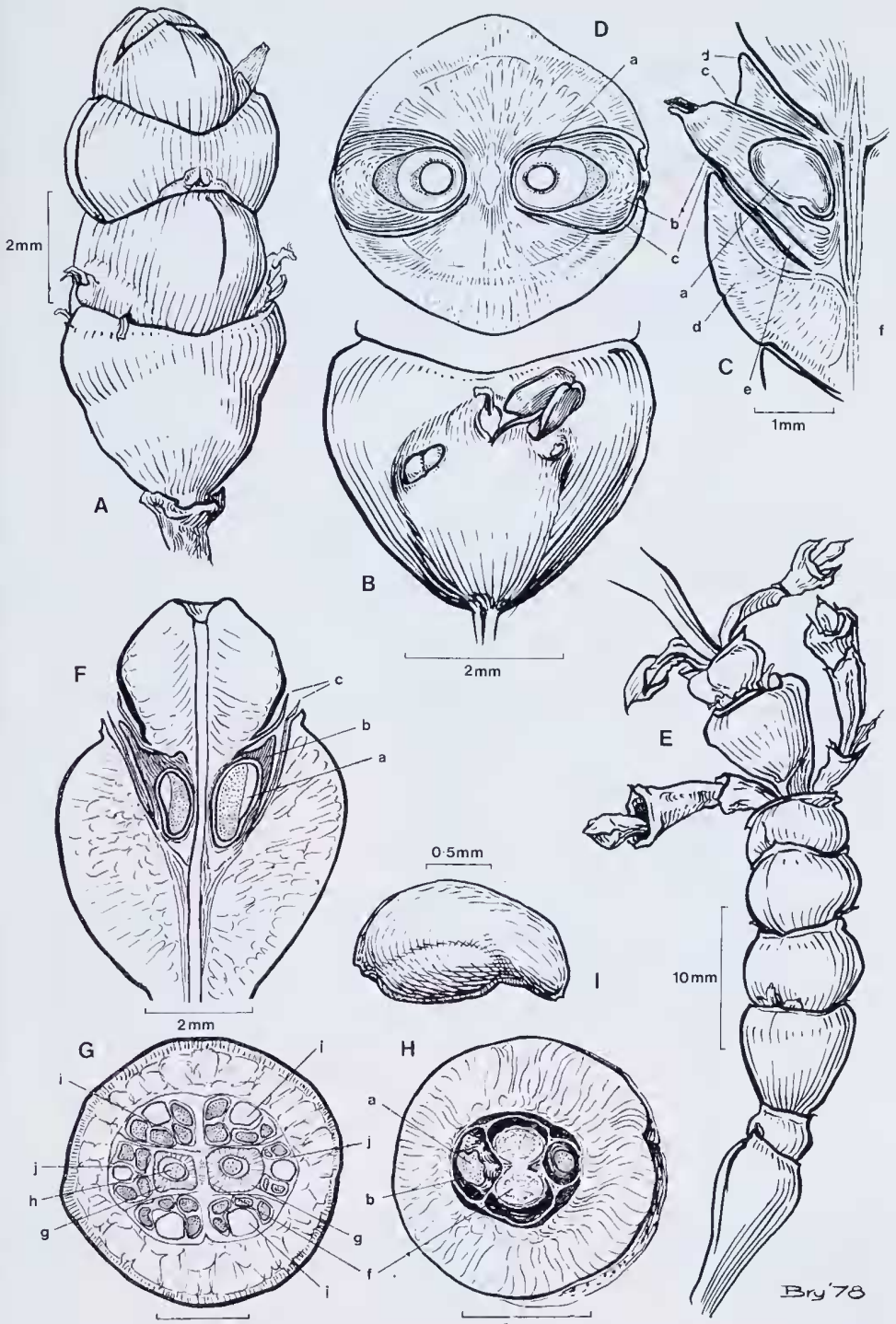

Figure 13. *Sclerostegia arbuscula:* A—Inflorescence; B—Triad of flowers fused to bract (abaxial view), lateral flowers male, central hermaphrodite; C—L.S. fruit; D—T.S. fruiting article. *Sclerostegia monili-formis:* E—Fertile portion of branch; F—L.S. fruiting article; G—T.S. fertile article with young flowers, lateral flowers male, central hermaphrodite; H—T.S. fruiting article (a—seed, b—pericarp, c—perianth, d—bract, e—stamen, f—stele, g—ovary, h—ovule, i—male flowers, j—hermaphrodite flowers).

A to D from M. Brown, Lauderdale, Tasmania; E to H from A. S. George 9385.

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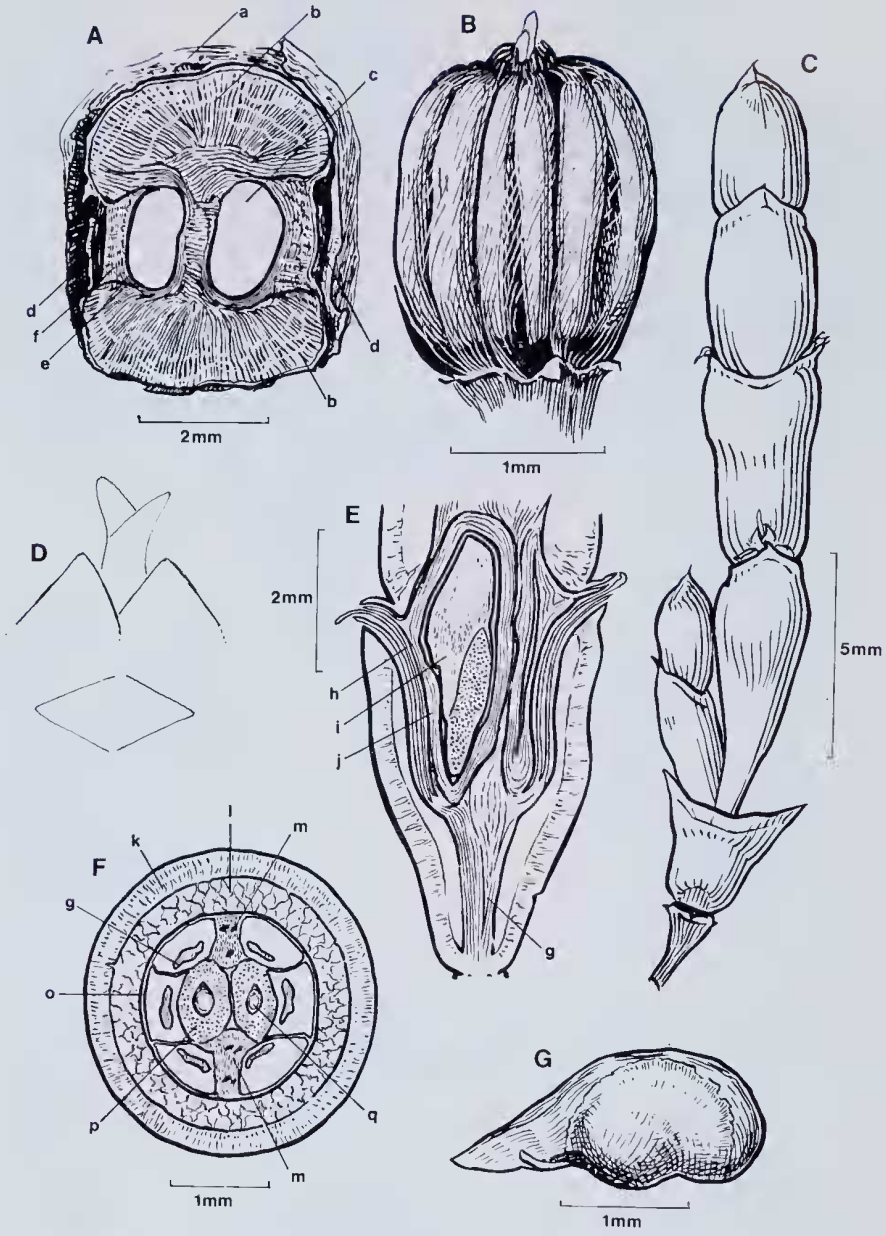


Figure 14. *Sclerostegia tenuis:* A—T.S. fruiting spike (a—bract tissue, b—secondary thickening, c—seed, d—remains of perianth, e—pericarp, f—secondary thickening of pericarp; B—Triad showing the enclosed anthers and stigmas emerging from central flower (abaxial view); C—Terminal inflorescence; D—Apex of perianth with emerging stigmas (below, T.S. of apex); E—L.S. through fruiting spike (g—stele, h—staminal filament, i—seed, j—thickened pericarp); F—T.S. immature fruiting spike (k—chlorenchyma, l—aqueous tissue, m—stele, n—staminal filament, o—perianth, p—ovary wall, q—ovule).

A—F from M. A. Wilson 34; G from T. E. H. Aplin 2236.

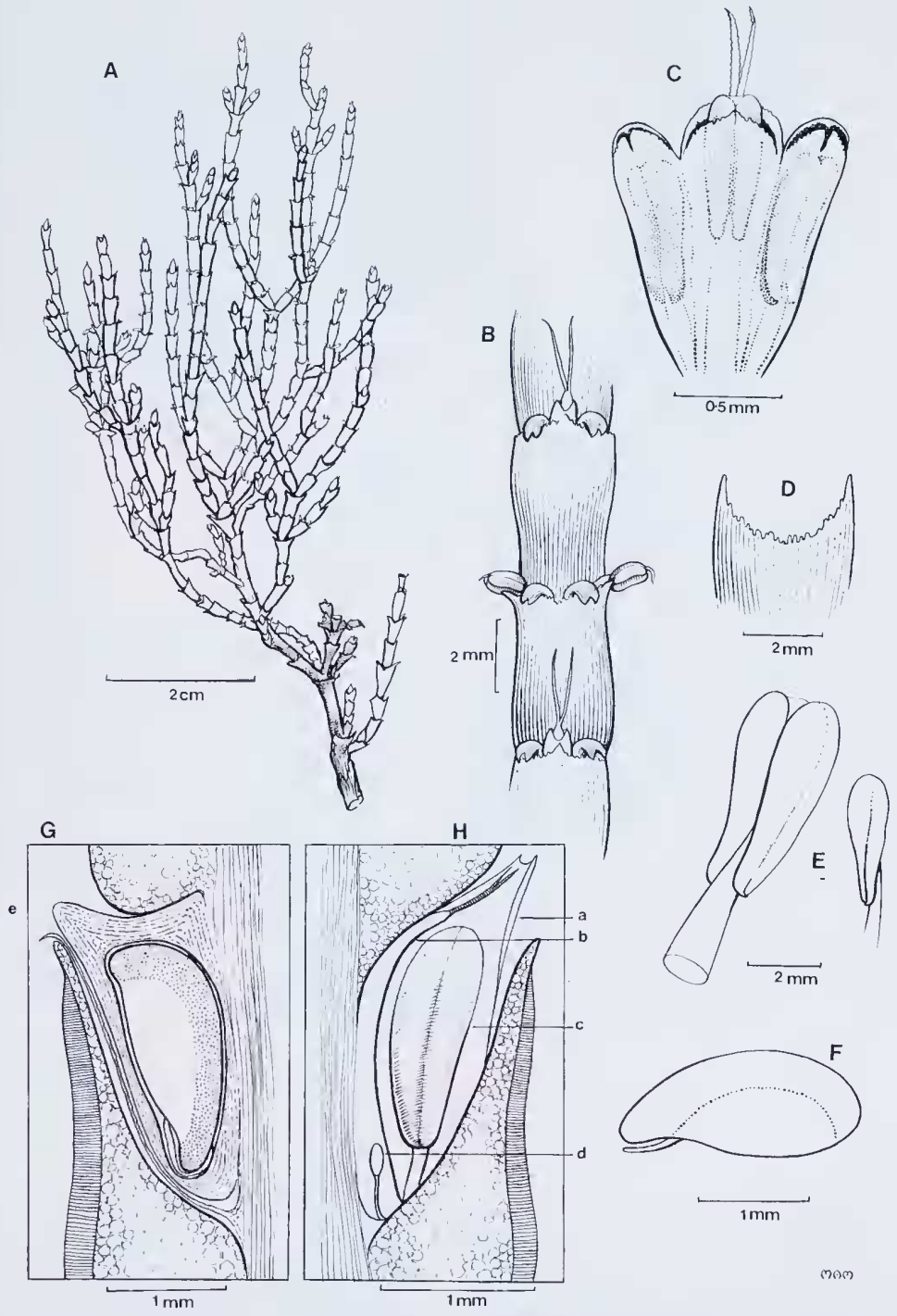


Figure 15. *Sclerostegia medullosa:* A—Flowering branch; B—Portion of branch showing triads of flowers; C—Triad of flowers (abaxial view), central hermaphrodite and lateral male flowers; D—Apex of article showing denticulate margin; E—Stamens; F—Seed; G—L.S. fruit (e—pericarp); H—L.S. flower (a perianth, b—ovary wall, c—stamen, d—ovule).

From D. Symon 11313 (dried material).

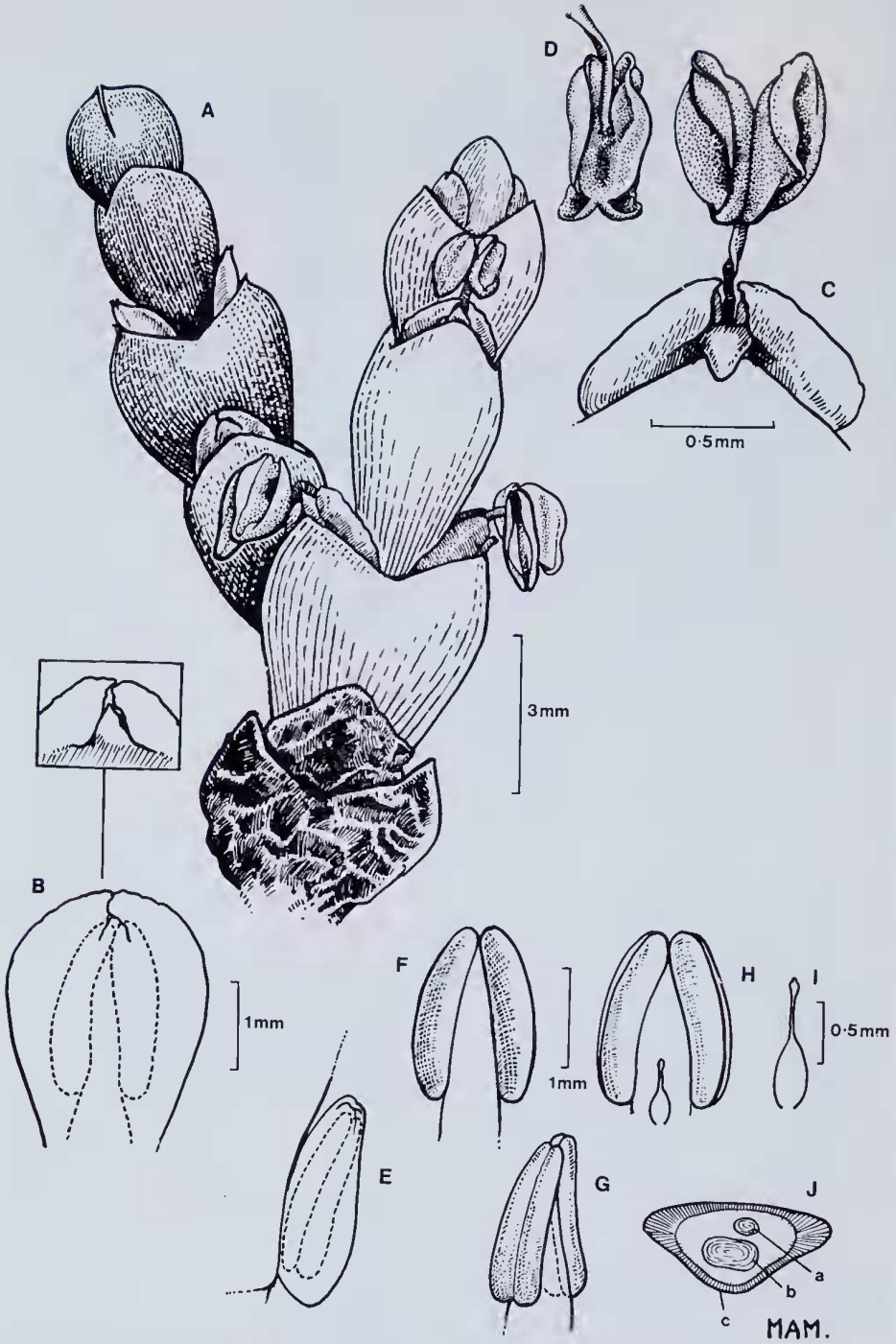
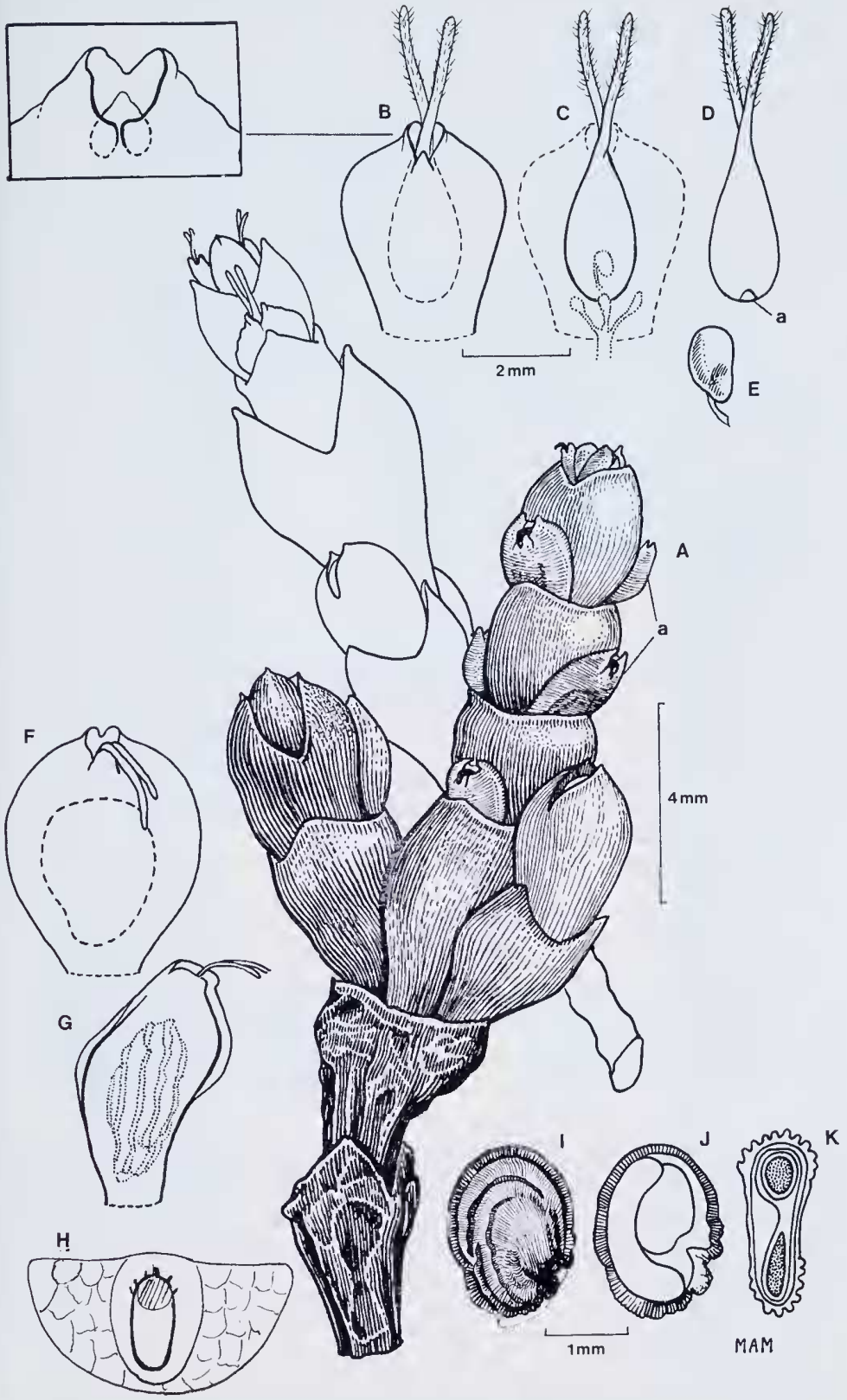


Figure 16. *Tegicornia uniflora*, male plant: A—Flowering branch; B—Flower (abaxial view) with enlarged view of perianth lobes; C—Apex of flower with exserted anther; D—Anther; E—Flower, lateral view; F and G—Anther in bud; H—Stamen with pistillode (adaxial view); I—Pistillode; J.—T.S. flower (a—pistillode, b—staminal filament, c—perianth).
From P. G. Wilson 11625.

Figure 17. *Tegicornia uniflora*, female plant: A—Flowering branch (a—flowers); B—Flower (abaxial view) with enlarged view of perianth lobes; C—Flower dissected to show ovule and vascular trace; D—Ovary with vestigial staminode 'a'; E—Ovule; F and G—Fruiting perianth showing tangential position of seed; H—T.S. fruiting perianth showing normal (radial) position of seed; I to K—Seed.
From P. G. Wilson 11626.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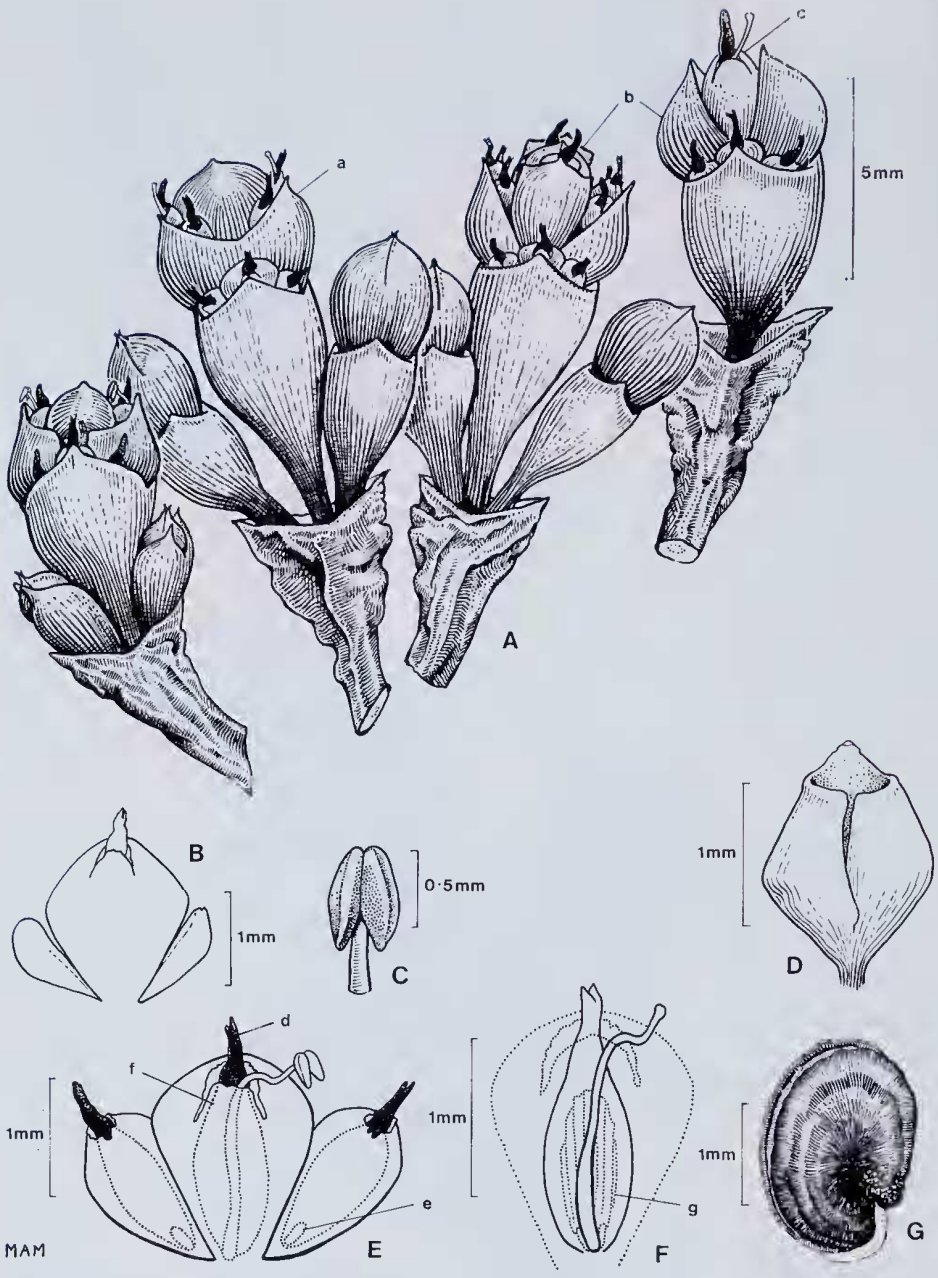

Figure 18. *Halosarcia* sp. x *Tegicornia uniflora:* A—Terminal inflorescences (a—united bracts, b—free bracts, c—terminal solitary flower); B—Triad with a central fertile flower and a pair of vestigial flowers; C—Anther; D—Terminal bract adaxial view); E—Triad with central hermaphrodite flower and lateral female flowers (abaxial view); (d—stigmas, e—staminode, f—abaxial perianth lobe); F—Central flower with seed 'g'; G—Seed.

