TAXONOMIC REVISIONS IN THE FAMILY HALORAGACEAE R.Br.

by

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SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

TO THE UNIVERSITY OF ADELAIDE

BOTANY DEPARTMENT

JANUARY, 1972

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SUMMARY

A taxonomic study has been made of forty-one species of Haloragaceae, belonging to the genera *Haloragis*, *Haloragodendron*, *Glischrocaryon*, *Meziella* and part of *Gonocarpus*. One genus (*Haloragodendron*), four species (*Haloragis uncatipila*, *Haloragis eichleri*, *Haloragis myriocarpa*, *Haloragodendron glandulosum*) and numerous infra-specific taxa are described for the first time, and the genus *Gonocarpus* is reinstated as distinct from *Haloragis*.

Aspects of wood ray structure have been studied in four genera, and a survey has been made of floral vasculature in all genera of Haloragaceae except *Meziella*, and in some putatively related families. Literature reports on aspects of embryology, chromosome numbers, phytochemistry, pollen morphology and fossils have been summarized, and used in conjunction with herbarium and field studies in a consideration of the relationships of the family Haloragaceae, and of the inter-relationships of its genera and species.

It is concluded that the genera *Callitriche*, *Ceratophyllum*, *Hippuris*, *Trapa* and *Gunnera*, which have been included in Haloragaceae by some authors, should be excluded from the family, which then consists of eight genera: *Haloragis*, *Haloragodendron*, *Glischrocaryon*, *Gonocarpus*, *Laurembergia*, *Meziella*, *Proserpinaca* and *Myriophyllum*. Of these, *Haloragis* shows the most primitive characters and *Myriophyllum* the most advanced. The traditional placement of Haloragaceae near Onagraceae is shown to be incorrect; the relationship between Cornaceae and Haloragaceae proposed by Schindler (1905) is more plausible.

STATEMENT OF ORIGINAL WORK.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any University; nor does it include, to the best of my knowledge, any information previously published or written by any other person, except where due reference is made in the text.

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ACKNOWLEDGEMENTS

I am indebted to the Directors and Curators of the herbaria who made available loans of herbarium material and photographs of type material for study, and to Dr. N.T. Burbidge, Mr. B.V. Sneddon and Dr. F.A. Sampson for providing liquid preserved material for anatomical studies. I am also grateful for the efforts of many collectors, particularly Mr. B. Copley and Mr. A.C. Beauglehole, who devoted much time and effort to increasing the number and diversity of collections available. Assistance with field studies was received from these collectors, Mr. J.R. Maconochie, Mrs. T. Parsons, my wife, and many other people. The advice of Mr. P.H. Smith and Mr. R.D. Seppelt, on technical matters connected with the anatomical studies, is gratefully acknowledged.

I particularly wish to thank Dr. Hj. Eichler for his constructive supervision and for the use of the facilities of the State Herbarium of South Australia, and Professors R.N. Robertson and P.G. Martin for the use of the facilities of the Botany Department, University of Adelaide.

The patience and understanding of my mother, Mrs. G.F. Orchard, who typed the thesis, and my wife, Theresa, who assisted with proof-reading and duplication, is very much appreciated.

The study was carried out under the tenure of a Commonwealth Post-graduate Award.

I. INTRODUCTION.

The material presented here forms the first part of a monograph of the predominantly southern hemisphere family Haloragaceae. It is based on all available herbarium material, supplemented by observations of many species in the field.

The only other monograph of Haloragaceae since the Prodromus of de Candolle (1828) is that of Schindler (1904, 1905). This treatment, although nearly 65 years old when the present study began, has formed the basis for considerations of family, generic and species relationships and delimitations for most of this century. Schindler's treatment suffered largely from the inadequacy and paucity of the only material available to him, namely that in continental European herbaria. In many cases only one or two collections were available for each species; rarely as many as ten. Despite, or possibly because of this, Schindler adopted a very narrow species concept (although his genera were relatively wide in circumscription) and described many new species and taxa of lower rank on account of a single specimen or very few collections. Not surprisingly, several of these new taxa have subsequently been found difficult to recognize.

In the past fifty years collections of Haloragaceae, particularly in Australian herbaria, have greatly increased by comparison with the amount of material available to Schindler. Attempts to name these collections have not only drawn attention to the unsatisfactory nature of many of Schindler's taxa, but also have resulted in the description of several species unknown to him. In some cases the authors of these new species tried to place them within Schindler's framework for the family, but more often they described the species in apparent ignorance of his work.