From G. Keighery, 18 Jan. 1978.

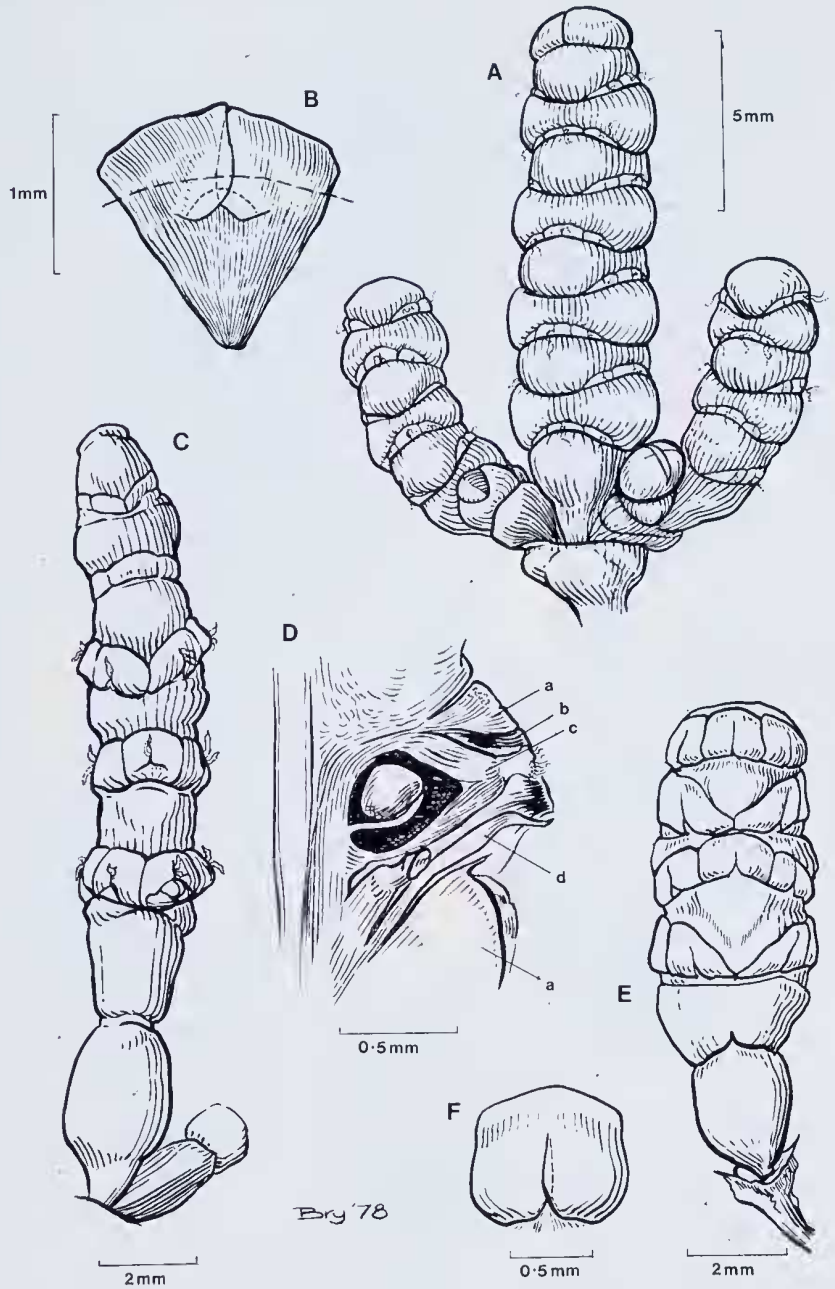

Figure 19. *Halosarcia halocnemoides* subsp. *halocnemoides:* A—Inflorescence; B—Central flower, abaxial view (showing position of bract and inner medial lobe). *Halosarcia halocnemoides* subsp. *catenulata:* C—Inflorescence; D—L.S. flower (a—bracts, b—perianth, c—ovary, d—medial lobe, e—staminal filament). *Halosarcia halocnemoides* subsp. *tenuis:* E—Inflorescence; F—Central flower, apex.

A and B from P. G. Wilson, 22 Feb. 1979, Alfred Cove; C and D from P. G. Wilson 8814; E and F from M. Trudgen, Aug. 1978, Dampier.

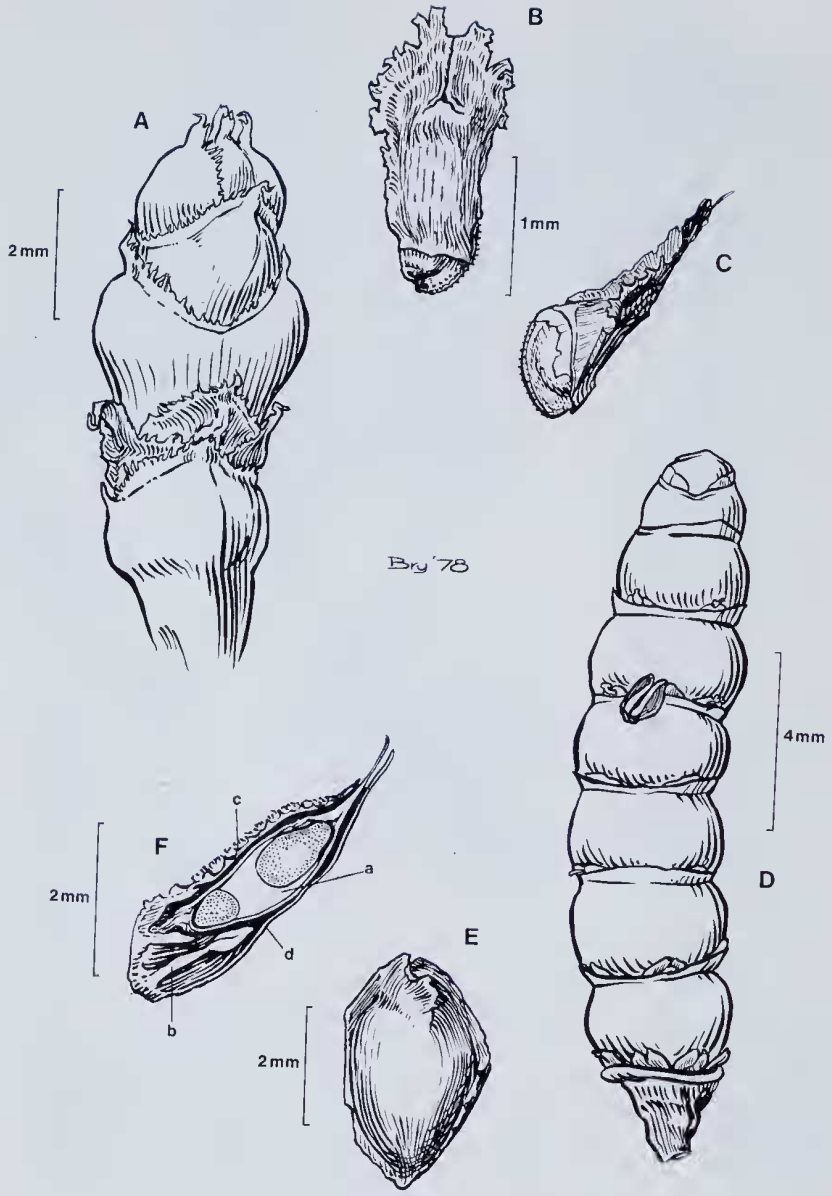

Figure 20. *Halosarcia fimbriata:* A—Terminal inflorescence (a—flower); B—Central fruitlet showing seed exposed at torn base, abaxial view; C—The same, lateral view. *Halosarcia chartacea:* D—Terminal inflorescence; E—Fruitlet, abaxial view; F—Fruitlet, medial longitudinal section (a—seed, b—base of staminal filament, c—perianth, d—pericarp).

A—C from D. and J. Lowry, June 1969: D—F from P. G. Wilson 7446.

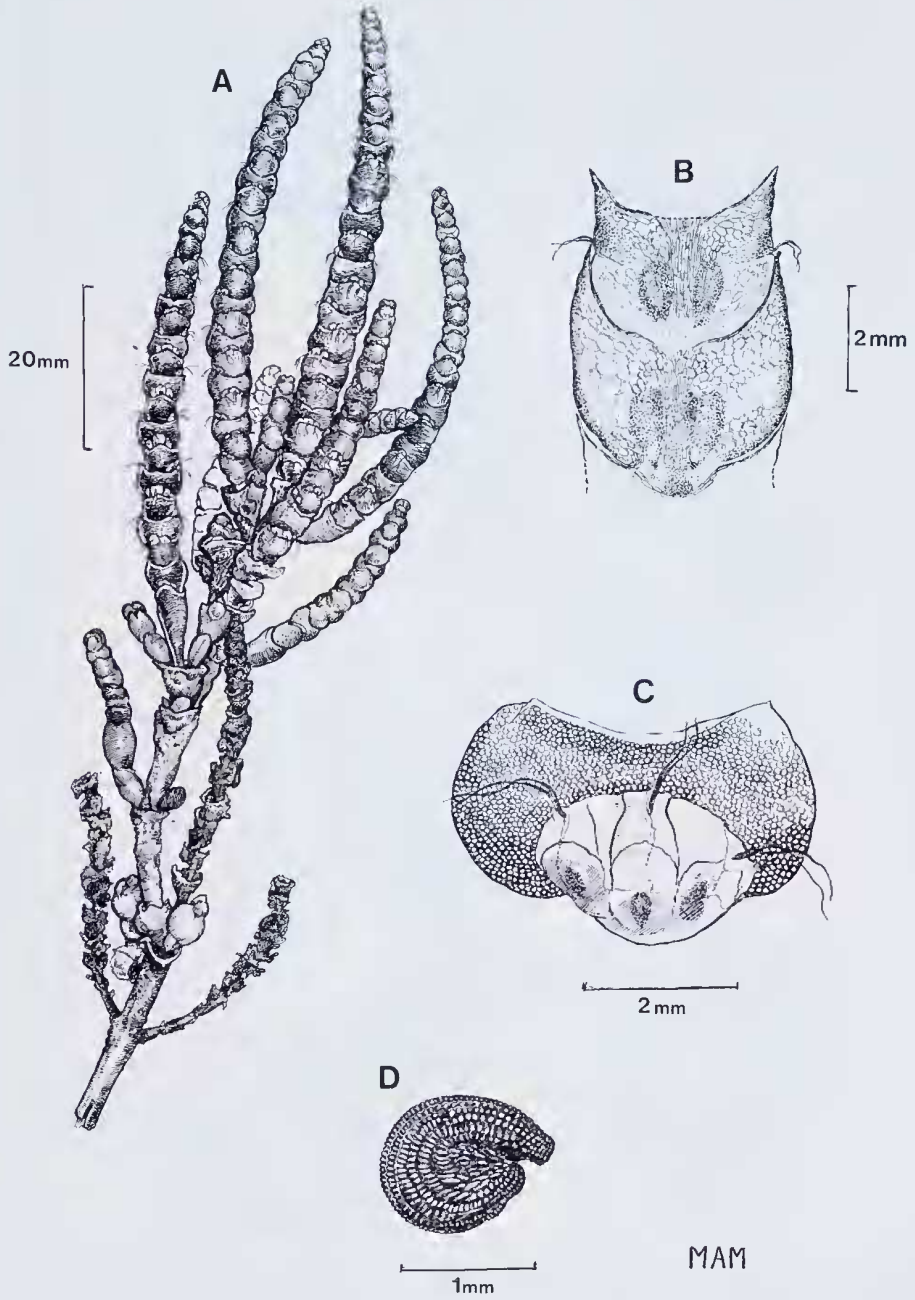

Figure 21. *Halosarcia pergranulata* subsp. *pergranulata:* A—Branch bearing inflorescences; B—L.S. through fertile articles; C—Fertile article with triad of flowers exposed; D—Seed.

From M. A. Menadue, October, 1974.

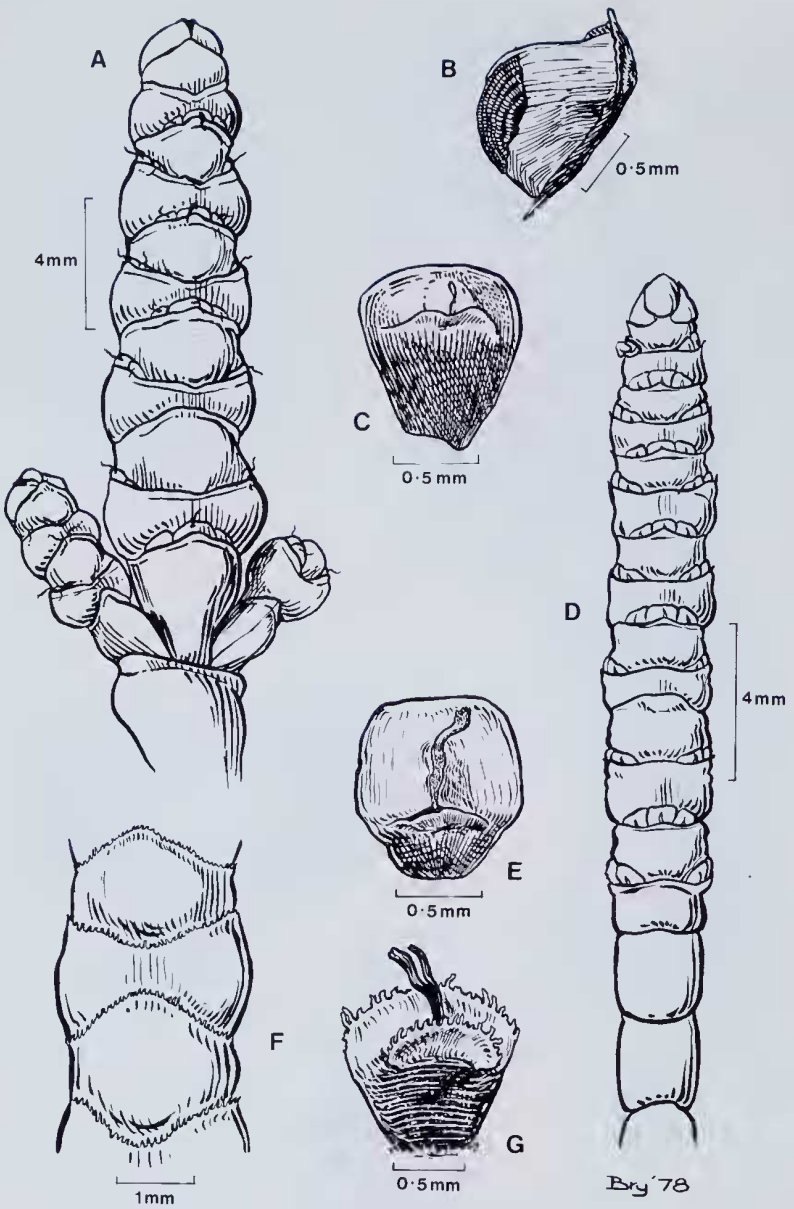

Figure 22. *Halosarcia pergranulata* subsp. *pergranulata:* A—Terminal inflorescence; B—Fruitlet, lateral view, showing seed exposed at torn base of perianth; C—Fruitlet, abaxial view. *Halosarcia pergranulata* subsp. *elongata:* D—Terminal inflorescence; E—Fruitlet, abaxial view. *Halosarcia doleiformis:* F—Portion of spike; G—Fruitlet, abaxial view.

A—C from P. G. Wilson, Nov. 1978; D—E from J. Maconochie 1032; F—G from P. G. Wilson 8310.

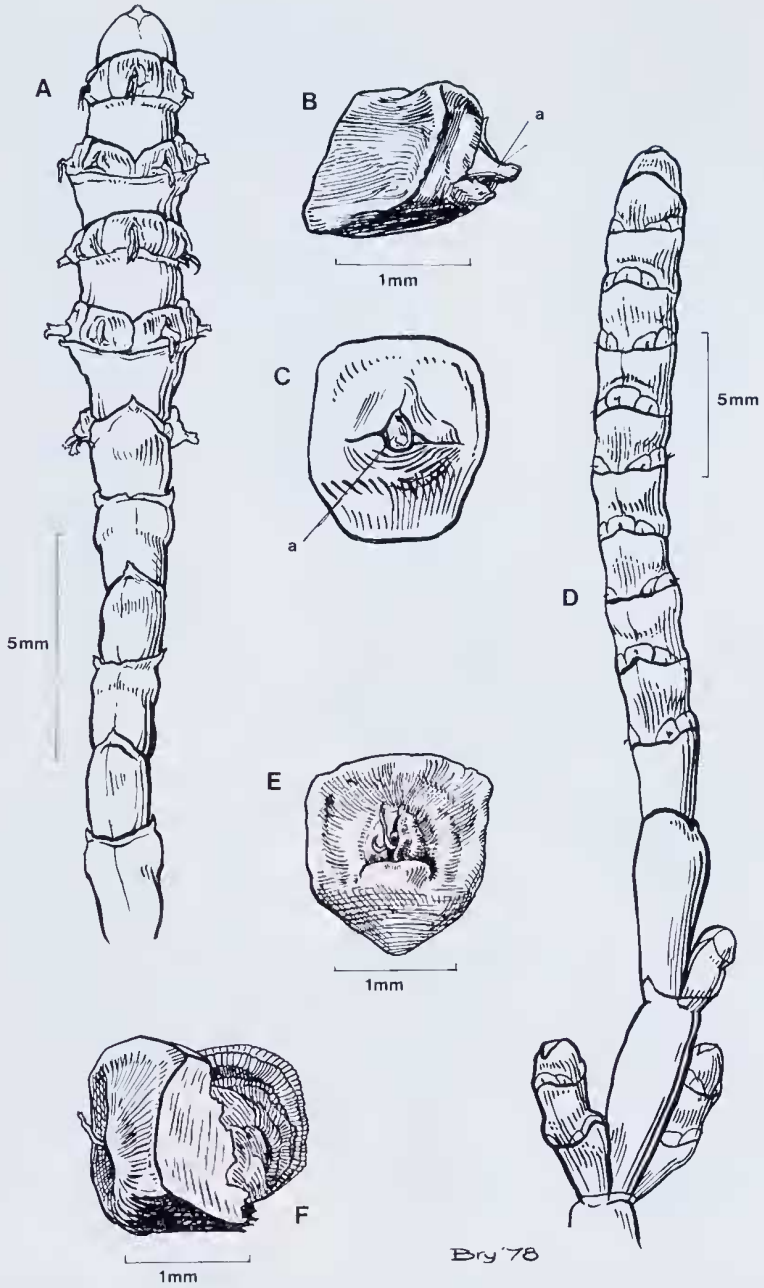

Figure 23. *Halosarcia lylei:* A—Terminal inflorescence; B—Fruitlet, lateral view (a—hard protruding style); C—Fruitlet, front view. *Halosarcia lepidosperma:* D—Terminal inflorescence; E—Fruitlet, front view; F—Fruitlet, lateral view, showing seed exposed at torn base of perianth.

A—C from P. G. Wilson 6448; D—F from K. Newbey 3103.

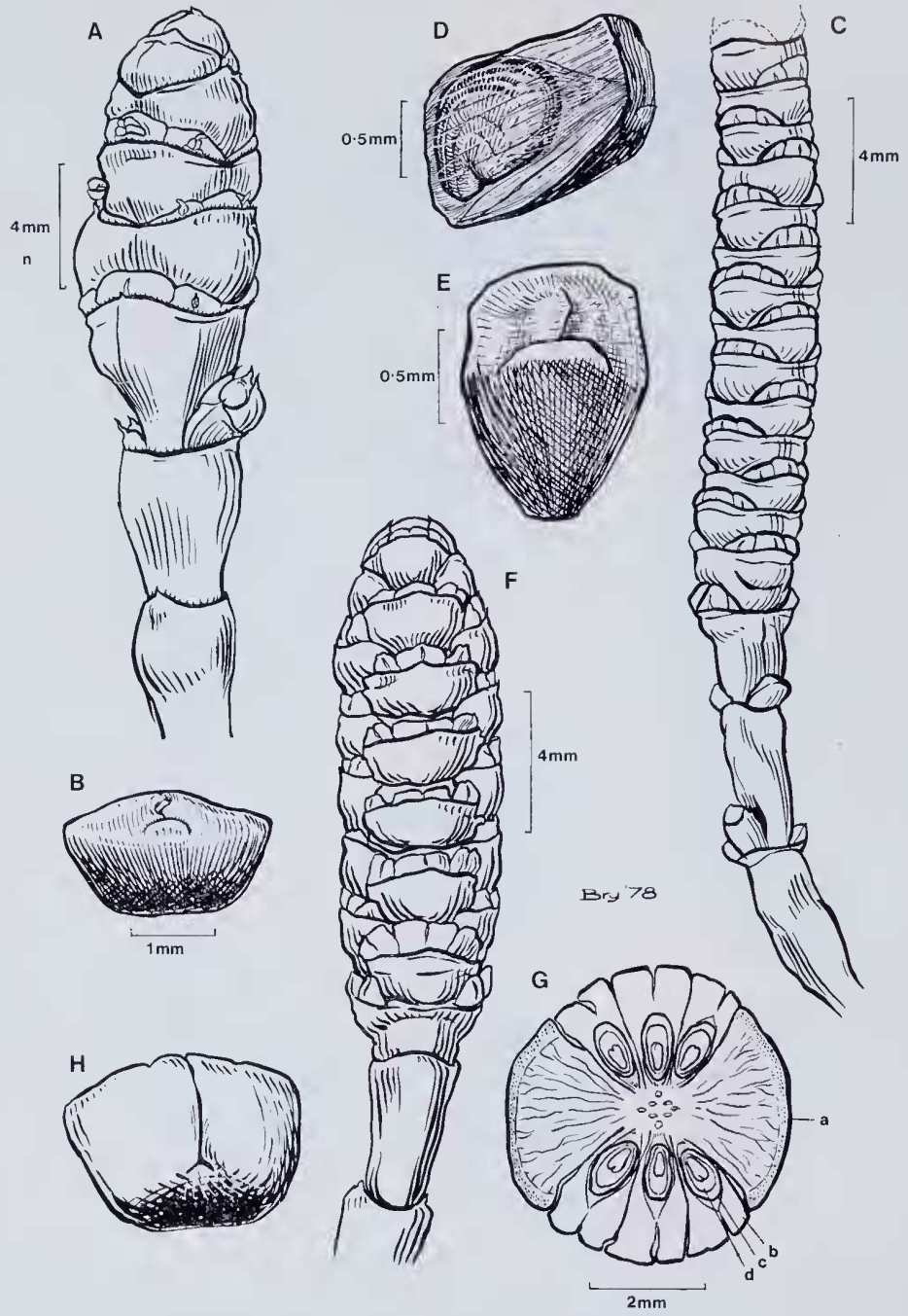

Figure 24. *Halosarcia pterygosperma* subsp. *denticulata:* A—Terminal inflorescence; B—Central flower, front view. *Halosarcia fontinalis:* C—Terminal inflorescence; D—Fruitlet, lateral view; E—Fruitlet, front view. *Halosarcia flabelliformis:* F—Terminal inflorescence; G—T.S. spike to show fan-shaped bracts and opposite triads of flowers (a—bract, b—perianth, c—pericarp, d—seed). H—Central floret, apex.

A and B from T. E. H. Aplin, Bellefin Prong; C to E from D. E. Symon 9302; F—H from R. Chinnock 3364.

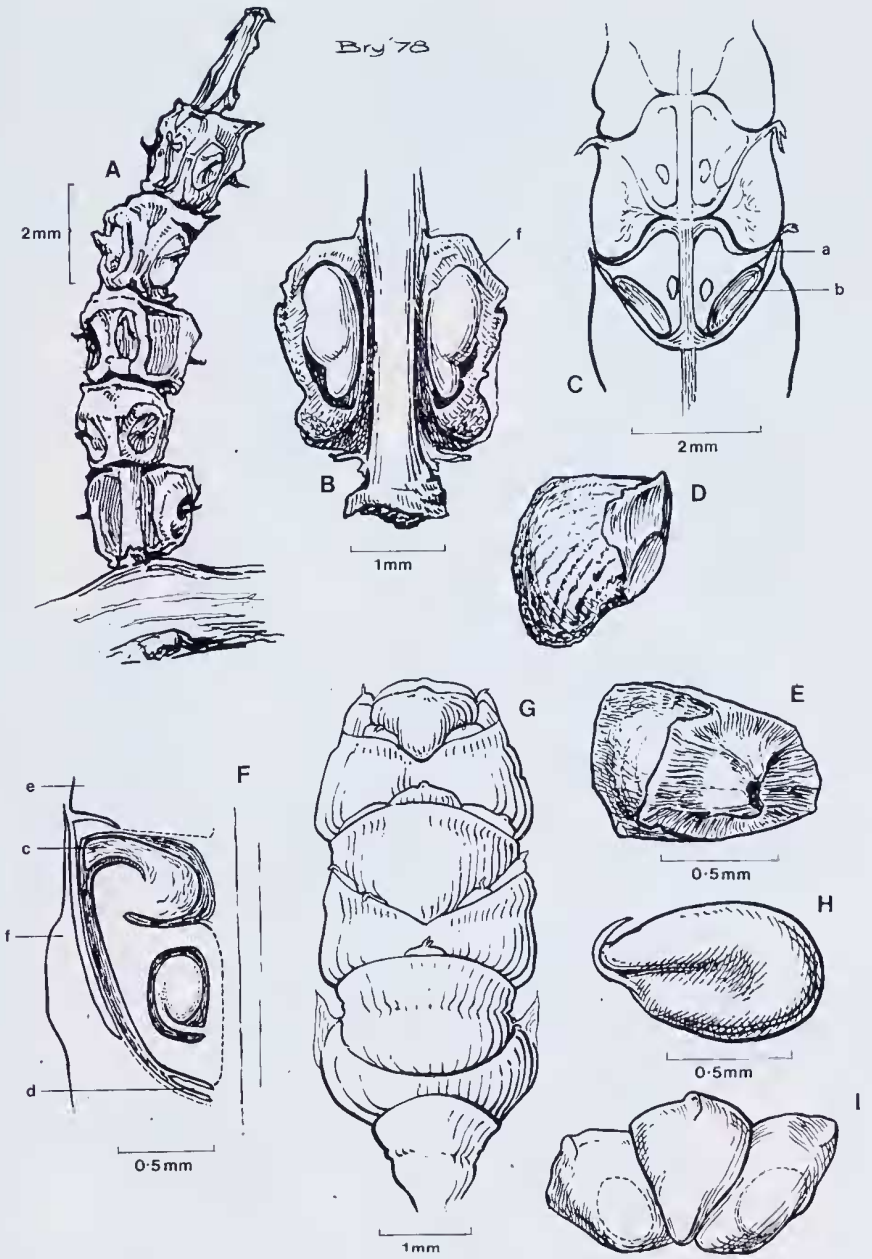

Figure 25. *Halosarcia calyptrata:* A—Fruiting branchlet; B—L.S. through whorl of fruitlets (f—hard pericarp); C—L.S. flowering spike (a—style, b—anther). *Halosarcia leptoclada* subsp. *leptoclada:* D and E Separate fruitlets. *Halosarcia leptoclada* subsp. *inclusa:* F—L.S. flower showing included style (c—style, d—staminode, e—bracts); G—Terminal inflorescence; H—Seed; I—Triad of fruitlets (abaxial view).

A—C from P. G. Wilson 10578; D—E from D. Wilcox 53; F—I from P. G. Wilson 11645.

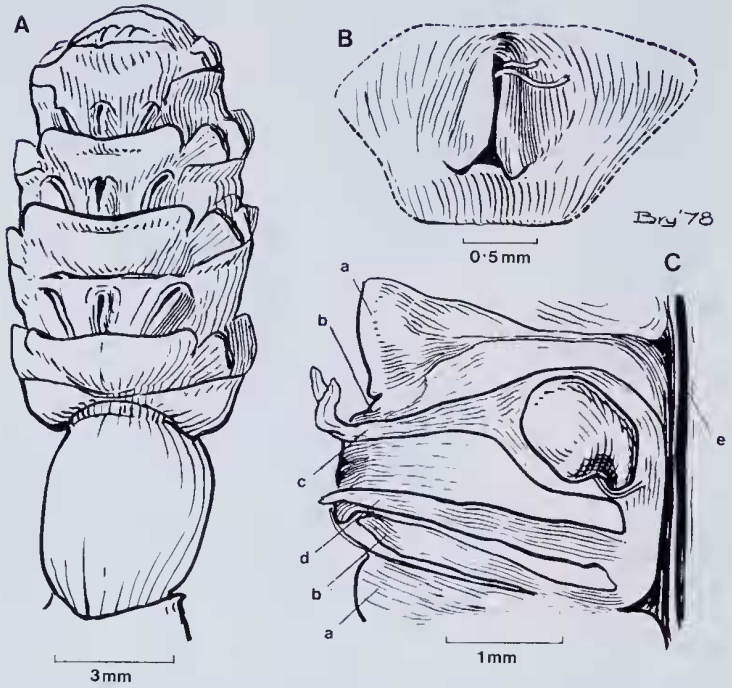

Figure 26. *Halosarcia peltata:* A—Terminal inflorescence; B—Central flowers, apex; C—L.S. through young fruit (a—bracts, b—perianth, c—style, d—staminal filament).

From H. G. Baker, Lake Annean.

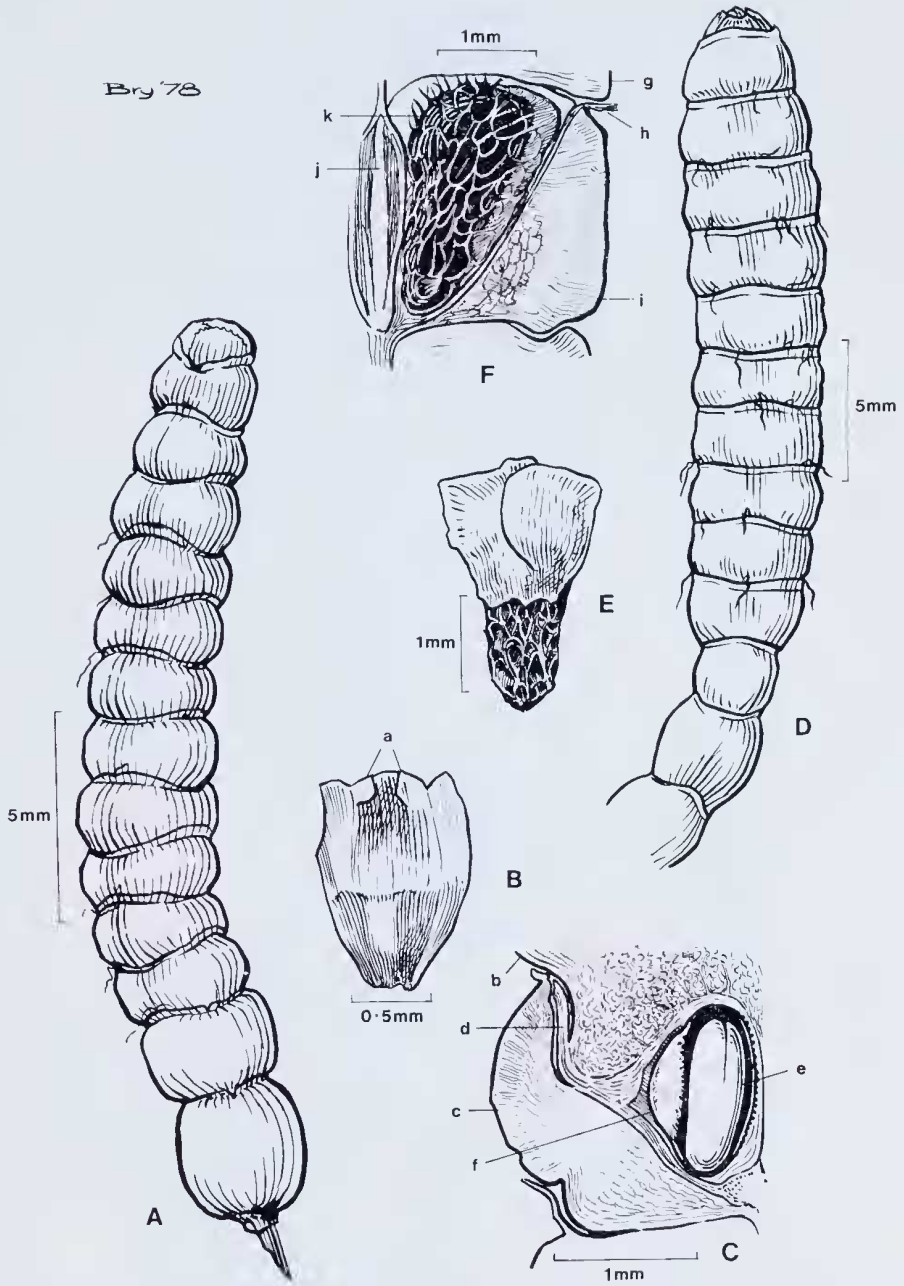

Figure 27. *Halosarcia auriculata:* A—Inflorescence; B—Central floret, abaxial view (a—lateral perianth lobes); C—L.S. of fruitlet (b—upper bract, c—lower bract, d—style, e—seed with embryo and perisperm, f—pericarp.) *Halosarcia pruinosa:* D—Terminal inflorescence; E—Central fruitlet, abaxial view; F—Lateral view of fruitlet within bracts (g—upper bract, h—staminal filament, i—lower bract, j—spike axis, k—lateral wall of fruitlet).

A—C from G. I. Parlerliet, 13 May 1971; D—F from D. Lowry, 14 Aug. 1971.

Figure 28. *Halosarcia halocnemoides* association. Saltmarsh bordered on right by *Melaleuca acacioides* and fringing a saltpan (on left). Dark compact shrubs of *H. halocnemoides* subsp. *halocnemoides* (K. F. Kenneally 6866), paler more open shrubs of subsp. *tenuis* (K.F.K. 6867). Photo by K. F. Kenneally, 13 Sept. 1978, Dampierland Peninsula, 175 km NNE of Broome, Western Australia.

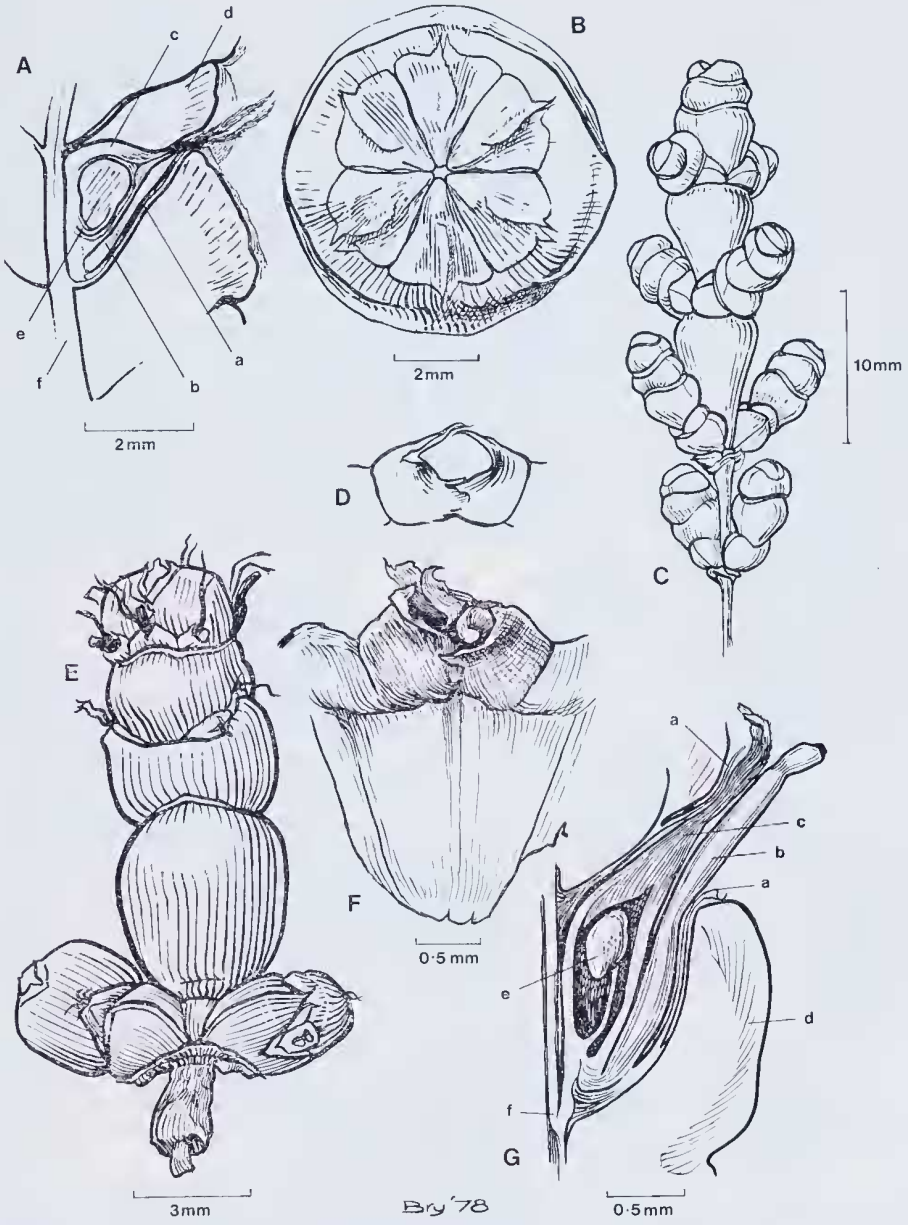

Figure 29. *Halosarcia undulata:* A—L.S. fruit; B—Fertile article from below to show the opposite triads of flowers; C—Fertile branch with flowering spikes; D—Apex of perianth to show imbrication of lobes. *Halosarcia syncarpa:* E—Spike, F—Central flower with portion of lateral flowers attached, G—L.S. flower (a—perianth, b—stamen, c—pericarp, d—bract, e—ovule, f—stele).

A to D from P. G. Wilson 11649; E to G from K. F. Kenneally, 13 Aug. 1970.

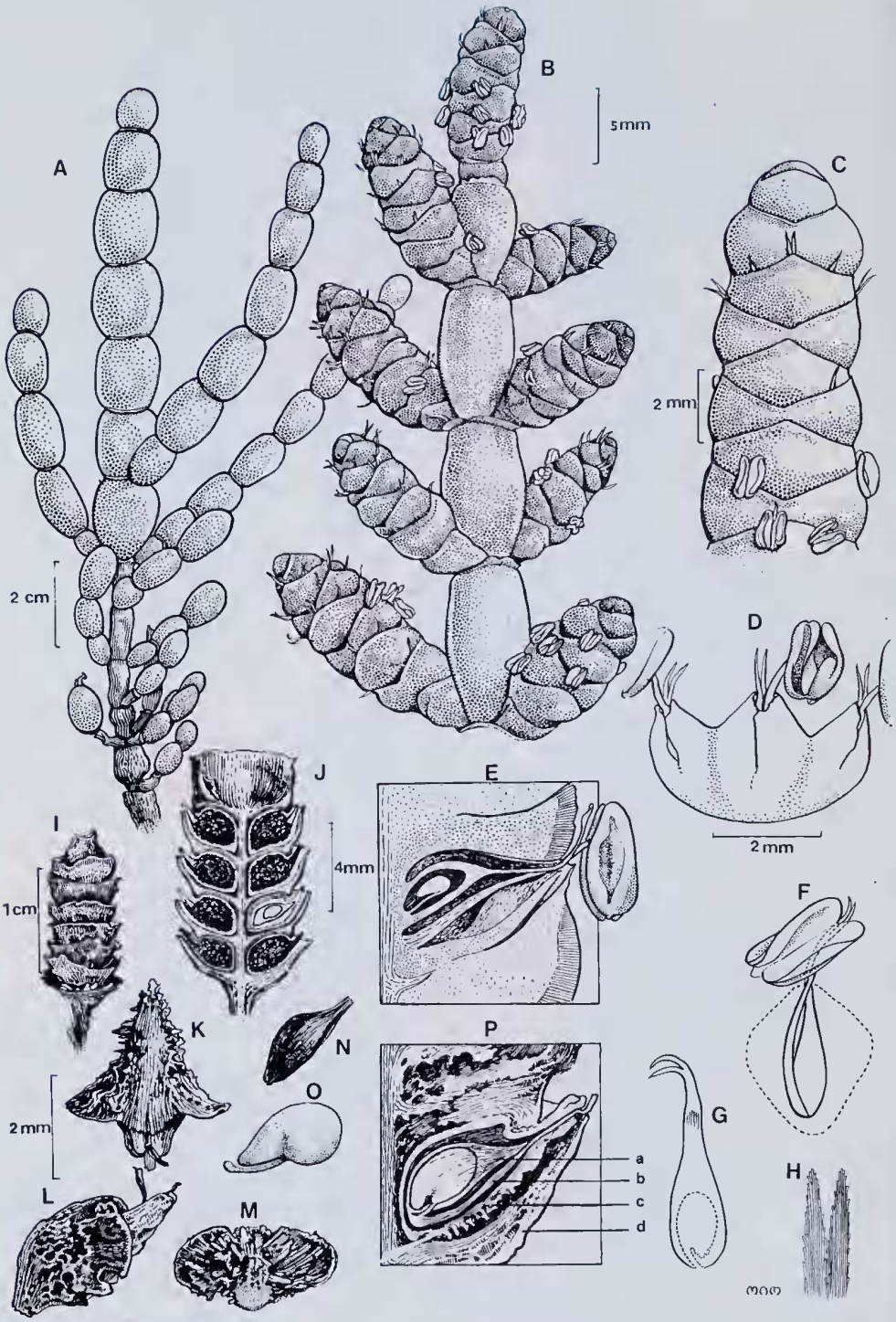

Figure 30. *Halosarcia bulbosa:* A—Vegetative branch; B—Flowering branch; C—Spike; D—Triad of flowers; E—L.S. flower; F—Stamen and ovary; G—Ovary, H—Stigmata; I—Fruiting spike; J—L.S. Fruiting spike; K—Fruitlet from above; L—Fruitlet from side; M—Fruitlet apex; N—Utricle; O—Seed; P—L.S. fruitlet within bracts (a—pericarp, b—staminal filament, c—perianth, d—lower bract.)
A—H from M. Demarz s.n. (cult.); J—P from P. G. Wilson 11702.

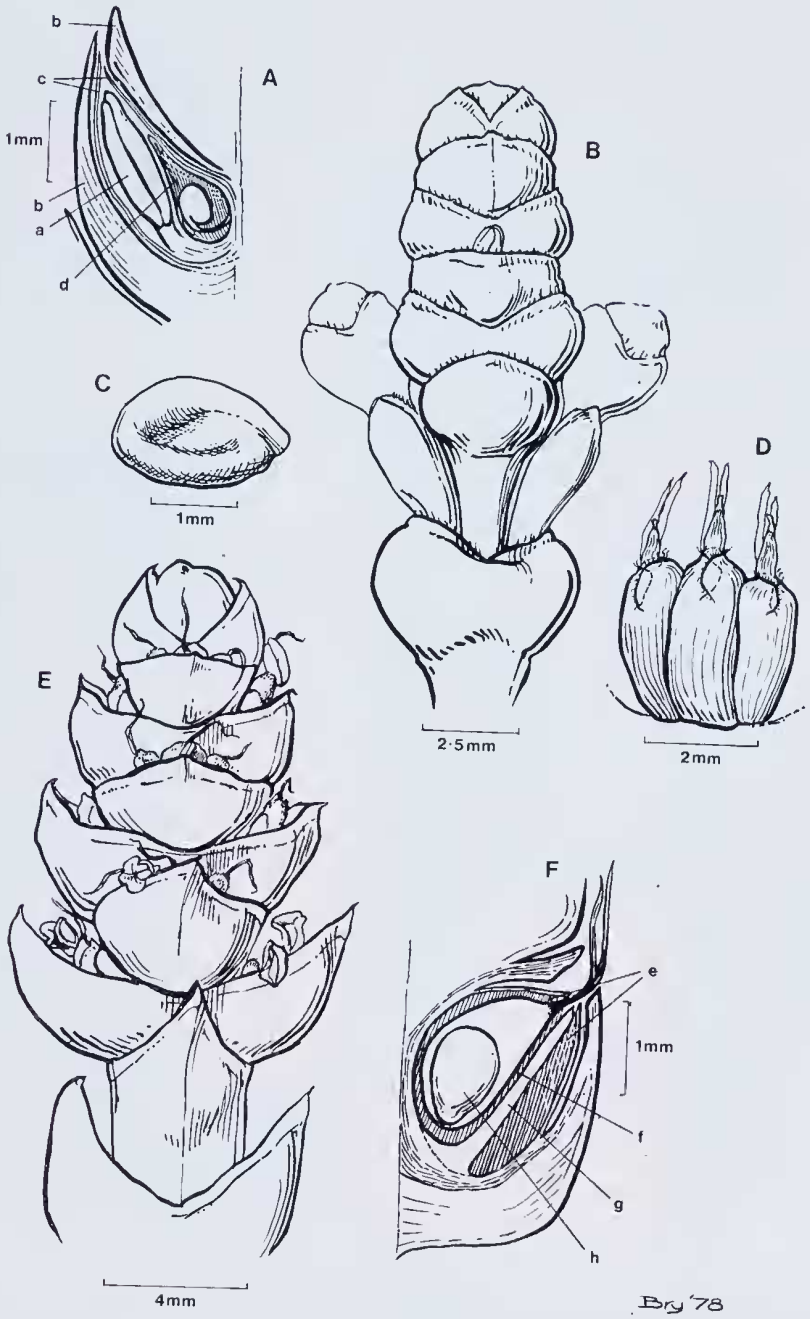

Figure 31. *Halosarcia entrichoma:* A—L.S. through flower (a—stamen, b—bracts, c—perianth, d—ovary); B—Terminal inflorescence; C—Seed; D—Triad of flowers abaxial view. *Halosarcia indica* subsp. *bidens;* E—Terminal inflorescence; F—L.S. fruitlet (e—spongy perianth, f—hard pericarp, g—staminal filament, h—seed).

A to D from R. Cranfield 804; E and F from P. G. Wilson, Feb. 1978 (Swan River).