Because of the accessibility of this new herbarium material and the fact that Australia is the centre of diversity for several major genera, (consequently offering considerable scope for field work by an Australian taxonomist),it was considered that this family constituted an appropriate subject for a taxonomic revision which promises significant results. It was also thought that a clarification of relationships between the species and genera of Haloragaceae might provide new data for discussions of Continental Drift. However the revisions accomplished in this study are inadequate for a useful contemplation of this aspect as so far very few extra-Australian taxa have been studied in detail. It is intended to rectify this shortcoming in the near future, when the monograph is completed as a contribution towards a much-needed new Flora Australiensis.

II. MATERIALS AND METHODS.

A. Herbarium and Laboratory.

The study of herbarium material was carried out at the State Herbarium of South Australia (AD); anatomical studies were made at the Botany Department, University of Adelaide.

Herbarium collections.

Collections from the following herbaria (abbreviated according to Lanjouw & Stafleu, 1964; Stafleu, 1966) were examined and annotated: AD, ADW, BRI, CANB, CBG, CGE, CHR, G, GH, GOET, HBG, K, LE, MEL, NE, NSW, NT, P, PERTH, S, SYD, U, UPS, US, UWA, W. A large number of specimens from the private herbarium of Mr. A.C. Beauglehole of Portland, Victoria, were also examined and these are cited as BEAUGLEHOLE. A few collections from other herbaria not listed by Lanjouw and Stafleu were also seen; the names of these herbaria are written out in full in the relevant place. Material of *Laurembergia* and *Proserpinaca* species was obtained on loan from herb. P and US for comparative purposes. As these genera were not revised at the species level, the collections were not annotated.

The types of most validly published names referred to the revised genera have been examined and this is indicated by an exclamation mark (!) after the abbreviation for the relevant herbarium. Where the type was not available, this is indicated by n.v. (non vidi) in the same position. Photographs of type material of *Haloragis racemosa* were sent from FI instead of the specimens and these were found sufficient for the purpose of lecto-typification. In the text these types are annotated (photo.!)

All collections examined in this study are cited after the relevant taxon, alphabetically by author under the State or Country of collection. Information about the specimen is given in the order Collector, Collector number, Date, Locality, Herbarium, Herbarium number, State of development, Special status (e.g. Types, Voucher Specimens). The Herbarium sheet number is only included if no collector's number is available. Where lectotypification was necessary, the reasons for the choice made are given under the Notes at the end of the relevant taxon.

Unless it is stated otherwise, the descriptions of all taxa are made from herbarium specimens. Measurements of flower parts are taken either from F.A.A. - preserved material, or from flowers of dried herbarium specimens brought to the boil in fresh water. It was found that the boiling treatment restored the flowers to approximately their size and shape in life or in liquid-preserved material. In the case of species with tightly conduplicately folded petals (e.g. *Haloragis*, *Gonocarpus*) the measurement of petal width was taken as that apparent without unfolding, i.e. the distance from the keel to one margin, and is given as "width (keel to margin ..)". In general,usage of terms follows Jackson (1928) and Stearn (1966). The distribution of each taxon studied is briefly summarized after its description,and the locations of the specimens examined are plotted on the series of maps.

All available information on soils, habitat preference, pollination rainfall, weediness, flowering and fruiting periods, etc., is included under the heading Ecology after each species. Usually this information is taken from collectors' notes on the labels of herbarium sheets to which reference is made, supplemented in some cases by reports from the literature and personal field observations. The units of measurement for altitude and rainfall are given in feet and inches (respectively) as well as in metres and centimetres, since the former are the units currently in use in Australia, and therefore the only ones appearing on present-day maps of the country.

Floral vascular anatomy.

The pattern of vascular strands in the flowers of all genera (except *Meziella*) and a large number of species of Haloragaceae has been studied using serial paraffin sectioning techniques. For the most part material preserved in formalin - acetic acid - ethyl alcohol (F.A.A.) was used. It was dehydrated using a tert-Butyl alcohol series, embedded in paraffin, sectioned at 10-15μ and stained in safranin - fast green, all according to the methods of Johansen (1940). Where it was necessary to use herbarium material, the flowers were softened according to the methods of Cunningham (1969), before proceeding as above. All sections were mounted in XAM and drawn using a Leitz Camera Lucida, at the magnifications shown. The slides will be deposited at the State Herbarium of South Australia (AD).

Wood anatomy.