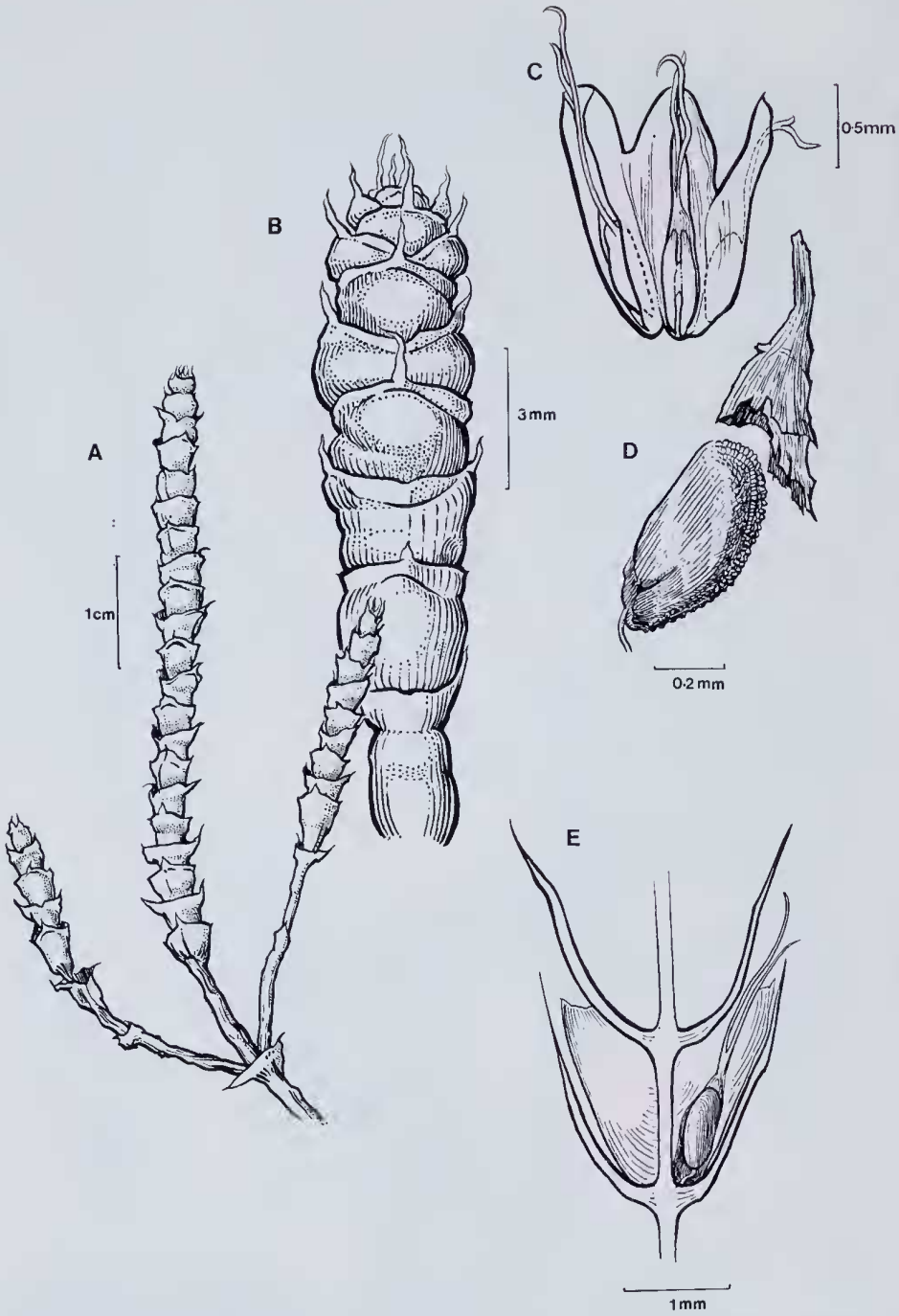

Figure 32. *Halosarcia cupuliformis:* A—Terminal inflorescence; B—Spike; C—Triad of flowers, abaxial view; D—Seed and pericarp; E—L.S. through spike to show developing seed.

From P. K. Latz 518 (resuscitated specimen).

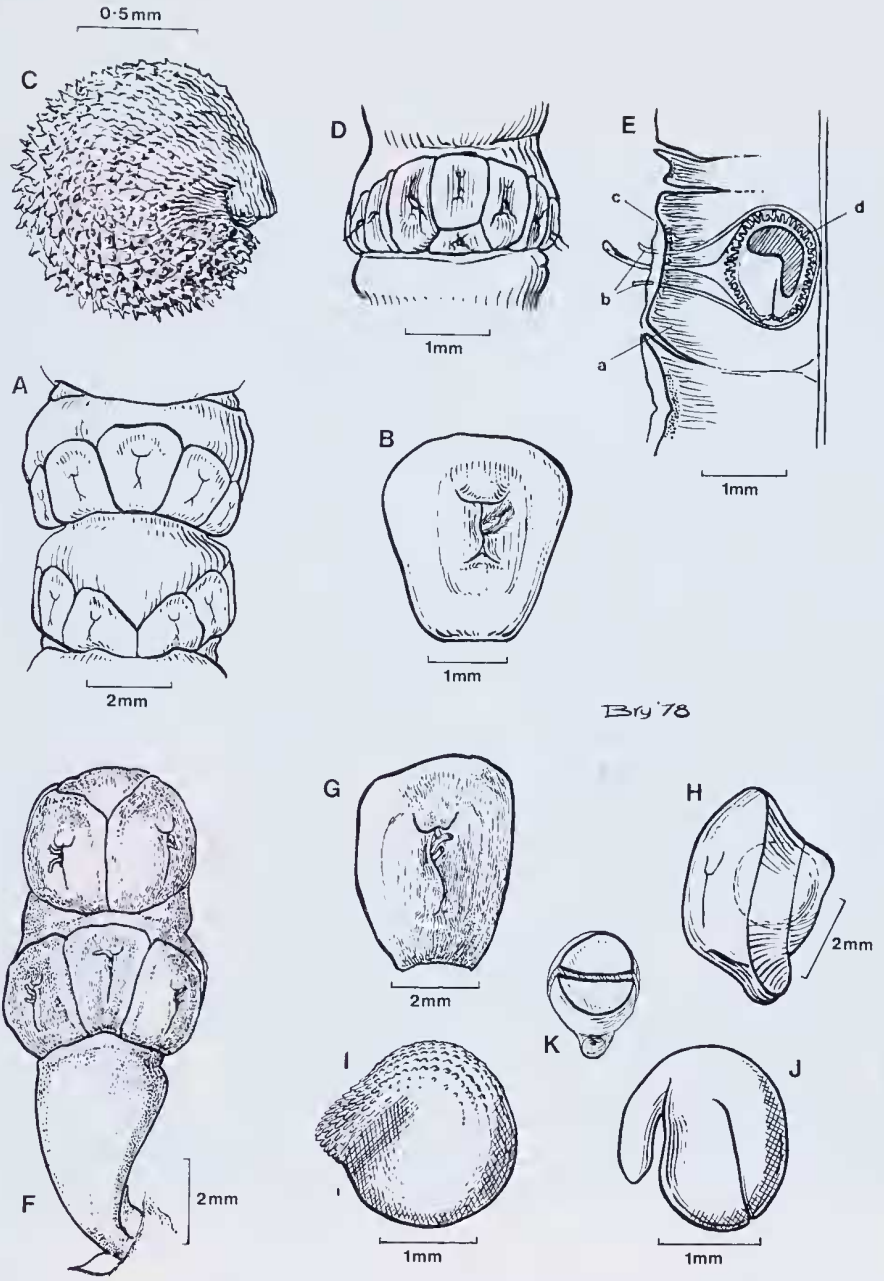

Figure 33. *Sarcocornia quinqueflora:* A—Portion of inflorescence; B—Apex of flower. *Sarcocornia quinqueflora* subsp. *tasmanica:* C—Seed. *Sarcocornia blackiana:* D—Portion of inflorescence; E—L.S. through fruiting spike (a—perianth, b—stamens, c—pericarp, d—seed).

Sarcocornia globosa: F—Inflorescence; G—Apex of flower; H—Side view of flower; I—Seed; J—Embryo; K—Section through embryo.

C from W. M. Curtis, March 1957; D and E from E. M. Bennett 2913; F to J from A. S. George 10502.

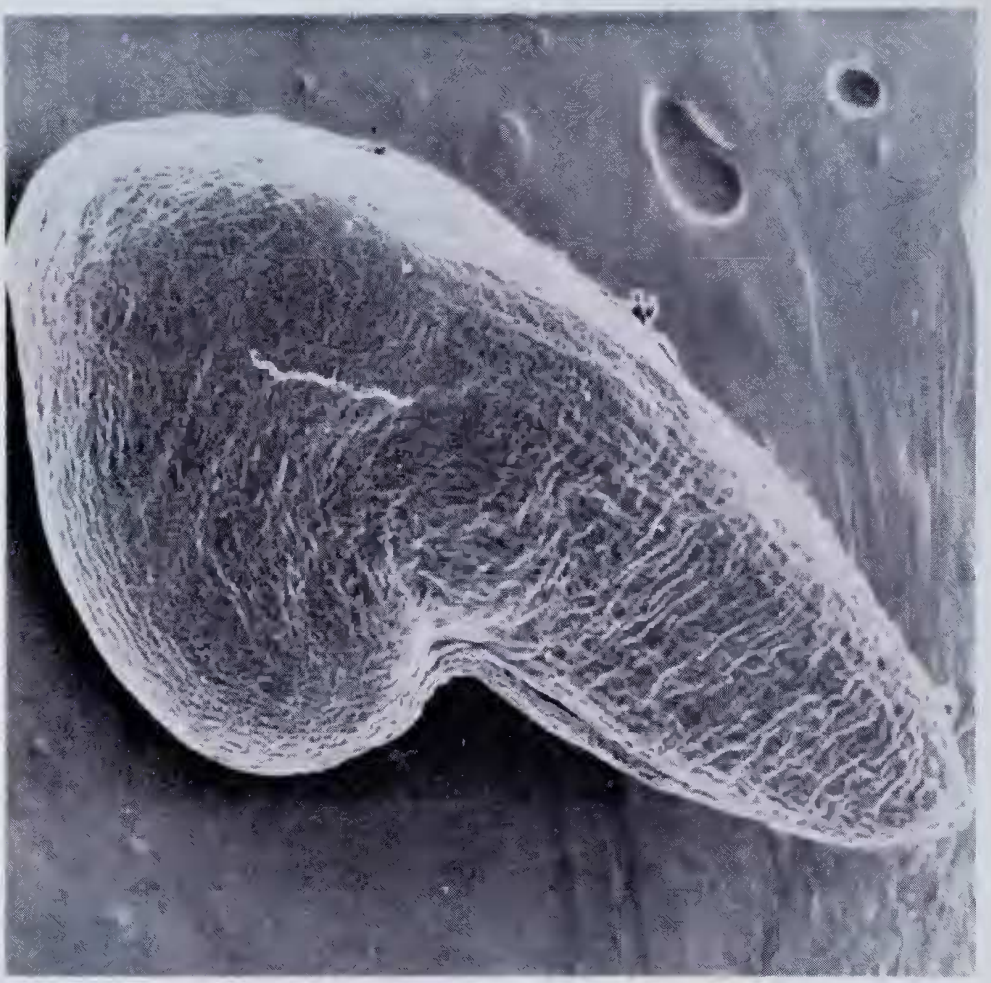

Figure 34. *Sclerostegia disarticulata;* SEM photo of seed x 108. V. Semeniuk, 19 Aug. 1976.

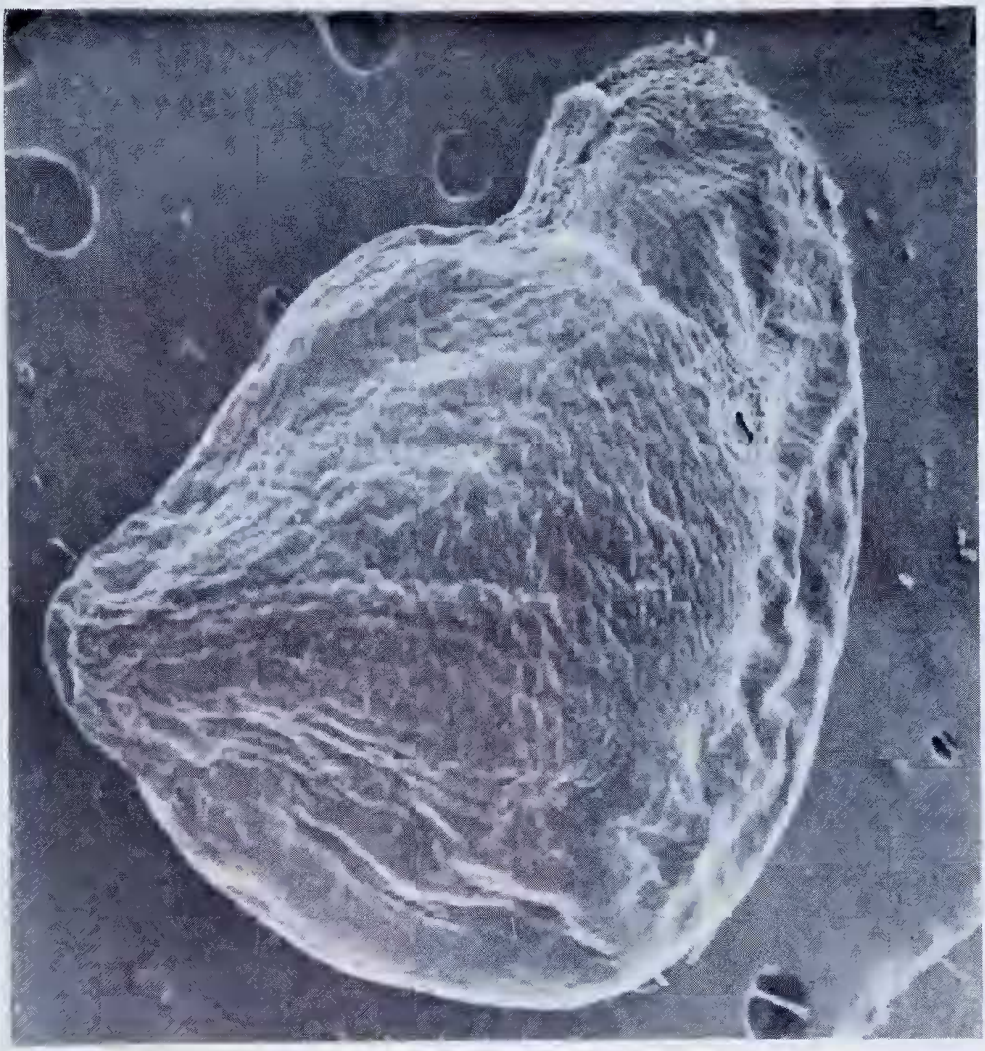

Figure 35. *Sclerostegia arbuscula:* SEM photo of seed x 102. J. Parham, 28 Feb. 1976.

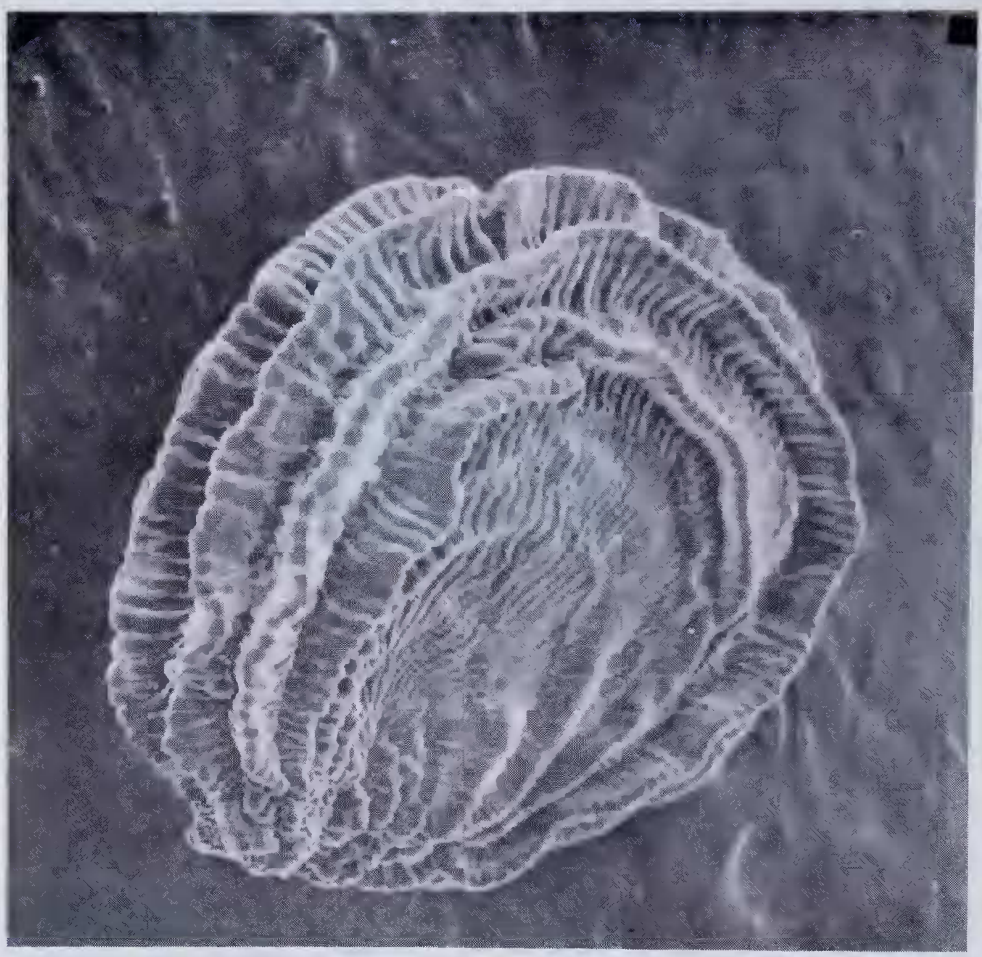

Figure 36. *Tegicornia uniflora:* SEM photo of seed x 76.

Figure 37. *Tegicornia uniflora:* Detail of Fig. 36 x 410.

Figure 38. *Halosarcia halocnemoides:* SEM photo of seed x 102. P. G. Wilson 8698, Alfred Cove.

Figure 39. *Halosarcia halocnemoides:* Detail of Fig. 38 x 410.

Figure 40. *Halosarcia halocnemoides:* SEM photo of seed x 128. P. G. Wilson 8650, Jibberding.

Figure 41. *Halosarcia halocnemoides:* Detail of Fig. 40 x 475.

Figure 42. *Halosarcia pergranulata*: SEM photo of seed x 115. P. G. Wilson 10106.

Figure 43. *Halosarcia pergranulata:* Detail of Fig. 42 x 410.

Figure 44. *Halosarcia lepidosperma:* SEM photo of seed x 102. R. A. Saffrey 6216.

Figure 45. *Halosarcia lepidosperma*: Detail of Fig. 44 x 275.

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Figure 46. *Halosarcia pterygosperma* subsp. *pterygosperma*. SEM photo of seed x 104. N. Macfarlane 852.

Figure 47. *Halosarcia pterygosperma* subsp. *pterygosperma:* Detail of Fig. 46 x 475.

Figure 48. *Halosarcia lylei:* SEM photo of seed x 129. A. S. George 8650.

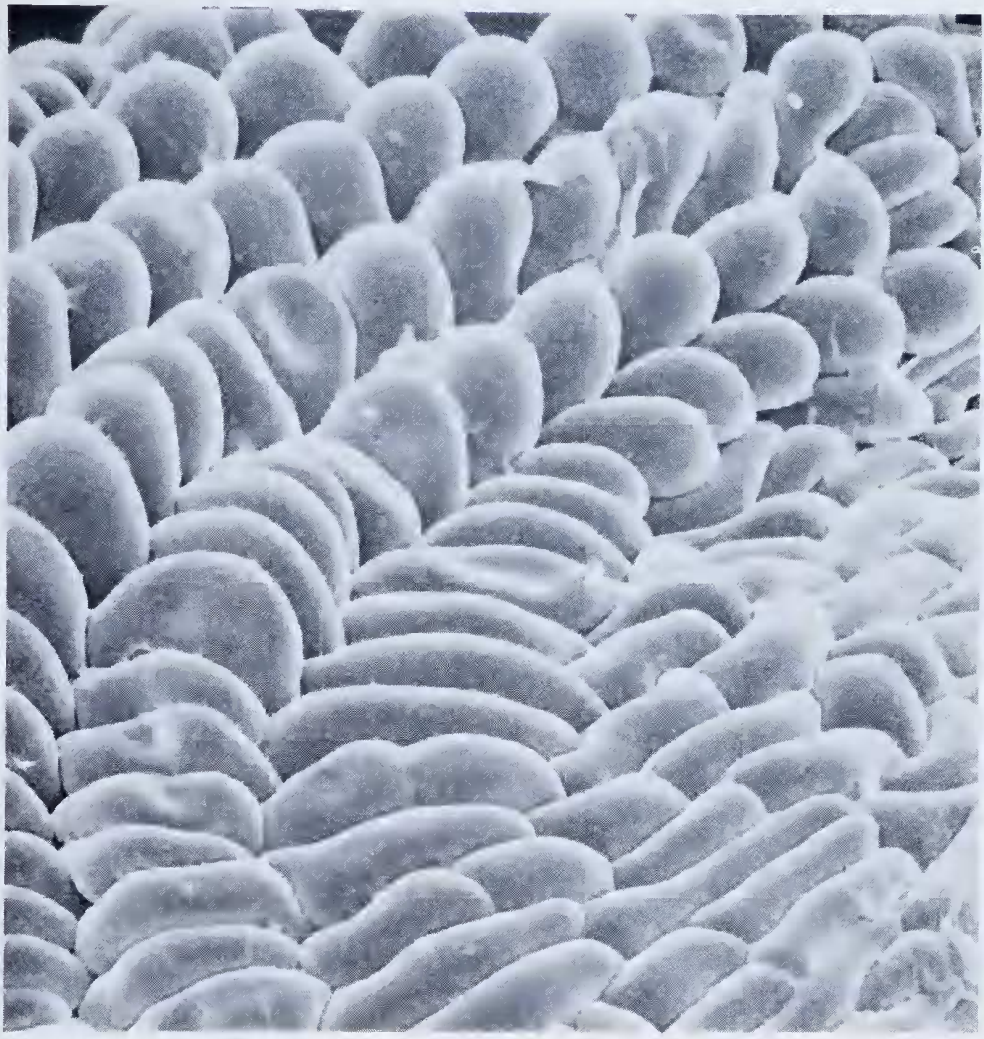


Figure 49. *Halosarcia lylei:* Detail of Fig. 48 x 324.

Figure 50. *Halosarcia flabelliformis:* SEM photo of seed x 80. R. Chinnock 2984.

Figure 51. *Halosarcia flabelliformis*: Detail of Fig. 50 x 688.

Figure 52. *Halosarcia peltata:* SEM photo of seed x 135. F. Williams 2.

Figure 53. *Halosarcia pruinosa:* SEM photo of seed x 108. T. E. H. Aplin 3258.

Figure 54. *Halosarcia auriculata:* SEM photo of seed x 122. A. C. Beauglehole 48279.

Figure 55. *Halosarcia auriculata:* Detail of Fig. 54 x 378.

Figure 56. *Halosarcia undulata*: SEM photo of seed x 128. P. G. Wilson 8830.

Figure 57. *Halosarcia chartacea:* SEM photo of seed x 108. J. Elkington 628.