For the study of wood ray structure in the stems and roots of species of *Haloragis, Haloragodendron, Glischrocaryon* and *Gonocarpus*, the wood samples used were usually fresh material preserved and stored in F.A.A., although in a few cases, herbarium material, soaked in F.A.A. for a few days, was used and found satisfactory. Transverse, radial longitudinal and tangential longitudinal sections were cut at 10-30μ on a sledge microtome, stained in safranin and mounted in XAM. The sections were photographed using an Olympus microscope and camera attachment. The slides will be deposited at AD.

B. Field.

Plants of most of the Australian species studied were observed in the field and collected during numerous field trips encompassing all Australian States, the Northern Territory and the Australian Capital Territory. Collections were made of all species of *Glischrocaryon*, three of the five species of *Haloragodendron*, thirteen of the twenty Australian species of *Haloragis*, numerous species of *Gonocarpus*, and several of *Myriophyllum*.

A special field study of the variation in the fruit morphology of *Haloragis acutangula* was made throughout the South Australian range of that species, resulting in a clearer understanding of the taxonomic standing of *H. semiangulata* and *H. ciliata*, which had been described previously, and in an extension of the known range of *H. acutangula*.

All collections made during this study are housed at AD.

III. HISTORY OF TAXONOMIC TREATMENTS OF HALORAGACEAE.

Although the family Haloragaceae R. Br. dates from 1814, all except three of the genera now recognized as comprising the family had been described at least 30 years earlier. The history of the family involved a great deal of inter-family generic shuffling, which, by the mid-nineteenth century, resulted in a heterogeneous assemblage of basically aquatic or semi-aquatic plants for which no other place in the "system" could be found. From that time to the present day the tendency has been to remove various anomalous genera to form several small monogeneric families. Some of these are considered to be fairly closely related to Haloragaceae, while others show little or no true affinity.

Species of *Myriophyllum*, *Proserpinaca* (based on *Trixis* Mitchell, 1748), *Callitriche*, *Hippuris* and *Trapa* were described in Linnaeus' Species Plantarum (1753) and the generic names were validated the following year. As a result of the artificiality of the scheme of classification, no relationship between these genera was recognised. In the Mantissa (Nov. 1767) two further genera later included in *Haloragaceae*, namely *Gunnera* and *Serpicula*, were described. *Laurembergia* had been described two months earlier by Bergius (Sept. 1767).

In the first attempt at a natural system, Adanson (1763) placed the Haloragacean genera known at that time into three distinct families. *Trapa* was included in the family Onagres while *Callitriche* and *Myriophyllum* were placed in the family Ara near *Ceratophyllum*. *Trixis*, based on the genus of Mitchell (1748), was included in the family Aristoloches near *Vallisneria*.

Haloragis was described by J.R. & G. Forster in 1776, and

Cercodia by Murray in 1780. These two genera were lumped under the later name by A.-L. de Jussieu in 1789. This genus fell into section I ("genera inter Ficoideas & Onagras media") of the family ('Ordo') Onagrae, while *Serpicula* was referred to section II of the same family. Although recognizing that *Laurembergia* and *Serpicula* were nomenclaturally synonymous, de Jussieu preferred the later name *Serpicula* to the earlier one. *Cercodia* and *Serpicula* were the only genera placed in the division Dicotyledones. In the division Monocotyledones, *Trapa* and *Proserpinaca* were placed in the family Hydrocharides with other herbaceous aquatics, although some affinity with the family Onagres was suggested for *Trapa*. The remaining genera (*Hippuris*, *Myriophyllum* and *Callitriche*) were assigned to the family Naiades in the intermediate division Acotyledones. *Gonocarpus* was placed in plantae incertae sedis, while *Gunnera* was referred to "genera Urticis affina".

The same author, in 1805, substituted the name Onagrariae for the family Onagrae, and added to it *Trapa*, placing it in the same section as *Serpicula*. In this he followed Ventenat (1799). *Proserpinaca* was also removed from the Monocotyledones, and placed next to *Cercodia* in Onagrariae. In this latter paper de Jussieu also removed *Myriophyllum* from the Naiades to Onagrariae, in a position close to *Cercodia*, and suggested a similar affinity for *Callitriche* and *Hippuris*. In an addendum to de Jussieu's paper, Koenig (1805) pointed out the close relationship of *Gonocarpus* (the name of which he changed to *Goniocarpus* because of "too great a similarity subsisting between *Gonocarpus* of Thunberg and *Conocarpus*") to *Cercodia*.

Richard (1808) proposed the name Hygrobiae for the group of genera

Hippuris, Proserpinaca, Haloragis and *Myriophyllum*. This name was taken up by Cambessedes (1830) ['Hygrobieae'] in preference to Brown's (1814) name (Halorageae) and de Jussieu's (1817) name (Cercodianae) for the family, and it was similarly used by Kunth (1838). Spach (1835) reduced Richard's name to the rank of Tribe under Halorageae. He changed the composition of the group by removing *Hippuris* to Tribe Hippurideae and adding *Trapa, Meionectes, Cercodia* and *Serpicula* to Hygrobieae. The third tribe of the family was the monogeneric Callitriche.

Spach's treatment of Halorageae differs markedly from that of Reichenbach (1828) in which three subdivisions were recognized: Hygrobiae ['Hydrobiae'] consisting of *Myriophyllum, Proserpinaca* and *Trapa*; Cercodeae (*Hippuris, Serpicula, Goniocarpus, Meionectes, Haloragis* and *Cercodia*) and Datisceae (*Tetrameles* and *Datisca*).

In 1814 Robert Brown discussed the difficulty of defining a family to include such diverse elements as *Myriophyllum* and *Fuchsia*. He proposed a new family, Halorageae, allied to Onagrariae, and comprising the genera *Haloragis, Serpicula, Proserpinaca, Hippuris, Callitriche* and the newly discovered *Meionectes*. *Gonocarpus* was reduced to a synonym of *Haloragis*. Brown was followed by Gray (1821) and Dumortier (1829) ['Halorageae']

A.P. de Candolle (1828) accepted the family Halorageae more or less as defined by Robert Brown and divided it into three tribes. Cercodianeae contained *Serpicula, Goniocarpus, Haloragis, Cercodia, Proserpinaca* and *Myriophyllum*, while Callitrichineae and Hippuridineae were both monogeneric. The family was placed between Onagrariae and Ceratophylleae. In 1868 A. de Candolle added a fourth tribe Gunnereae, following

Endlicher (1840), Bentham & Hooker (1865), and Blume (1856), *Gunnera* having previously been placed in Artocarpaceae by Bartling (1830), in Urticaceae by Gaudichaud (1830) and Endlicher (1837), and in Araliaceae by Lindley (1846). The de Candolle arrangement of the family was widely accepted in continental Europe, and was adopted, in essence, by many subsequent writers, e.g. Don (1832), Wight & Arnott (1834) and Meisner (1838).

Glischrocaryon, the last of the major genera included in modern treatments of Haloragaceae, was described by Endlicher in 1838 and assigned to the family Santalaceae. The same genus was described by Lindley (1840) as *Loudonia* in the family Halorageae. The two names were united under the latter by Endlicher (1840), and this precedent was followed by all subsequent authors (The priority of *Glischrocaryon* was discussed by Orchard, 1970).

Lindley (1846) changed the spelling of Brown's name for the family to Haloragaceae, and recognized two tribes. Halorageae consisted of *Hippuris*, *Myriophyllum*, *Serpicula*, *Proserpinaca*, *Meionectes*, *Haloragis* and *Loudonia*; Trapeae contained only *Trapa*.

The content and postulated relationships of the Haloragaceae in the mid-19th century is summarized by Bentham & Hooker (1865). The family consisted then of nine genera, *Loudonia*, *Haloragis*, *Meionectes*, *Serpicula*, *Proserpinaca*, *Hippuris*, *Gunnera*, *Myriophyllum* and *Callitriche*. *Gonocarpus* and *Cercodia* were considered synonyms of *Haloragis*, *Glischrocaryon* was subjugated to *Loudonia*, *Laurembergia* to *Serpicula*, and *Trixis* to *Proserpinaca*. *Trapa* was referred to Onagraceae. This family was considered to be the most closely related to Haloragaceae.

Bentham (1864) had divided the Australian Haloragaceae into two groups, "True Halorageae" (*Loudonia, Haloragis, Meionectes* and *Myriophyllum*) and "Anomalous genera of a very reduced type allied to Halorageae, but often referred to Monochlamydeae" (*Gunnera, Ceratophyllum* and *Callitriche*). The inclusion of *Ceratophyllum* is not surprising as most authors, from Linnaeus onward, had considered this genus related to Haloragaceae, in particular, to *Myriophyllum* and *Hippuris*, both in its habit and in the reduction of the flowers. In Bentham & Hooker's Genera Plantarum, *Ceratophyllum* was excluded from Haloragaceae, as it has been by all subsequent authors.

A. Brown (1864) recognized three subfamilies in 'Halorrhagidaceae', namely Hippuridoideae, Callitrichoideae and Myriophylloideae. The family was placed in the order Myrtiflorae near Onagraceae, and Gunneraceae was tentatively removed to Umbelliflorae, near Araliaceae.