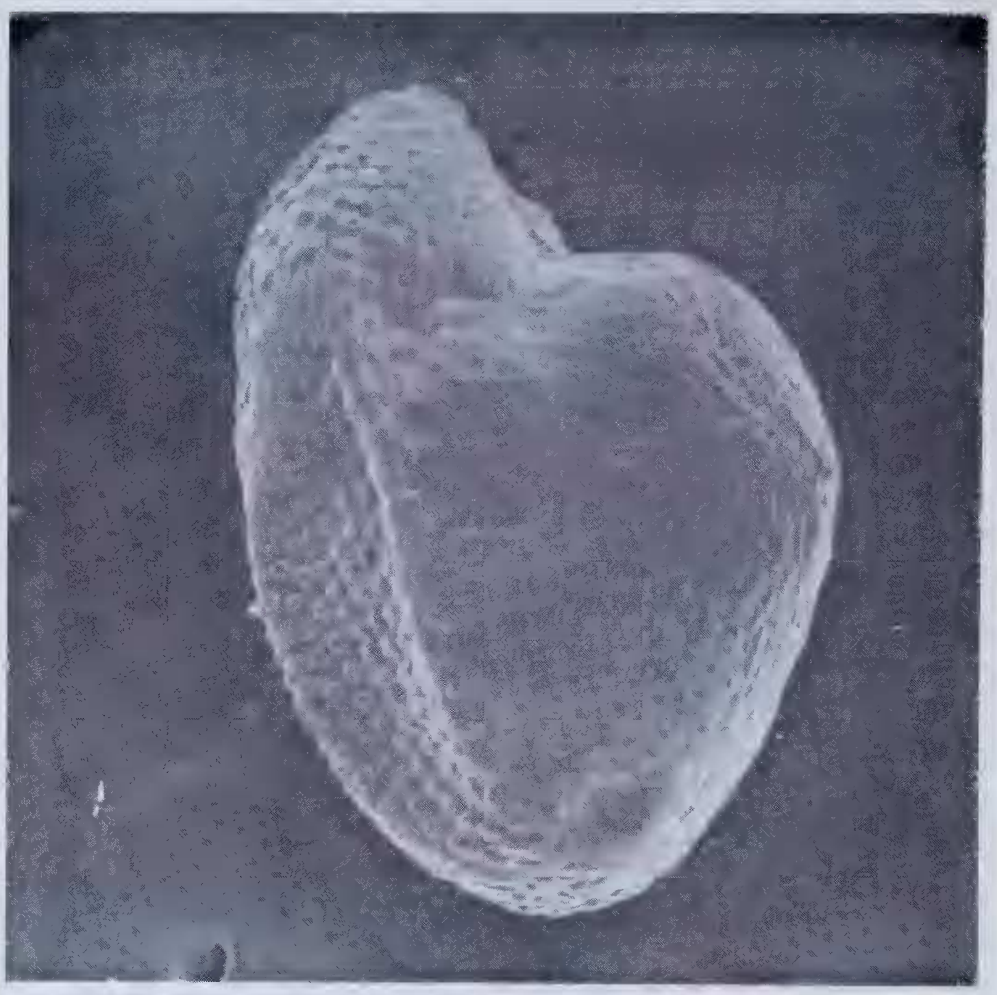


Figure 58. *Halosarcia calyptrata*: SEM photo of seed x 128. P. G. Wilson 8939.

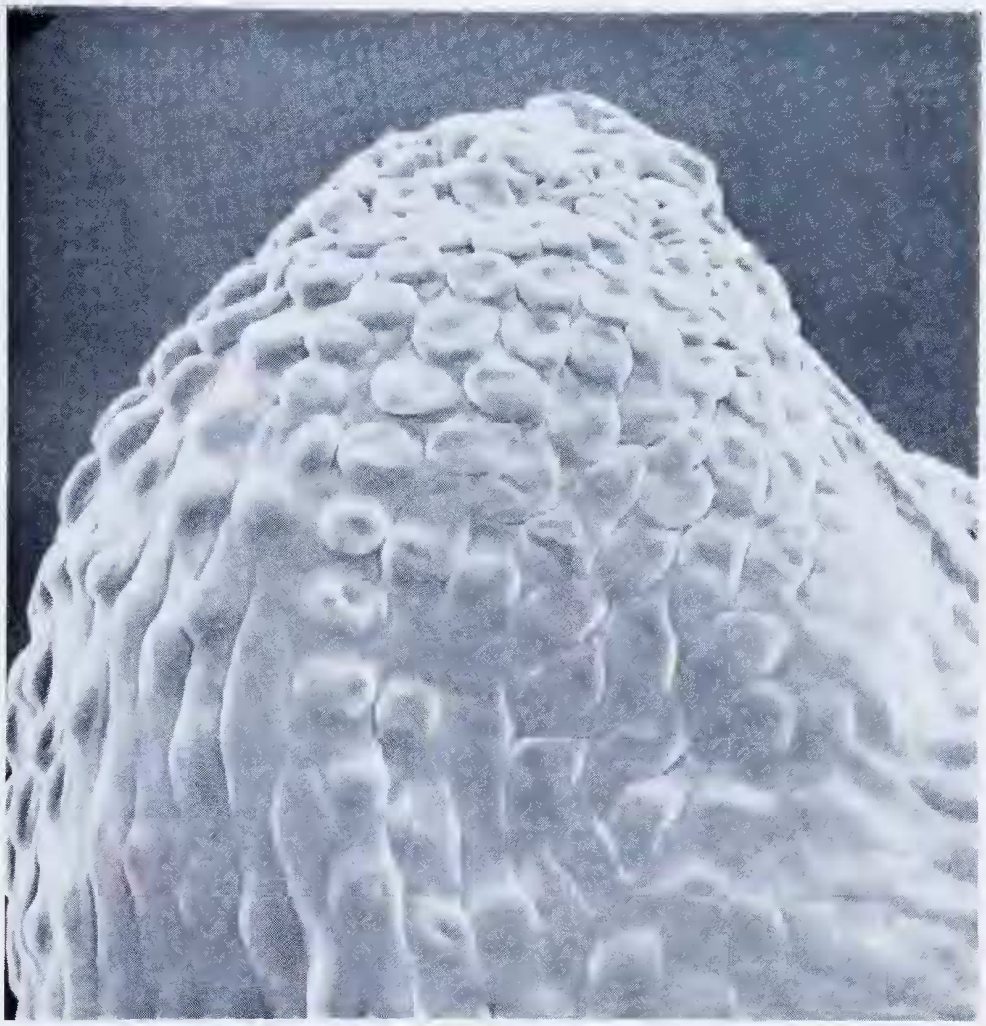


Figure 59. *Halosarcia calyptrata*: Detail of Fig. 58 x 410.

Figure 60. *Halosarcia leptoclada:* SEM photo of seed x 108. B. R. Maslin 182.

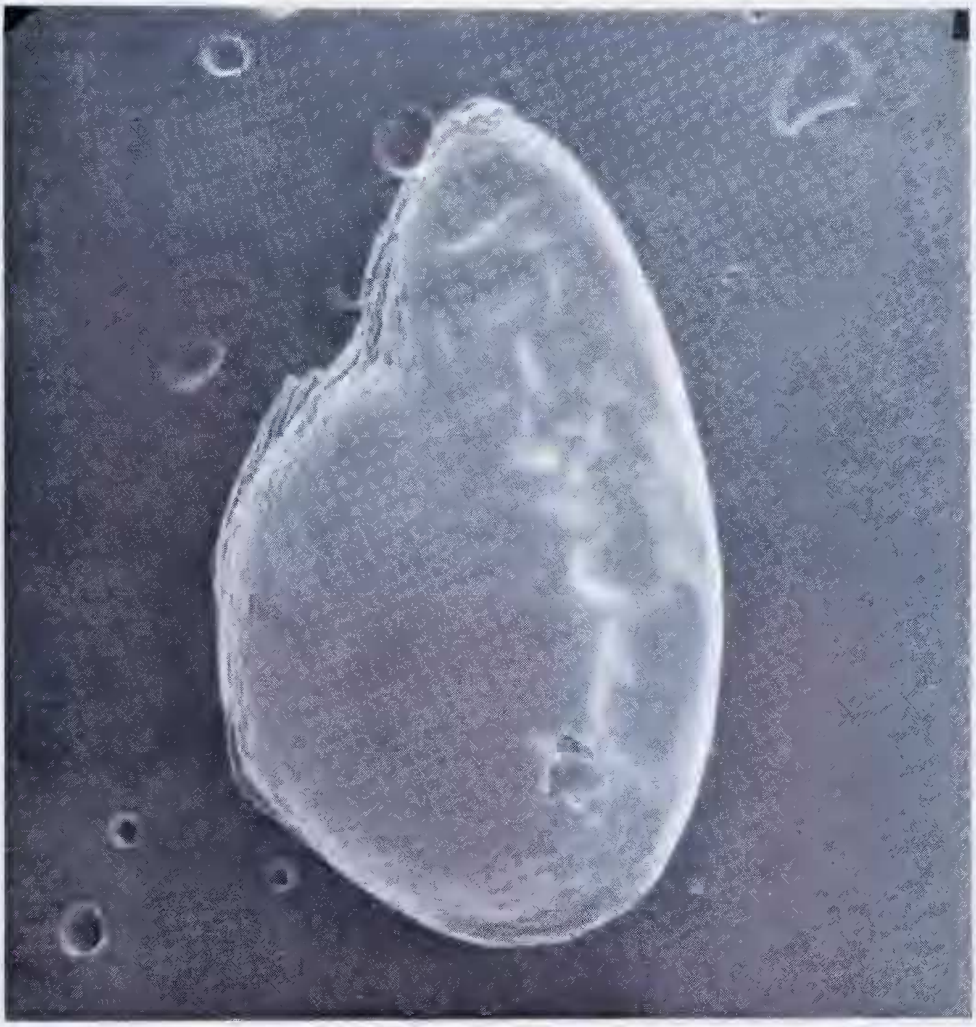


Figure 61. *Halosarcia indica* subsp. *indica*: SEM photo of seed x 76. P. G. Wilson, 24 Feb. 1977, Townsville.

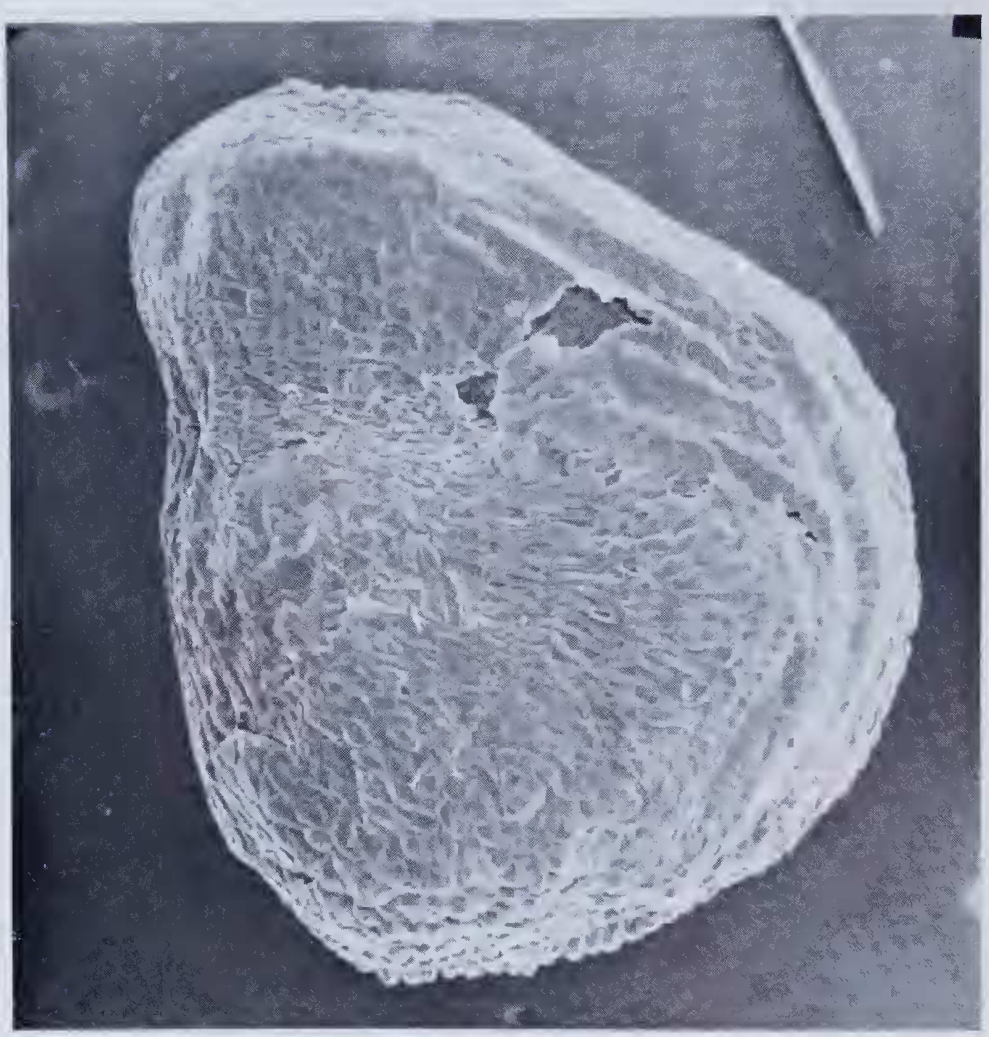


Figure 62. *Halosarcia indica* subsp. *julacea:* SEM photo of seed x 81. V. Semeniuk, 18 Sept. 1975, Derby.

Figure 63. *Halosarcia indica* subsp. *julacea:* Detail of Fig. 62 x 405.

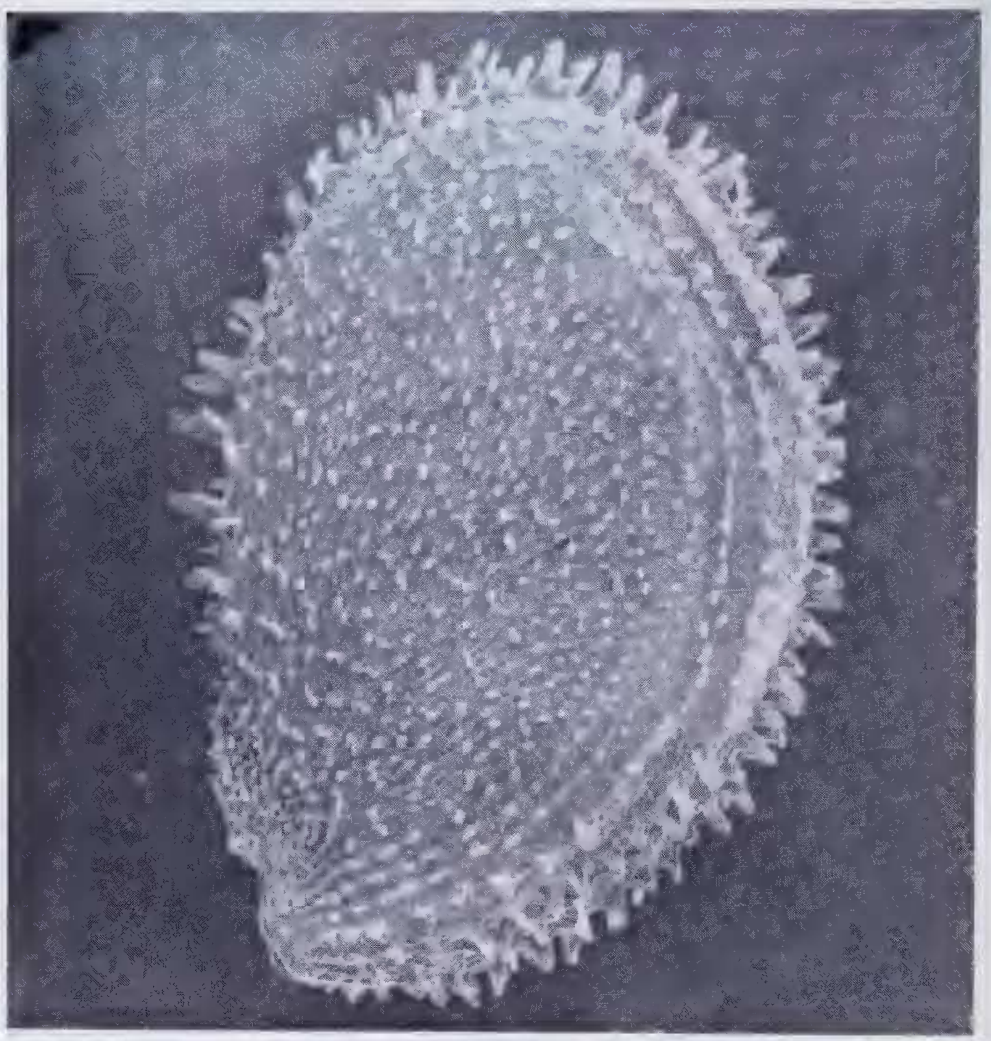


Figure 64. *Tecticornia australasica:* SEM photo of seed x 76. Kalkman, BW6226, Merauke, New Guinea.

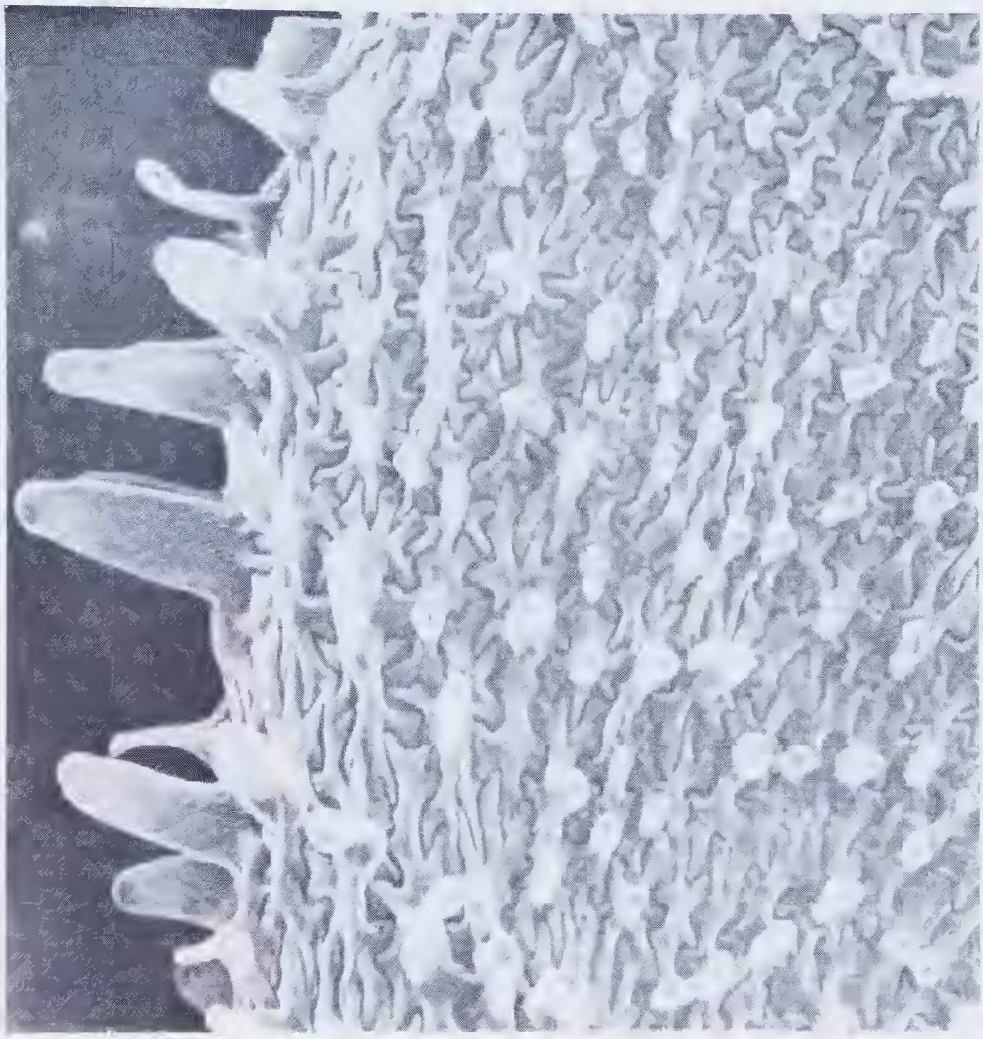


Figure 65. *Tecticornia australasica:* Detail of Fig. 64 x 275.

Figure 66. *Halosarcia fontinalis:* SEM photo of seed x 184. D. Symon 9302.

Figure 67. *Halosarcia pluriflora:* SEM photo of seed x 118. C. W. Bonython, May, 1951, Lake Eyre, ADW7194.

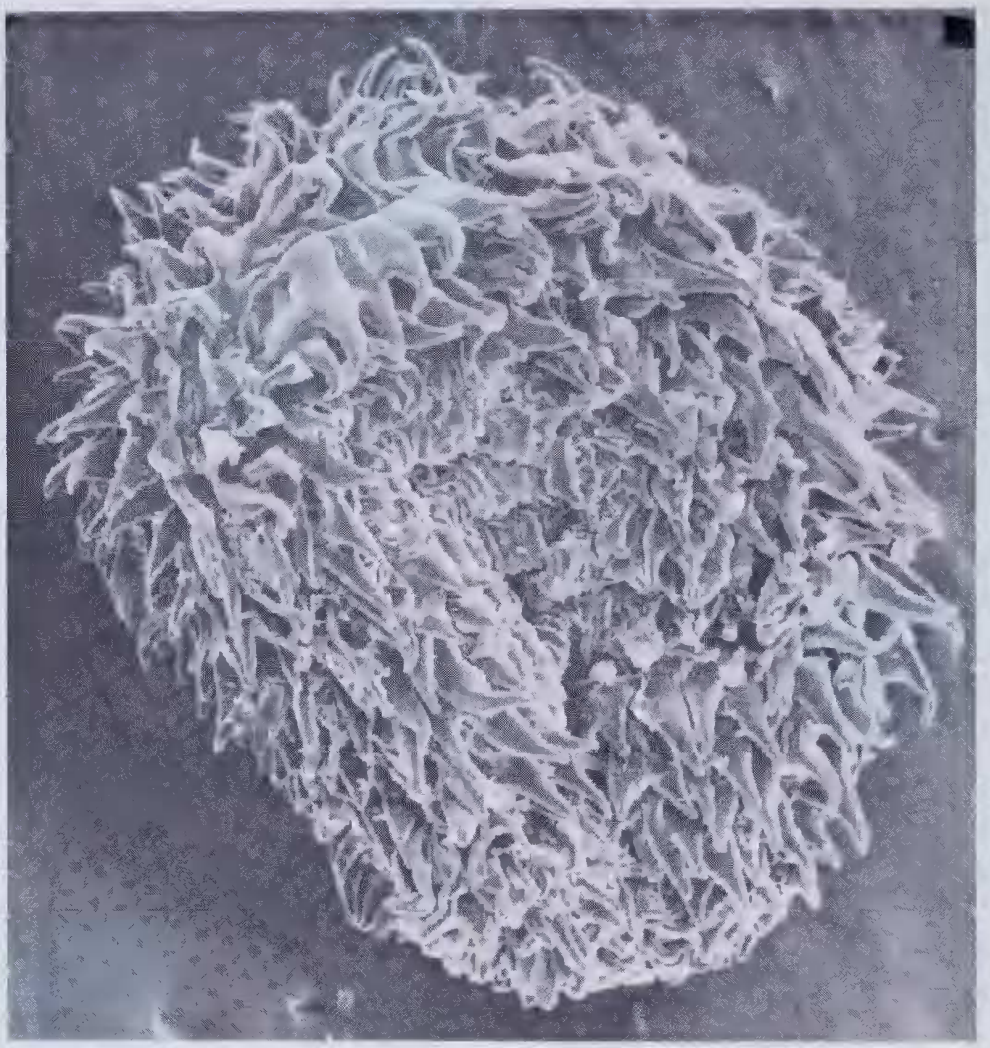


Figure 68. *Sarcocornia quinqueflora* subsp. *quinqueflora*; SEM photo of seed x 108. K. Newbey 3156.

Figure 69. *Sarcocornia quinqueflora* subsp. *quinqueflora:* Detail of Fig. 68 x 324.