Baillon (1877) retained the Halorageae in his family Onagrariaceae, as one of the seven "series". Only five genera were retained in Baillon's concept of Halorageae: *Haloragis, Loudonia, Myriophyllum, Serpicula* and *Proserpinaca*. *Trapa, Gunnera* and *Hippuris* each formed another monogeneric series in the same family. *Callitriche* formed its own series in the family Euphorbiaceae.

Petersen, in Engler & Prantl (1893), excluded *Callitriche* from Haloragaceae, but otherwise recognized the same genera as Bentham & Hooker. Three sub-families (? Tribes), Halorrhageae, Gunnerae and Hippurideae, were distinguished, the last two being monogeneric.

Schindler (1904), in a preliminary paper to his monograph of the family Haloragaceae, listed the differences between *Hippuris* and the other genera (excluding *Callitriche*) making up Haloragaceae. He concluded that *Hippuris* should be placed in a separate family Hippuridaceae related to the Santalaceae, and in this separation (but not in the placement) he has been followed by most later workers. In his monograph (1905), Schindler divided the family into two subfamilies, Halorrhagoideae and the monogeneric Gunneroideae. The former was further subdivided into two tribes: Halorrhageae consisting of *Loudonia, Laurembergia* (syn. *Serpicula*), *Proserpinaca*, *Halorrhagis* (including *Meionectes*) and *Meziella* (a monotypic, segregate genus from *Halorrhagis*), and Myriophylleae containing only *Myriophyllum*. He considered the family to be most closely related to Onagraceae, although some affinity to Umbelliflorae, especially Cornaceae was recognized. Hippuridaceae and Callitrichaceae were regarded as unrelated to Haloragaceae by Schindler. *Trapa* was assigned to Onagraceae, *Ceratophyllum* to its own family. Schindler's placement of the genera and families has geen followed by many authors, including Hegi (1925, 1931). Hallier (1912) included *Hippuris* and *Gunnera* in the family Haloragaceae, which he placed in the Ranales, deriving it from a group of families including Nymphaeaceae, Ceratophyllaceae, Circaeastraceae and Podostemaceae. From Haloragaceae he derived Theligonaceae. *Callitriche* was excluded, being placed in a separate family, with a suggestion that its derivation could have been from Linaceae (Guttales) by reduction. *Trapa* was included in Onagraceae (Polygalines).

Rendle (1925) apparently followed Schindler in including *Gunnera* in Haloragaceae and excluding *Hippuris*, *Callitriche* and *Trapa*. The affinity of Haloragaceae was considered to be with Onagraceae, to which family *Trapa* was referred. *Hippuris* formed its own family, of unknown affinity, but included with Haloragaceae and Onagraceae in the order Myrtiflorae. Rendle followed Lindley, Eichler (1878) and Baillon in placing Callitrichaceae near Euphorbiaceae (Tricocceae).

The system of Lawrence (1951) very closely matched that of Rendle. Haloragaceae were derived from Onagraceae, while Hippuridaceae, although placed close to Haloragaceae, were not considered to be related. Callitrichaceae was positioned near Euphorbiaceae. Lawrence followed Diels (1936) in placing *Trapa* in its own family, Hydrocaryaceae, and derived it from Onagraceae by reduction.

Wettstein (4th ed., 1935) retained *Trapa* in Onagraceae, but recognized Gunneraceae and Hippuridaceae. These three families were placed with Haloragaceae in Myrtales, Callitrichaceae were considered to be close to Euphorbiaceae, although an affinity with the Tubiflorae was not ruled out. Onagraceae and Lythraceae were thought to be the families most closely related to Haloragaceae, but the inclusion of this family in Myrtales was questioned. Similarly, the affinities of Gunneraceae and Hippuridaceae, except to Haloragaceae, were considered doubtful.

Pulle (1952) recognized the families Trapaceae and Gunneraceae, but placed them with Haloragaceae and Theligonaceae near Onagraceae at the end of Myrtales. The order adopted was Onagraceae - Trapaceae - Haloragaceae - Gunneraceae - Theligonaceae. *Callitriche* and *Hippuris* were each the basis of monogeneric orders derived from the Solanales.

Hutchinson (2nd ed., 1959; 1969) recognized the families Trapaceae and Callitrichaceae, but included *Gunnera* and *Hippuris* in Haloragaceae.

All three families were placed near Onagraceae in the Lythrales (1959) or Onagrales (1969).

Melchior (1964) followed Schindler in the internal subdivisions of the family Haloragaceae, which was placed in the suborder Myrtineae of Myrtales near Onagraceae, Oliniaceae and Theligonaceae. Hippuridaceae was referred to its own suborder, adjacent to the above families. Trapaceae was assigned a position near Lythraceae, after Miki (1959). Callitrichaceae fell between Verbenaceae and Labiatae, this position for the family reflecting embryological findings by Joergensen (1923) and Soueges (1952).

Airy Shaw (1966) excluded *Gunnera*, *Hippuris* and *Callitriche* from Haloragaceae, for which he postulated a relationship with Datiscaceae, (c.f. Reichenbach, 1828) at the same time suggesting that any connection with Gunneraceae was superficial. The latter family was considered to be related to Urticaceae. Callitrichaceae was assigned a doubtful position near Scrophulariaceae, Verbenaceae and Labiatae, while the affinities of Hippuridaceae were considered to be even more doubtful, "prob. connected with Haloragidac., Elatinac., Lythrac., Primulac., etc."

Thorne (1968) placed the Haloragaceae (subfamilies Haloragidoideae and Gunneroideae) and Hippuridaceae in their own suborder Haloragidineae of the Cornales. Here they come between the suborder Cornineae, containing Cornaceae and satellite families, and suborder Aralineae, containing Araliaceae and Apiaceae (as subfamilies of Araliaceae). *Callitriche* was far removed (near Lamiaceae in Lamiales), as was *Trapa* (in Myrtales, near Cryteroniaceae, Combretaceae, Punicaceae, etc.)

Cronquist (1968) agreed with Airy Shaw in placing Callitrichaceae near Labiatae and Verbenaceae. He differed however, in linking the families Haloragaceae, Gunneraceae, Hippuridaceae and Theligonaceae in the order Haloragales, derived parallel to the Myrtales from Rosales. *Trapa* (Trapaceae, Myrtales) was considered to be unrelated to, but convergent with the Halorages.

The relationships envisaged by Takhtajan (1969) are almost identical to those of Cronquist, differing mainly in the derivation of Haloragales (Hippuridales) and Myrtales from Saxifragales instead of Rosales. *Trapa* and *Callitriche* assumed the same places as in Cronquist's system, but Theligonaceae were referred to an order of their own, related possibly to Caryophyllales.

Ehrendorfer (1971) adopted a system which agrees closely with those of Takhtajan and Cronquist.

In retrospect, the taxonomic history of Haloragaceae has been a process of gradual recognition of relationships between originally widely separated taxa which by the mid-nineteenth century had resulted in an agglomeration of genera, some related, some placed together for convenience. Since then, as more evidence became available, the anomalous genera have been removed, often to form monotypic families.

Most modern surveys of angiosperm relationships place Haloragaceae in or near the order Myrtales, often close to Onagraceae, although some workers favour Cornaceae as the most closely related family. *Gunnera, Callitriche, Hippuris* and *Trapa* are now usually excluded from Haloragaceae and form monogeneric families of their own. Of these Gunneraceae and Hippuridaceae are often placed close to Haloragaceae, while Trapaceae is considered to be a link between Onagraceae and Haloragaceae. Callitrichaceae is usually far-removed from Haloragaceae in modern treatments, often being placed near Verbenaceae-Labiatae.

IV. DIAGNOSTIC CHARACTERS.

Habit.

Many accounts of the Haloragaceae describe the family as herbaceous, probably influenced to a large extent by the cosmopolitan genus *Myriophyllum*. However, the majority of the species and genera are characterized by a low shrub-like habit, with a perennial woody root-stock and usually herbaceous or woody annual stems. In some species of *Gonocarpus (G. halconensis, G. sanguineus)* and *Haloragis (H. exalata, H. erecta, H. uncatipila)* the branches are also more or less perennial, whereas the genus *Haloragodendron* is wholly shrubby or tree-like in habit *(H. racemosum* grows up to 3 m tall).

Rootstock.

In herbaceous aquatic species (e.g. *Myriophyllum*) the rootstock may be stoloniferous, although herbaceous terrestrial species are usually annuals. Shrubby or treelike species (*Haloragodendron, Glischrocaryon*, most *Haloragis* and *Gonocarpus*) usually have a simple taproot system with laterals, and often in the shrubby species, adventitious roots from the nodes and/or internodes of the lower branches. However, particularly in *Haloragis*, species from semi-arid regions (e.g. *H. aspera, H. glauca, H. heterophylla*) vegetative reproduction occurs from a deep, horizontal network of underground stolons or roots. In non-stoloniferous species of *Haloragis* and *Gonocarpus*, the rootstock acts as a woody perennating organ, giving rise to new branches each growing season.