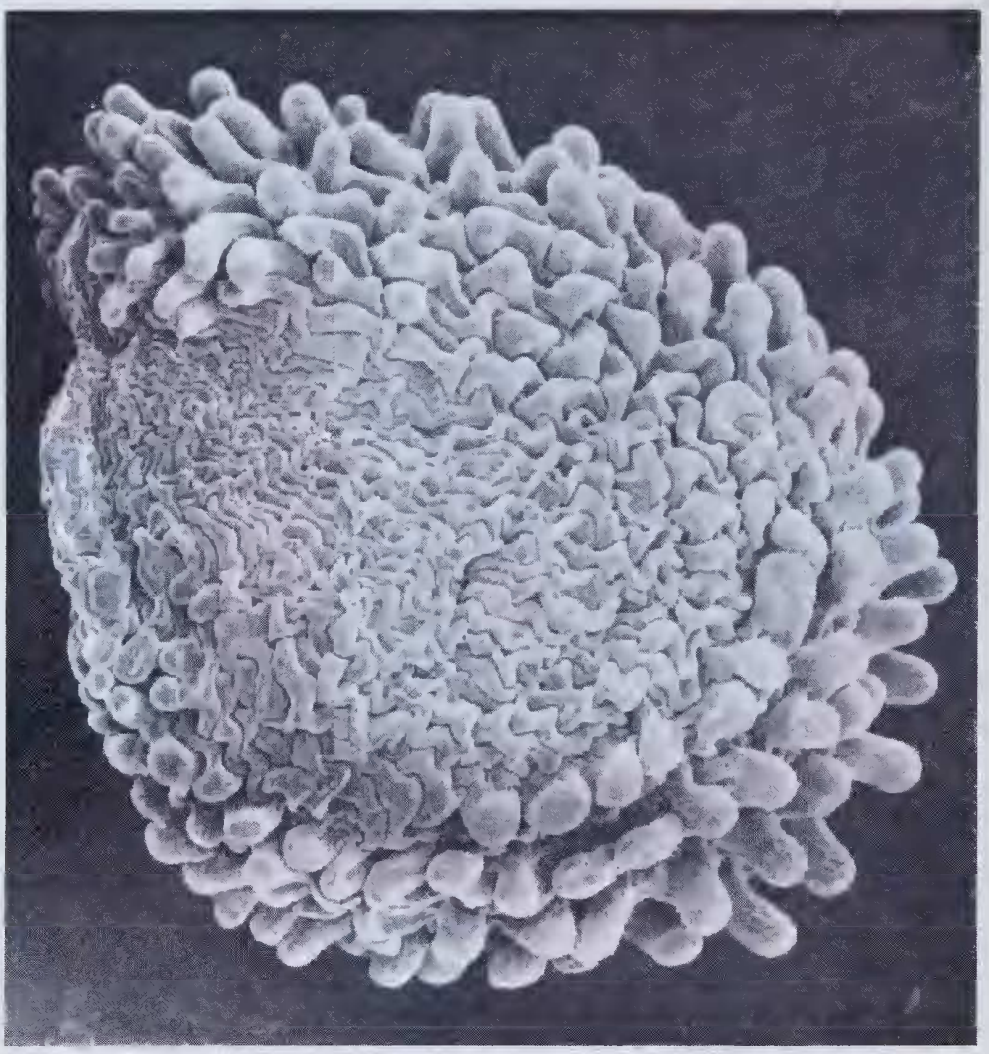


Figure 70. *Sarcocornia blackiana:* SEM photo of seed x 108. K. Newbey 4030.

Figure 71. *Sarcocornia blackiana:* Detail of Fig. 70 x 324.

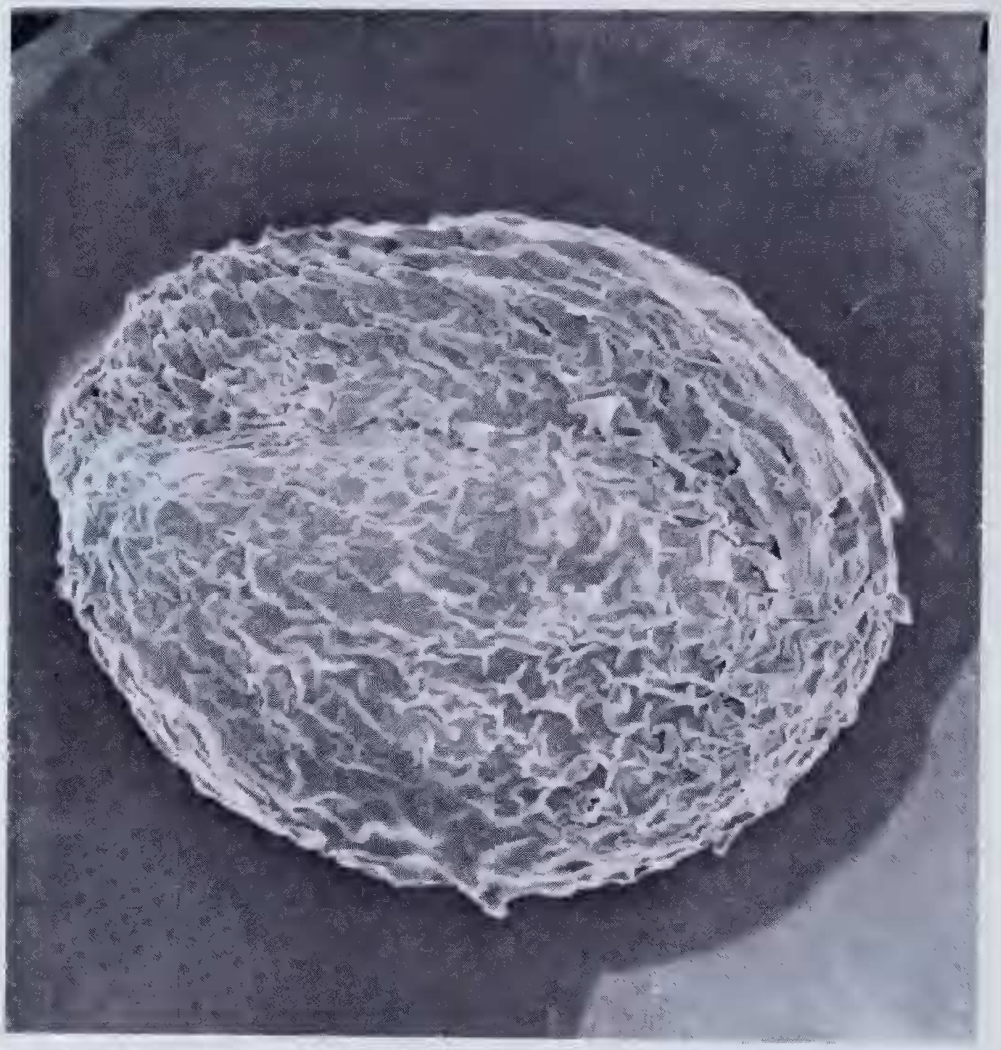
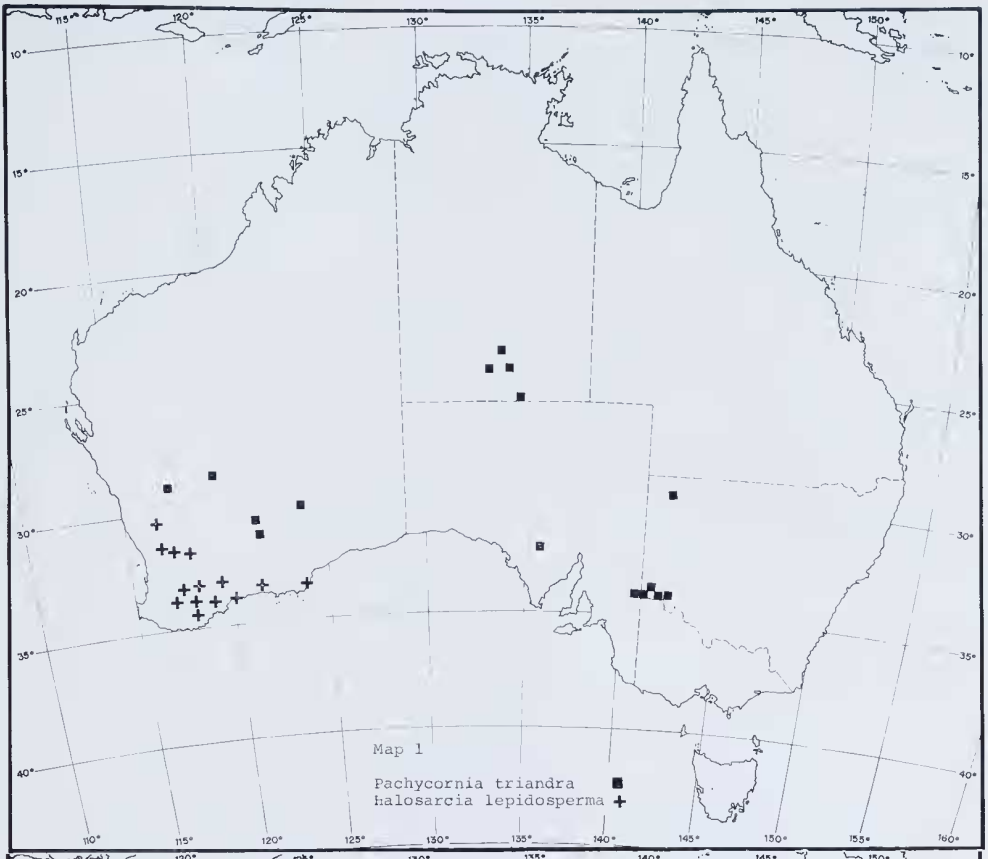
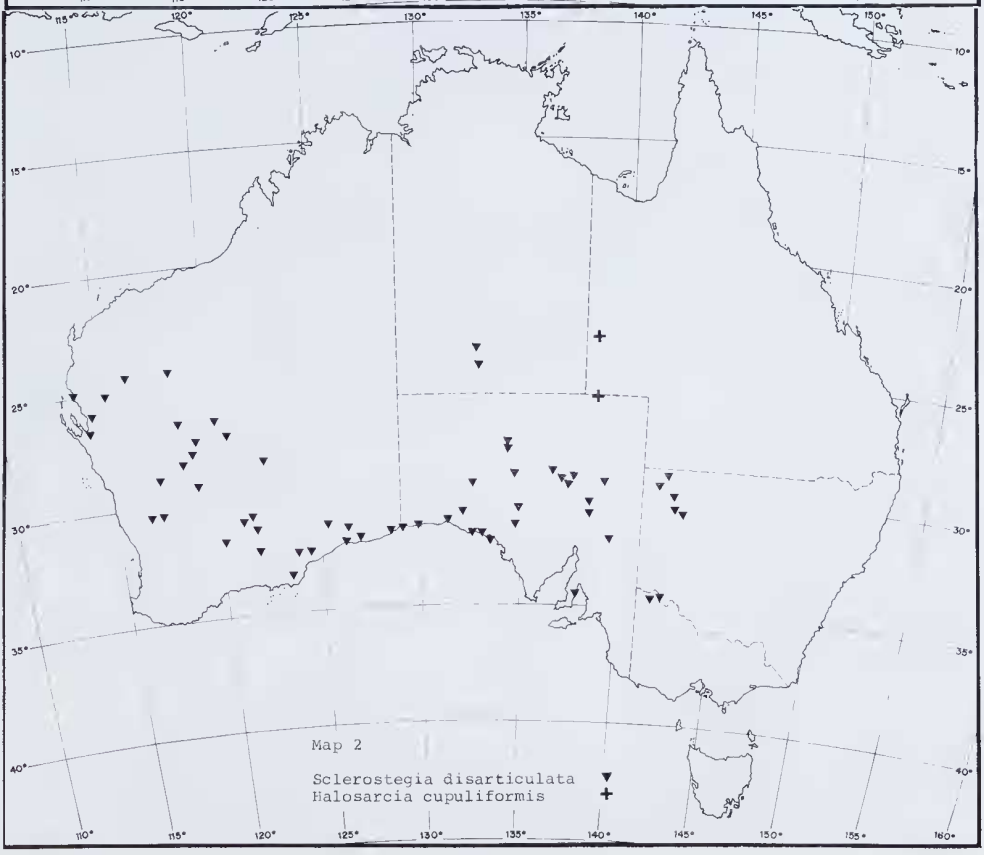
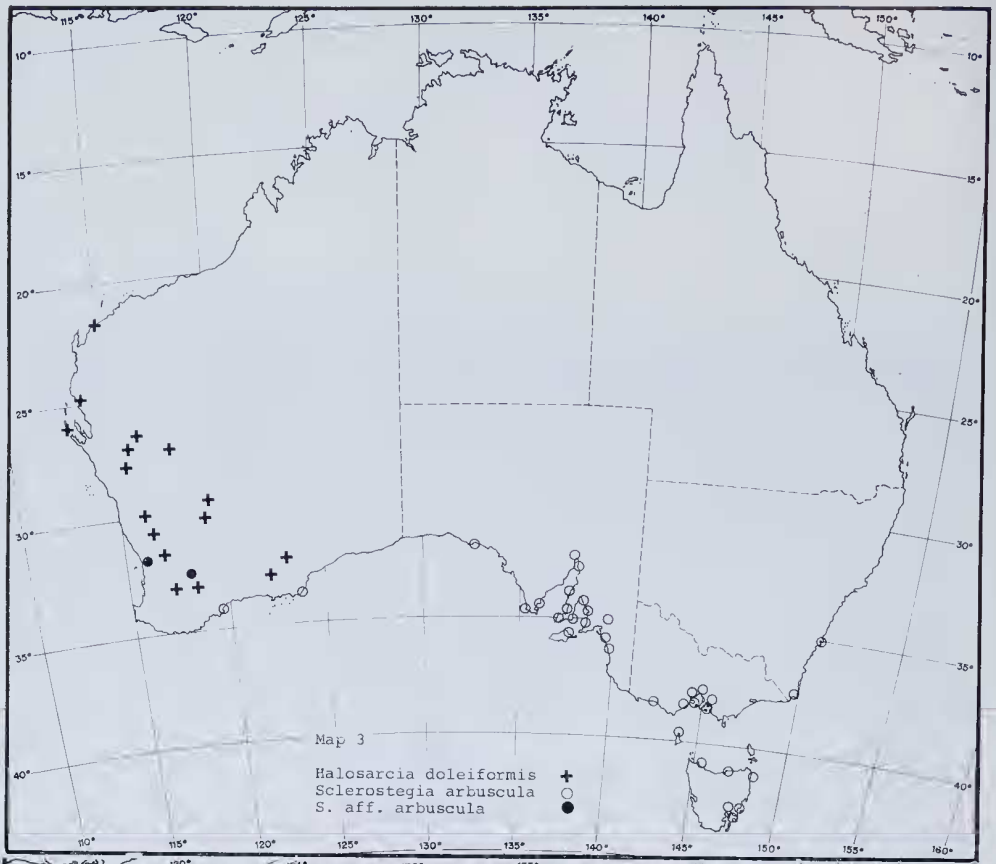
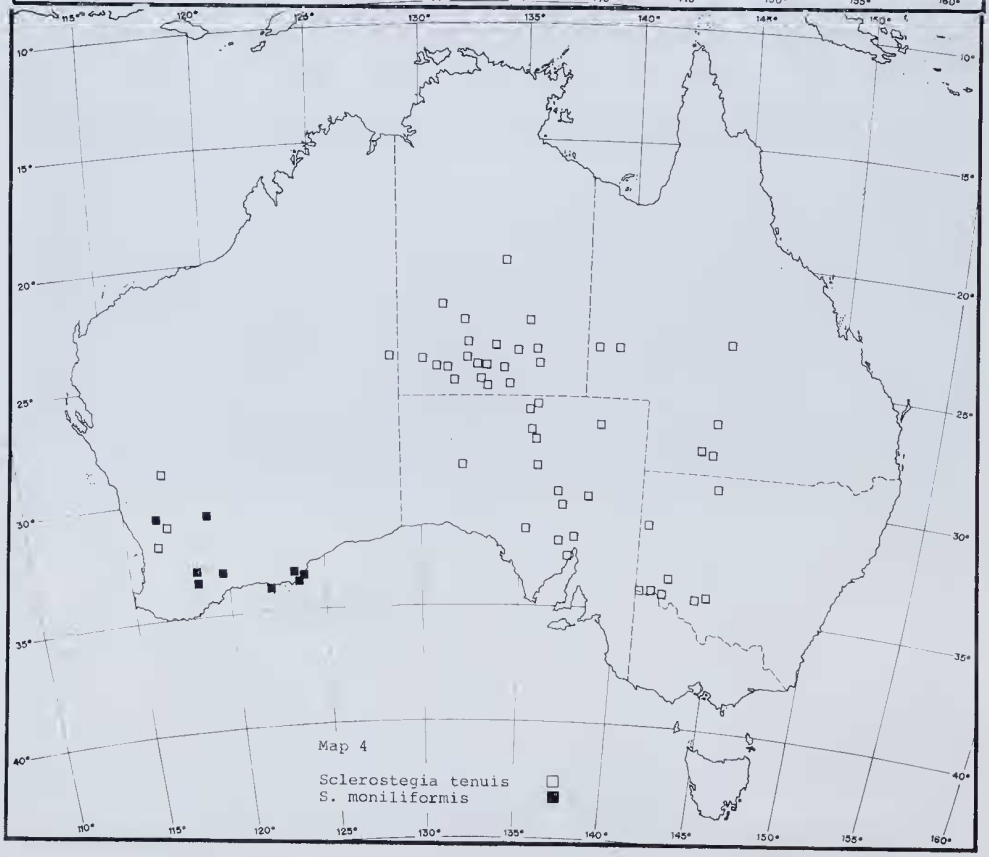


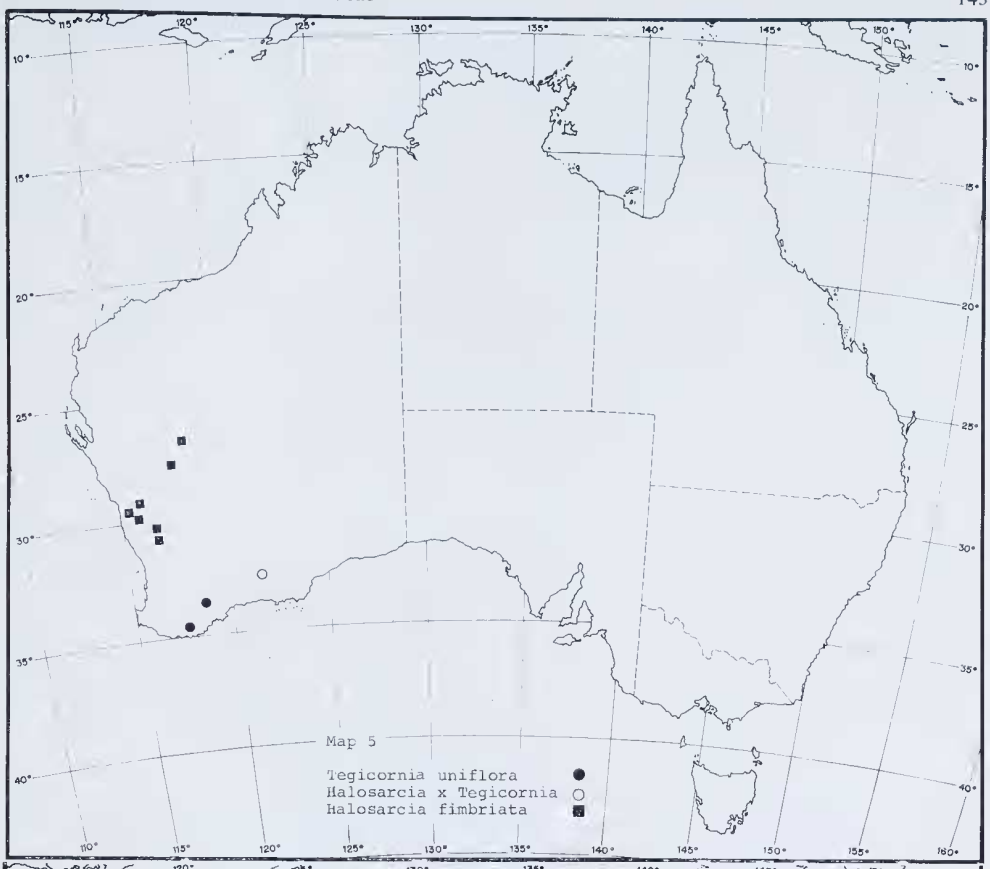
Figure 72. *Sarcocornia quinqueflora* subsp. *tasmanica:* SEM photo of seed x 102. J. S. Whinray 422.

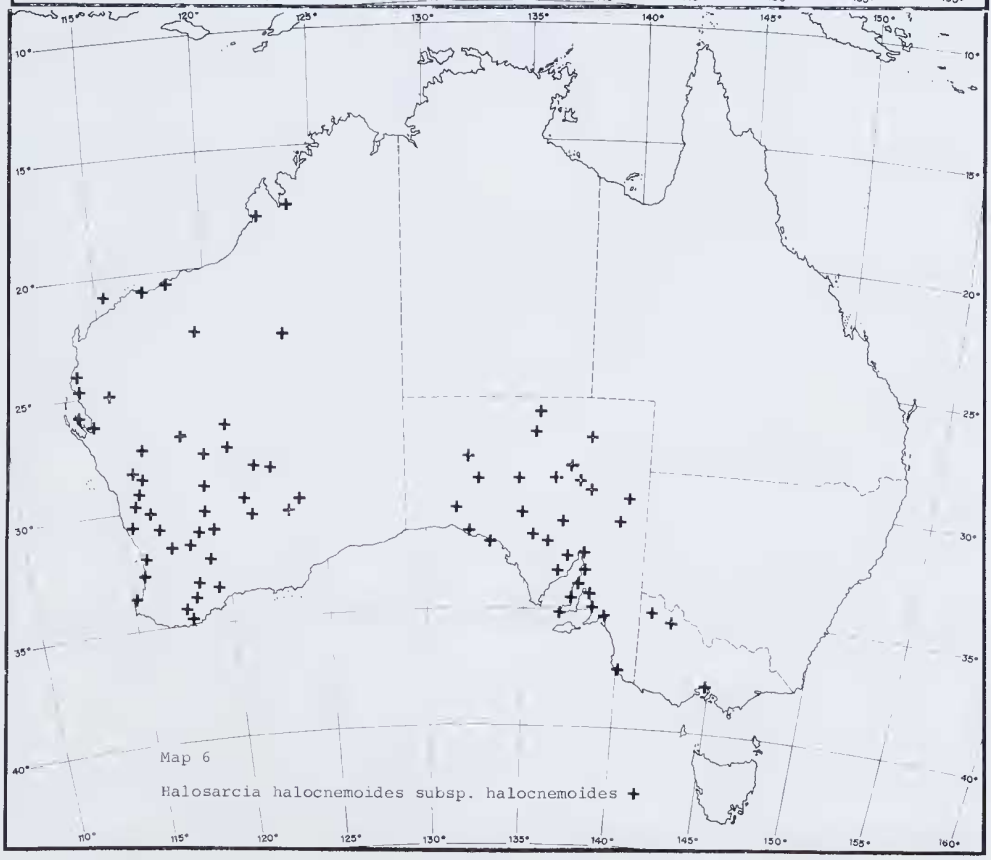

Map 1
Pachycornia triandra
halosarcia lepidosperma

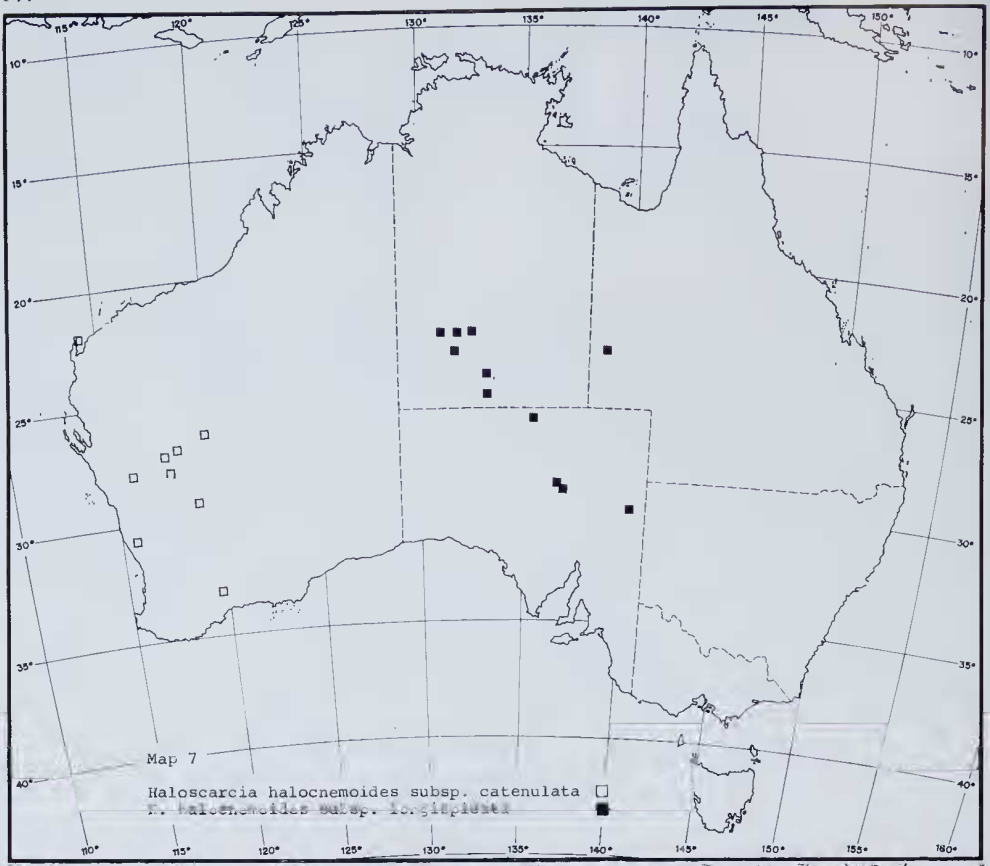

Map 2
Sclerostegia disarticulata
Halosarcia cupuliformis

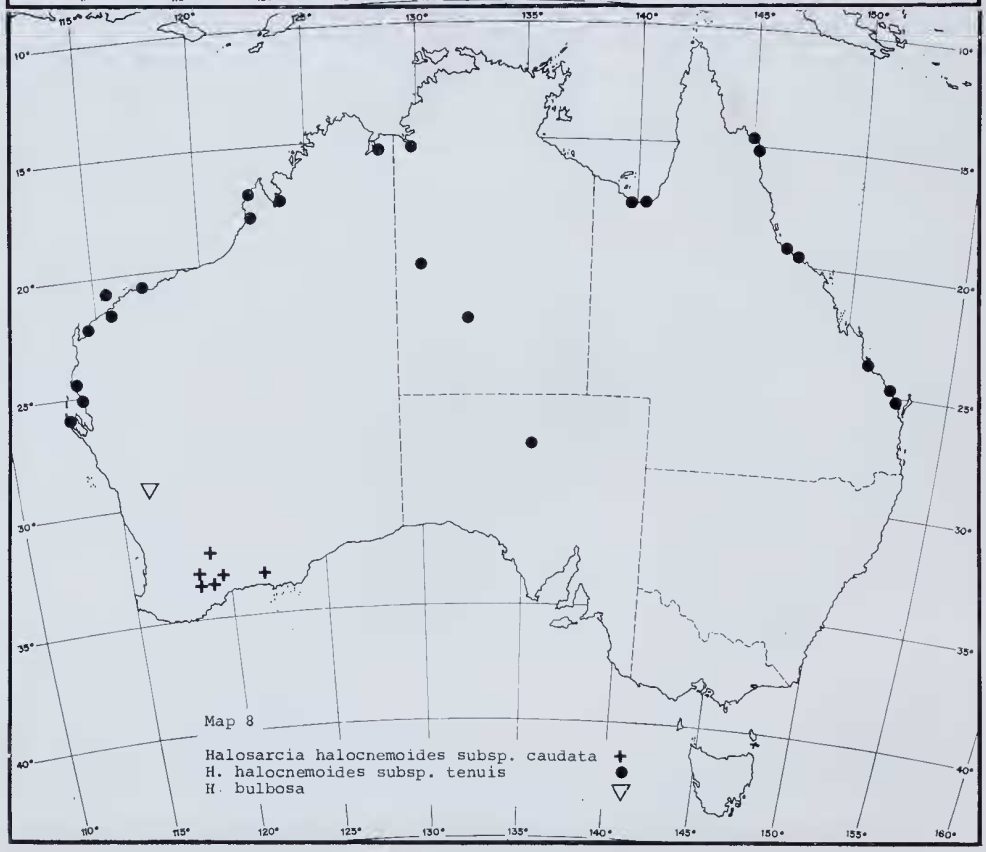

Map 3
Halosarcia doleiformis
Sclerostegia arbuscula
S. aff. arbuscula

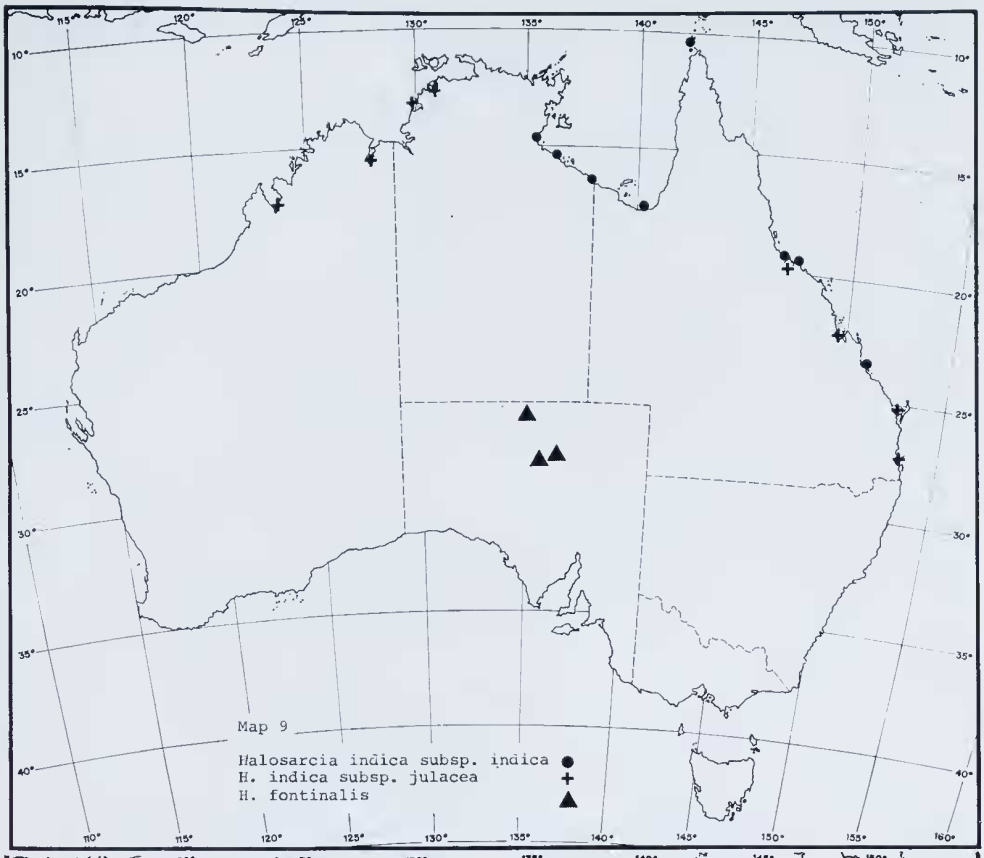

Map 4
Sclerostegia tenuis
S. moniliformis

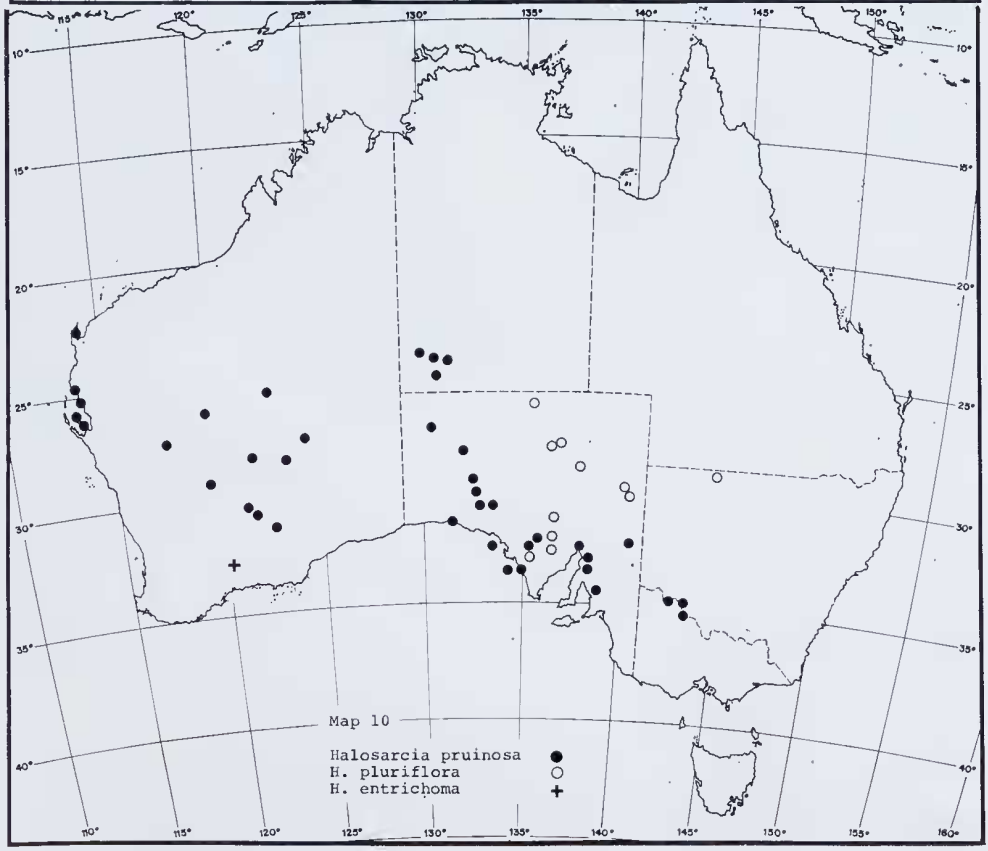

Map 5
Tegicornia uniflora
Halosarcia x Tegicornia
Halosarcia fimbriata


Map 6
Halosarcia halocnemoides subsp. halocnemoides


Map 7
Haloscarcia halocnemoides subsp. catenulata
H. halocnemoides subsp. longiplumis


Map 8
Halosarcia halocnemoides subsp. caudata
H. halocnemoides subsp. tenuis
H. bulbosa


Map 9
Halosarcia indica subsp. indica
H. indica subsp. julacea
H. fontinalis


Map 10
Halosarcia pruinosa
H. pluriflora
H. entrichoma

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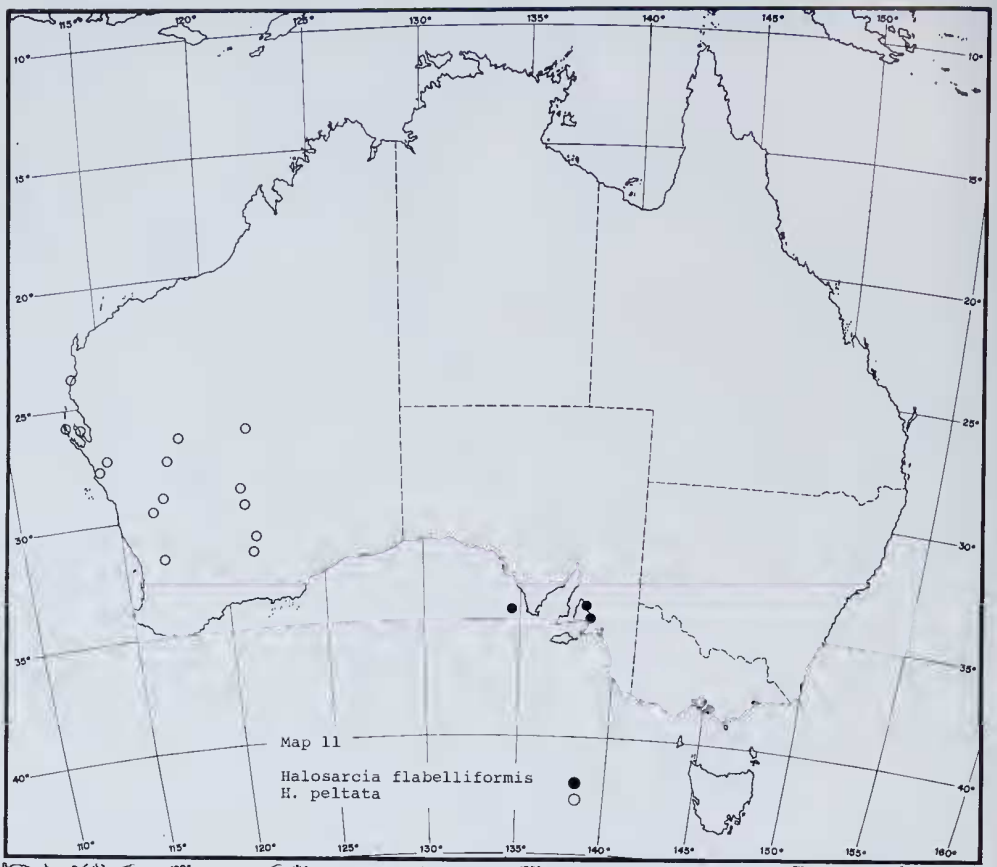
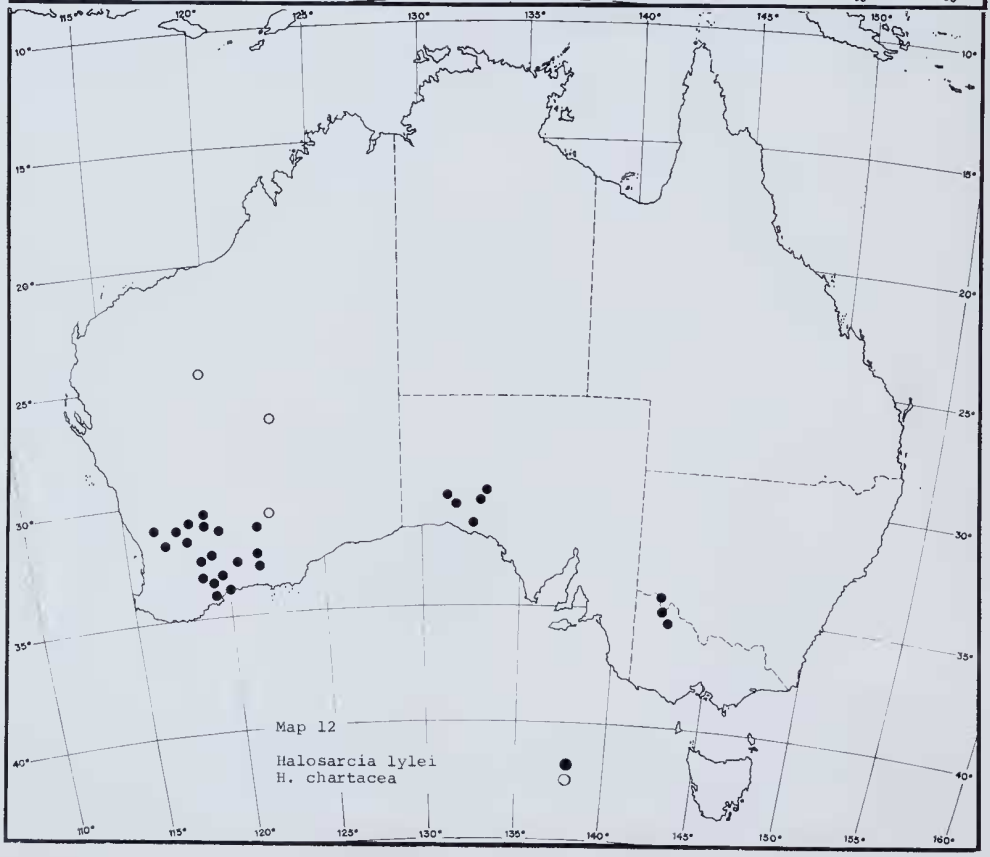
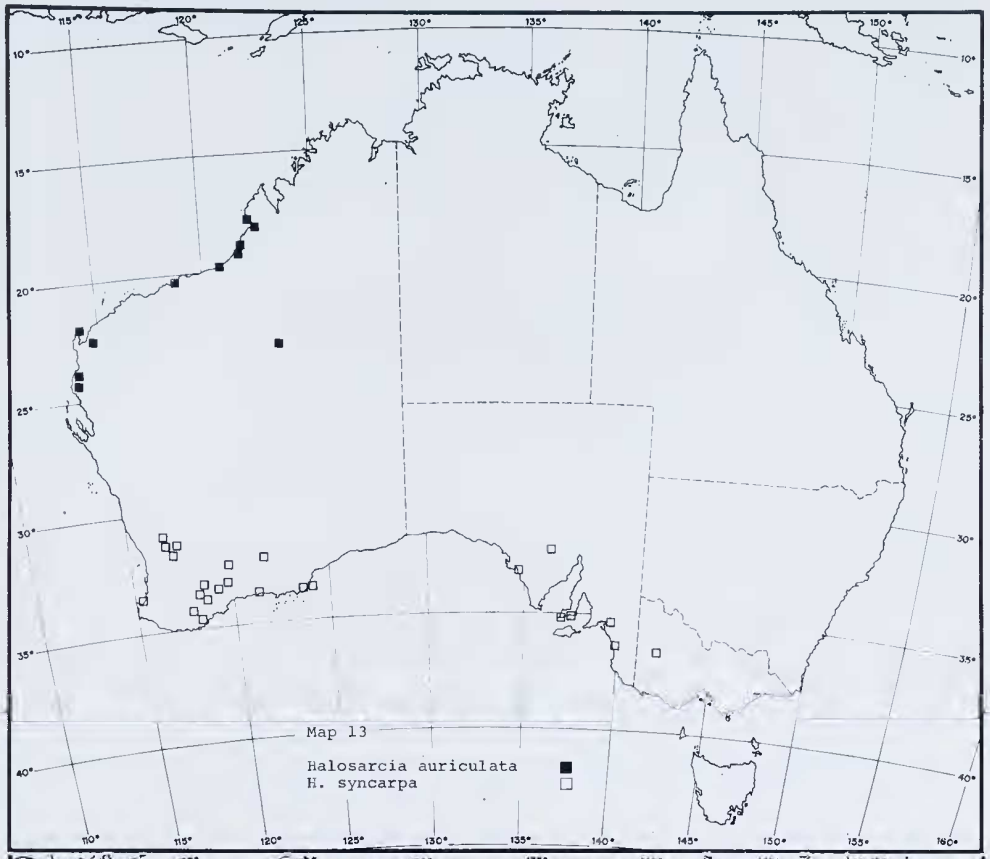
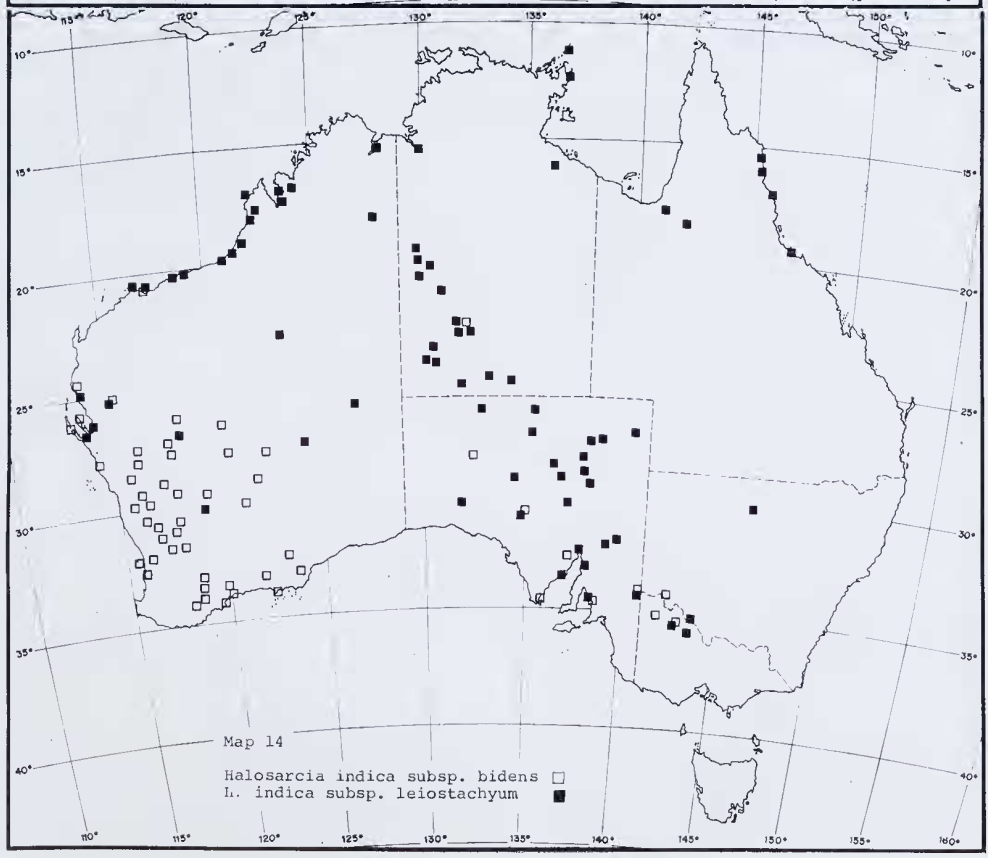
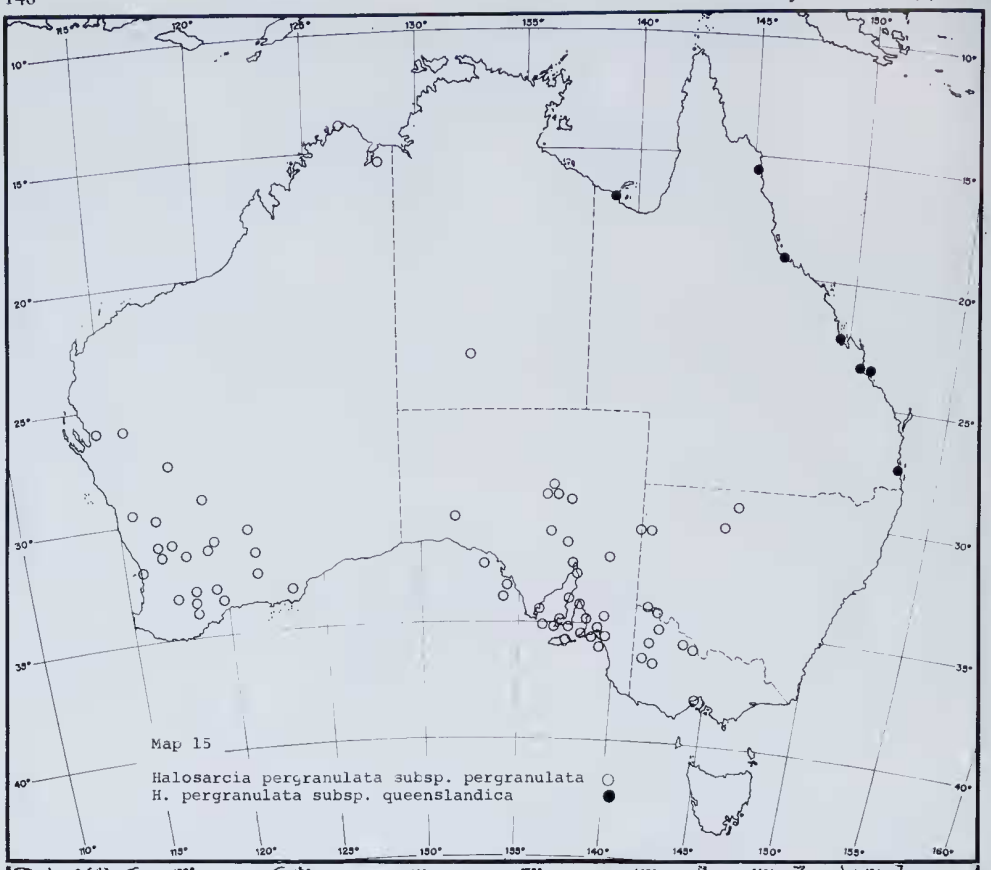
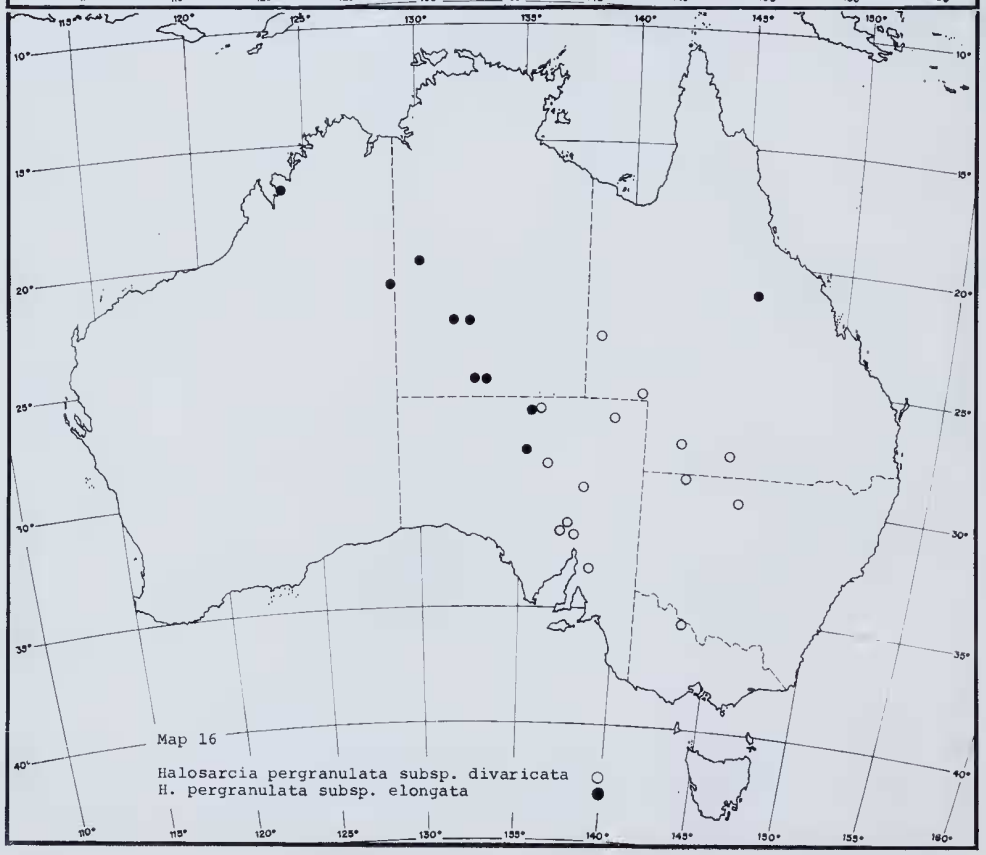