Indumentum.

All species of *Myriophyllum, Glischrocaryon, Haloragodendron,* *Meziella* and *Proserpinaca* are glabrous. In the remaining three genera some species are glabrous, but most are more or less densely pilose or scabrous. The hairs are always simple and uniseriate, but differ from species to species in the number of cells (1 to about 6), length, colour (hyaline to opaque), texture (arachnoid to scabrous) and shape (straight, curved or hooked at the tip). In *Haloragis platycarpa* the hairs are unicellular, rounded, transparent and papillose, while in *Haloragodendron glandulosum* the leaves, stems and bracts are covered with large, red, globular, apparently glandular processes (although the plants are apparently not viscid).

Leaf arrangement.

Of the genera of Haloragaceae, *Glischrocaryon, Proserpinaca* and *Meziella* consistently have alternate leaves while *Haloragodendron* always has opposite leaves. In *Haloragis, Laurembergia* and *Gonocarpus* species may have either alternate or opposite leaves, sometimes with both on the same plant, and then with the opposite arrangement at the base. *G. halconensis* and *G. sanguineus* have leaves in whorls of 3-4 or opposite. The leaves of *Myriophyllum* are usually whorled, but are alternate or opposite in some species.

Leaf shape.

In *Glischrocaryon* the leaves are always sessile and linear to terete This genus and *Haloragodendron* are characterized by their possession of both juvenile and adult leaf forms in some species. *Haloragis* and *Gonocarpus* have leaves of a wide variety of shapes, ranging from terete to linear, (ob-)lanceolate, (ob-)ovate, oblong, cordate or orbicular, entire or ± deeply dissected,multifid or pinnatifid, petiolate or sessile. The margins may be smooth or serrate. In *Haloragis* and *Haloragodendron* the teeth are usually deltoid or falco-deltoid, while in *Gonocarpus* the teeth are usually obliquely cuspidate. The leaves of *Glischrocaryon* are never serrate while those of *Haloragodendron* are never entire, and those of *Haloragis* and *Gonocarpus* are toothed in most species. The leaves of *Meziella* are unique in the family, being trifid with a small tooth or spur in the angle between the segments. The submerged leaves of *Myriophyllum* and *Proserpinaca* species are usually pinnatifid or multifid, while the emergent leaves are usually more or less entire.

Inflorescence.

The basic unit of the inflorescence in this family is the dichasium, often compounded, rarely reduced. In *Haloragis* the inflorescence consists of dichasia of up to about 15 flowers borne in the axils of alternate primary bracts. The bracts are arranged along the distal portion of the upright annual stems, with reduction in size towards the apex. At the base of the inflorescence the primary bracts closely match the upper leaves in size and shape, but become reduced higher up. The inflorescence is indeterminate, growing continuously at the apex throughout the flowering season. Below the terminal inflorescence, lateral inflorescences, similar in construction to the main inflorescence but usually somewhat reduced in complexity, may be borne in the axils of the upper leaves. Within each fascicle of flowers, scale-like secondary, tertiary etc. bracts occur at successive branchings.

The inflorescences of other genera can be derived by slight modifications of the situation in *Haloragis*. In *Haloragodendron* the primary bracts are always opposite, and the inflorescence is determinate, with a (usually) simple dichasium terminating the axis. The order of maturation of the flowers within the inflorescence in this genus varies from species to species.

The inflorescence in *Glischrocaryon* also has a terminal dichasium, but in this genus it is a compound dichasium of up to 31 flowers. Below the terminal dichasium there are usually up to about 5 lateral dichasia in the axils of alternately arranged primary bracts, and below these there may be 2 or 3 lateral inflorescences in the axils of the upper leaves. The main axis is contracted so that the entire inflorescence forms a more or less flat-topped pseudo-umbel. As well as their overall shape, the inflorescences of *Glischrocaryon* are unique in the family in that the primary (and sometimes secondary and tertiary) bracts are fused to the subtended peduncles for part of their length, and therefore appear to be displaced upwards by about half the length of the peduncle.

In *Gonocarpus* (with the exception of *G. hexandrus*) the individual dichasia have been reduced relative to the situation in *Haloragis* and consist of single flowers in the axils of spirally or decussately arranged primary bracts. That this is probably derived and not the primitive condition within the family is indicated by the pair of sterile secondary bracts (= bracteoles) borne on the pedicel of each flower. As in *Haloragis* there may also be lateral inflorescences arising from the axils of the upper leaves.