Map 11
Halosarcia flabelliformis
H. peltata

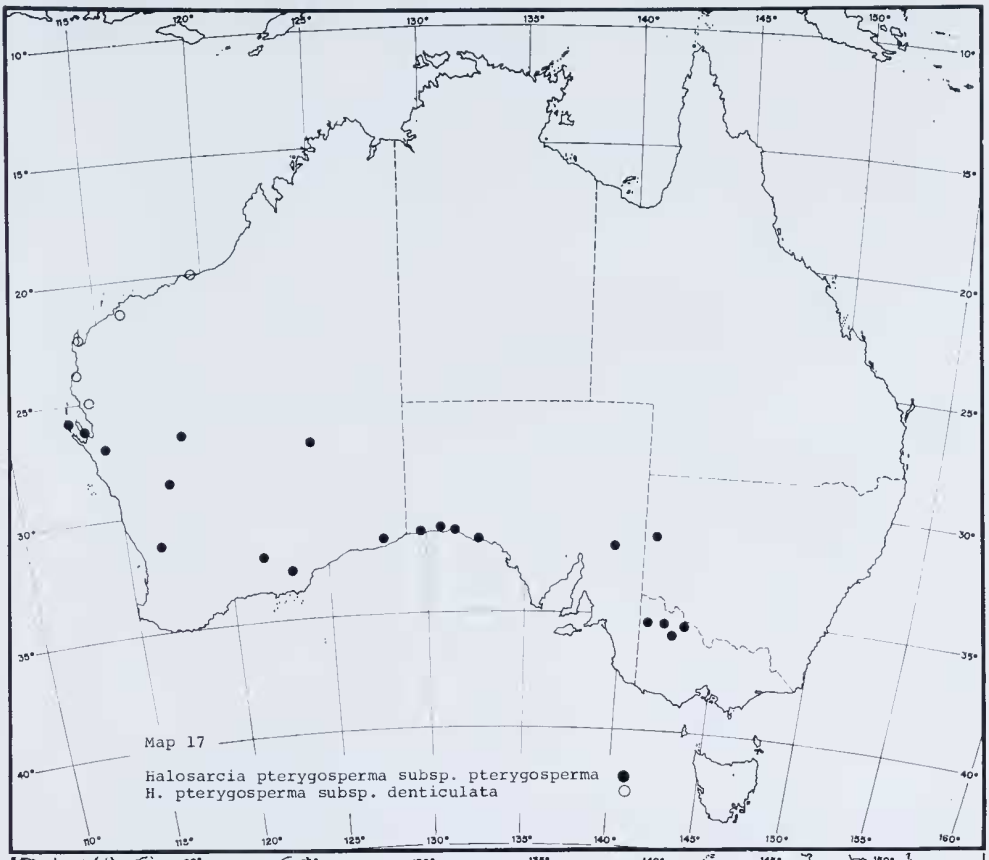

Map 12
Halosarcia lylei
H. chartacea

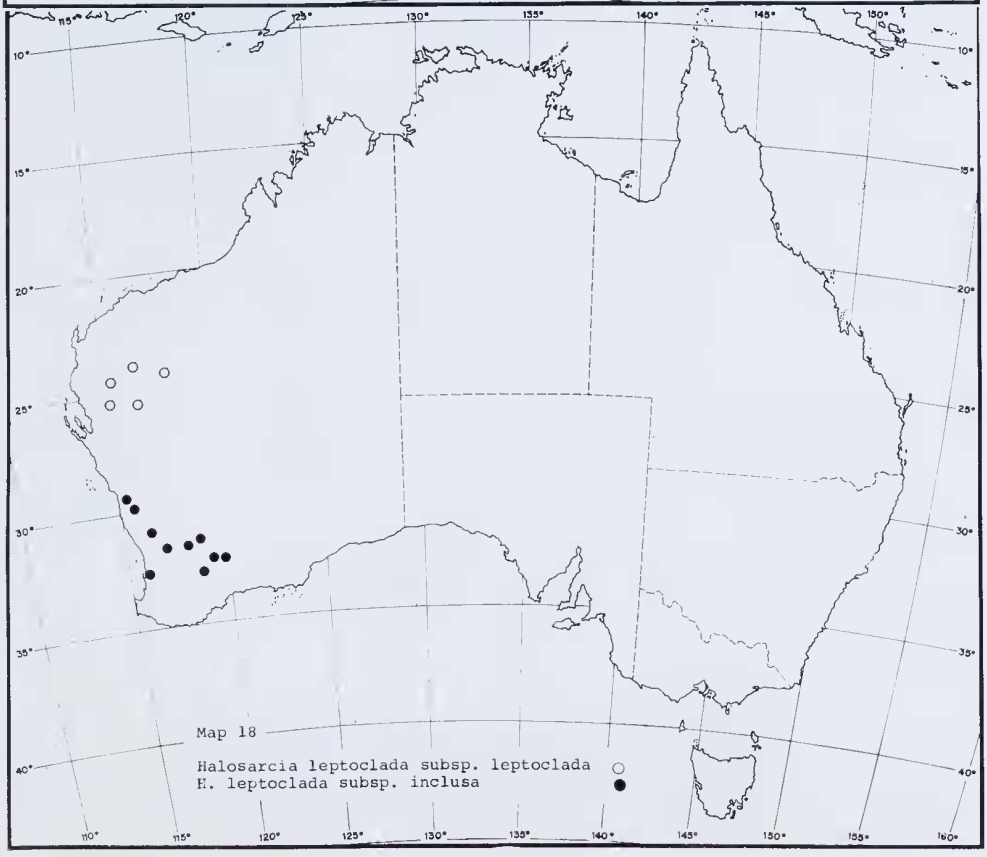

Map 13
Halosarcia auriculata
H. syncarpa

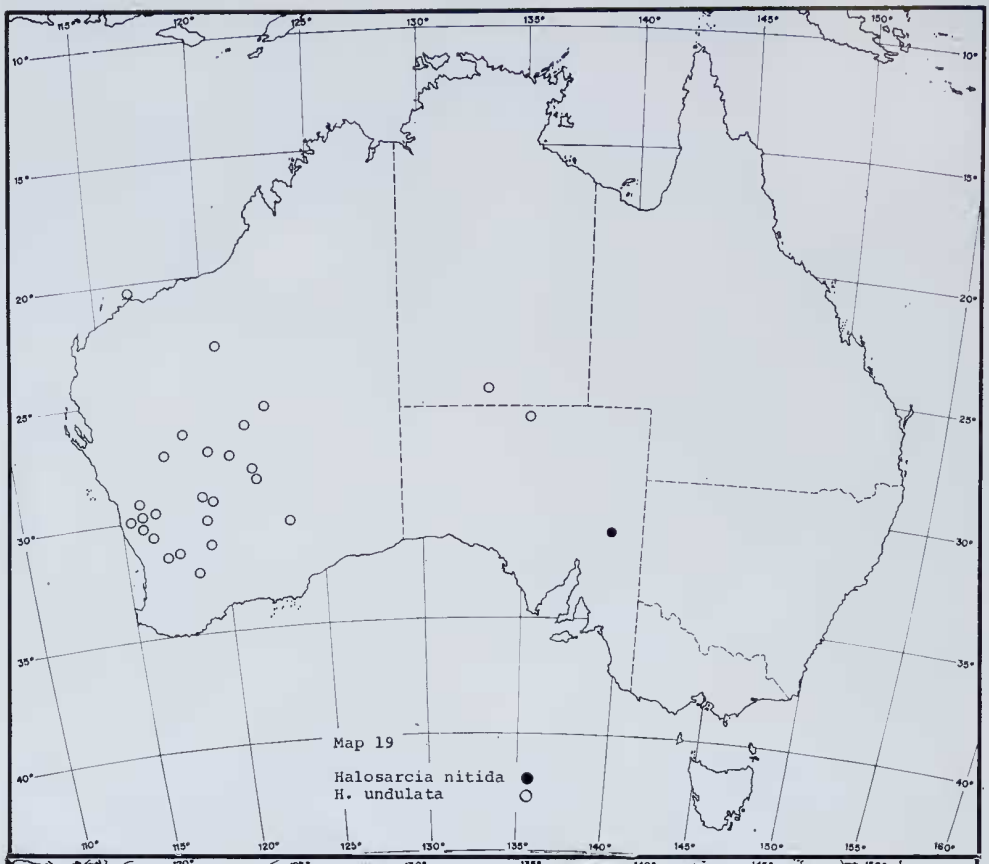

Map 14
Halosarcia indica subsp. bidens
H. indica subsp. leiostachyum

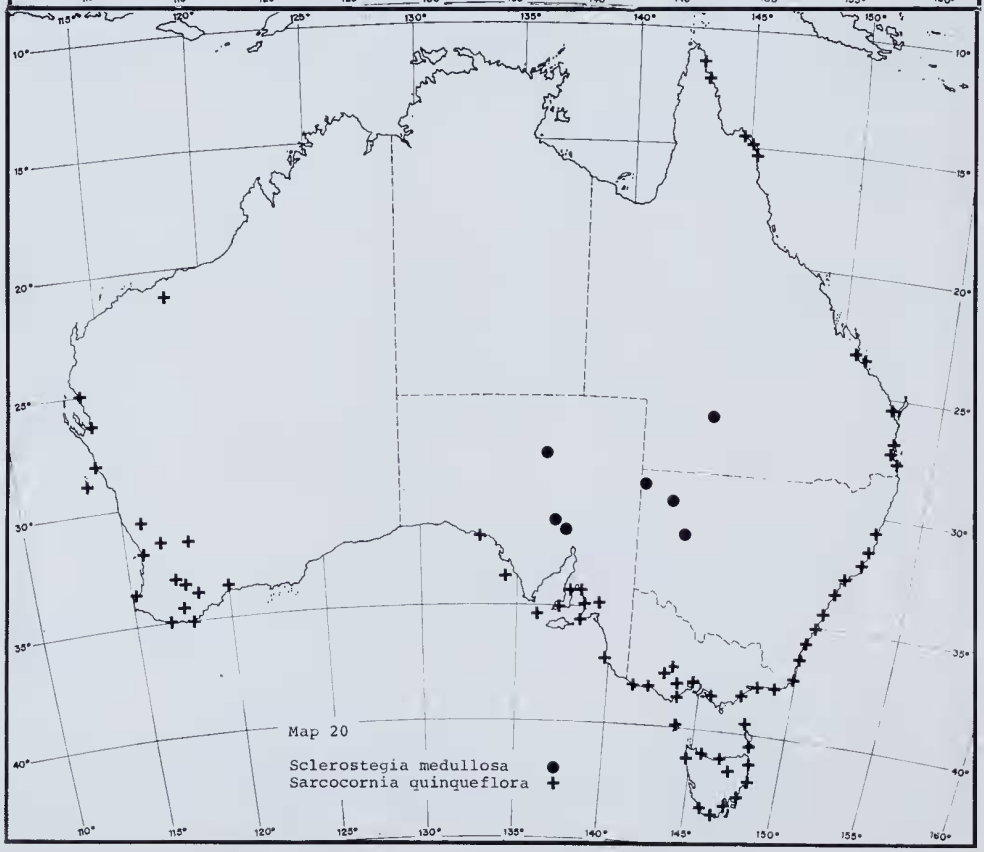

Map 15
Halosarcia pergranulata subsp. pergranulata
H. pergranulata subsp. queenslandica

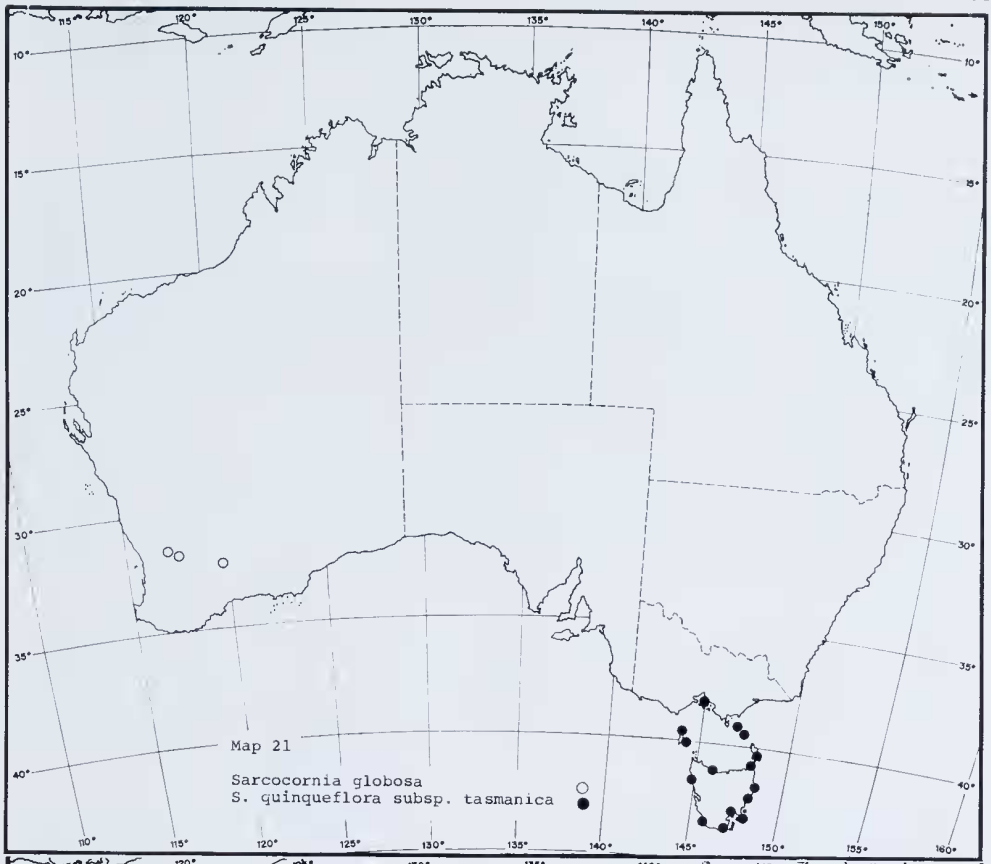

Map 16
Halosarcia pergranulata subsp. divaricata
H. pergranulata subsp. elongata

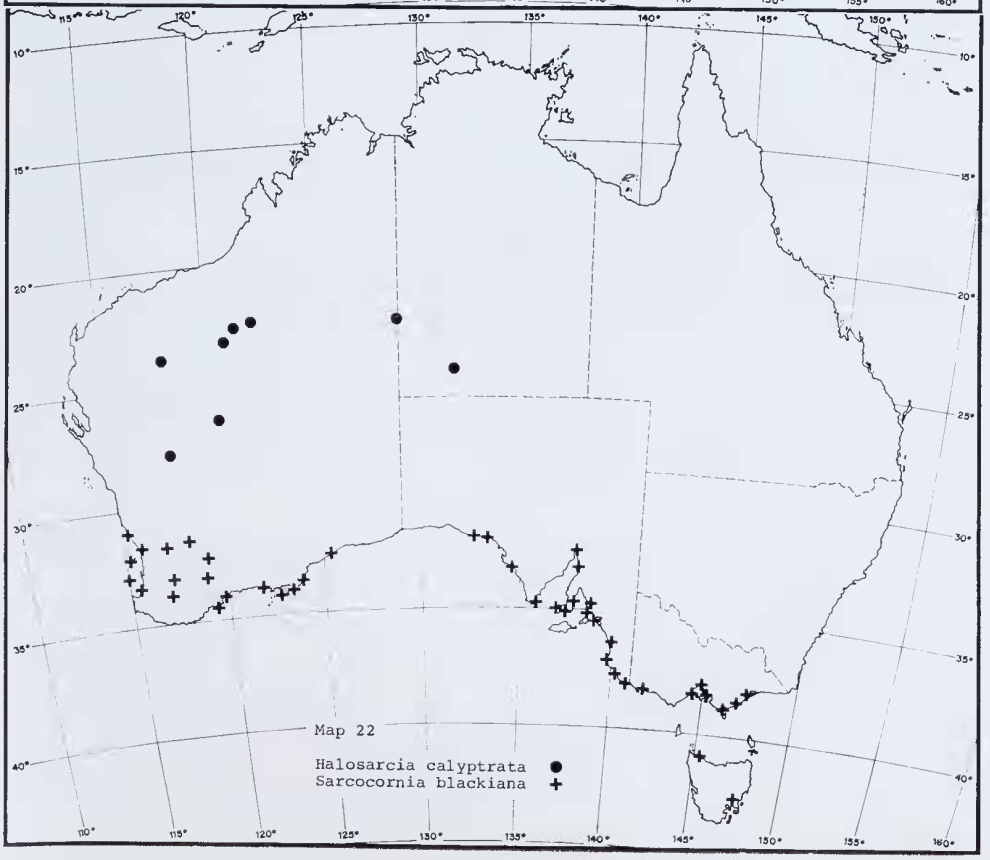

Map 17
Halosarcia pterygosperma subsp. pterygosperma
H. pterygosperma subsp. denticulata


Map 18
Halosarcia leptoclada subsp. leptoclada
H. leptoclada subsp. inclusa


Map 19
Halosarcia nitida
H. undulata


Map 20
Sclerostegia medullosa
Sarcocornia quinqueflora


Map 21
Sarcocornia globosa
S. quinqueflora subsp. tasmanica


Map 22
Halosarcia calyptrata
Sarcocornia blackiana

Note added in proof

The type species of *Arthrocnemum* is stated earlier in this article to be *A. glaucum* (Delile) Ung.-Sternb. (1876); however, the epithet *glaucum* dates from 1876 since the combination is based on *Salicornia glauca* Delile (1813), an illegitimate name being a later homonym of *S. glauca* Stokes (1812). Some recent authors (see synonymy) have therefore used for the same species the name *Arthrocnemum macrostachyum* (Moric.) C. Koch (1853) which is based on *S. macrostachya* Moric. (1820); however, according to Index Kewensis (1895) an earlier synonym exists, viz. *Salicornia mucronata* Lag. (1817), a name which has never been accepted by botanists nor has it been transferred to *Arthrocnemum*. Ungern-Sternberg (1876) appears to have been the first person to suggest the synonymy of *S. mucronata* with *A. glaucum* although he did so with a query, which was understandable since the description of the former species was based on vegetative material. Index Kewensis (1895) provided the same synonymy and Moss (1911) stated that he was following that work. It is likely that the later authors did likewise since, in each of those papers cited above in which the name *Salicornia mucronata* is mentioned (except for that of Ungern-Sternberg), the page reference for the original publication is incorrectly given as 58 instead of 53.

I am not transferring *Salicornia mucronata* to *Arthrocnemum* in view of the lack of evidence that any worker since Ungern-Sternberg has looked into its correct application. Until such a study is undertaken it would appear desirable that the name applied to the species in question should be *Arthrocnemum macrostachyum*. The relevant synonymy is as follows:

Arthrocnemum macrostachyum (Moric). C. Koch, Hortus dendrologicus 96 (1853); Zohary, Fl. Palaest. 1:156 (1966); Jafri et Rateeb, Fl. Libya 58: 51 (1978).—*Salicornia macrostachya* Moric., Flora Veneta 1: 2 (1820) n.v.—*A. fruticosum* (L.) Moq. var. *macrostachyum* (Moric.) Moq., Chen. Mon. Enum. 112 (1840).

? *Salicornia glauca* J. Stokes, Botanical Materia Medica 1: 8 (1812), non *Arthrocnemum glaucum* Ung-Sternb..

Salicornia virginica Forsskal, Flora aegyptiaco-arabica 2 (1775) nom. illeg. non L. (1753).—*S. glauca* Delile, Florae aegyptiacae illustratio 49 (1813) based on preceding, nom. illeg. non Stokes (1812); Moss, J. Bot. Brit. & For. 49: 177 (1911).—*A. glaucum* Ung.-Sternb., Atti Congr. Bot. Firenze 1874: 283 (1876); Ball in Tutin et al., Fl. Europ. 1: 101 (1964); A. J. Scott, Bot. J. Linn. Soc. 75: 370 (1977).

? *Salicornia mucronata* Lag., Mem. Pl. Barrilleras 53 (1817); Lag. in G. A. de Herrera, Agricultura general 1: 280 (1818) n.v.

Index to Names

Entries in **bold** type are of new taxa; entries in roman type are accepted names; entries in *italics* are of synonyms. Page numbers in bold type refer to the main taxonomic treatment.

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