As far as can be determined, the situation in *Meziella* is as for *Gonocarpus*, but apparently there are no lateral inflorescences.

The inflorescence in *Laurembergia* agrees well with that of *Haloragis*, except that in the former the flowers are usually unisexual, the male flower occupying the terminal (central) position of each compound dichasium, standing out on a long pedicel from the almost sessile (lateral) female flowers. As in *Haloragis*, the main axis of the inflorescence is indeterminate, but there are few, if any, lateral inflorescences.

In *Proserpinaca* the inflorescence structure also agrees well with that in *Haloragis*. The main axis is indeterminate and the bisexual flowers are grouped in dichasia of 1-3(-5) flowers in the axils of alternate primary bracts. Lateral inflorescences are rare.

The inflorescence in *Myriophyllum* represents a further modification of the system in *Gonocarpus*. In its simplest state, the *Myriophyllum* inflorescence consists of an indeterminate axis bearing single flowers (each with a pair of secondary bracts) (bracteoles) in the axils of spirally or decussately arranged primary bracts. Only female flowers occur in the lower part of the inflorescence, male flowers in the upper part. In some species, bisexual flowers are found in the median portion of the inflorescence. More advanced species of *Myriophyllum* have an arrangement in the inflorescence that reflects the situation in the vegetative parts, where the leaves are whorled. In the inflorescences of these species, the primary bracts are also whorled, with only one flower per bract, and the distribution of sexes is the same.

The purely descriptive nature of the above account of inflorescence structure has been adopted in preference to classifying them as spikes, racemes etc. It is an attempt to show the basic similarity in structure in all genera, modified only by reduction in degrees of branching and in segregation of the sexes in some genera. This descriptive approach seems more appropriate to the comparative treatment of the species and genera aimed at here, than a typological classification according to the scheme of Troll (1964) outlined by Weberling (1965). If interpreted in terms of Troll's scheme, then the inflorescences of *Glischrocaryon* and *Haloragodendron* are monotelic and the "lateral inflorescences" are homologous with the axillary dichasia, all of them being termed paracladia. The *Glischrocaryon* type of inflorescence would be considered acrotonic while that of *Haloragodendron* would be basimesotonic. In *Haloragis*, *Gonocarpus*, *Laurembergia*, *Proserpinaca* and *Myriophyllum* the inflorescences would be termed polytelic with a terminal indeterminate main-florescence and (in some cases) lateral coflorescences ("lateral inflorescences").

Differences in structure and floral sex distribution within the inflorescence are useful in delimiting genera in this family (especially *Gonocarpus* - *Haloragis* - *Haloragodendron*), and differences in degree of branching have been found useful in distinguishing closely related species and taxa of lower rank (e.g. *G. sanguineus* - *G. halconensis*, and the subspecies of *G. micranthus*).

Floral Sexual Segregation.

This is dealt with in part above (Inflorescence). The flowers of all genera with the exceptions of *Myriophyllum* and *Laurembergia* are normally all bisexual. In *Laurembergia*, one flower (usually the terminal one), in each dichasial fascicle is male or bisexual, while the others are female. In *Myriophyllum* the flowers at the base of the inflorescence are female while those at the apex are male, with sometimes a few bisexual flowers in the transitional region. In some species of *Gonocarpus* there is an apparent trend towards dioecy. Field studies revealed that in *G. tetragynus* all flowers on some plants had much reduced petals and non-functional anthers but apparently normal styles and ovaries, while other plants in the same populations had normal petals and functional anthers. Praglowski (1969) reported apparently abortive pollen from some flowers of *'Haloragis ciliata'* (= *H. acutangula*) and *'H. alata'* (= *H. erecta*). He found that flowers of the two species had both large and small anthers and that the abortive pollen came from the small anthers. Observations in the present study have revealed that in *Haloragis*, *Gonocarpus*, *Glischrocaryon* and *Haloragodendron* the antipetalous anthers are often 0.2-0.5 mm shorter than the antisepalous ones. However, Dr. Praglowski (pers. comm.) has indicated that it is only in the species here included in *Haloragis* and *Gonocarpus* that the phenomenon of reduced pollen size regularly occurs. The extent of this apparent trend towards unisexual flowers is still unknown, but deserves further study for the light it could shed on generic relationships and direction in phylogeny. The presence of functionally unisexual flowers in some species should not be confused with the presence of small rudimentary flowers found in inflorescences of various species of *Haloragis*, *Haloragodendron* and *Glischrocaryon*. These are the flowers of the ultimate branchings of compound dichasia, and are fully differentiated when they abort well before anthesis, perhaps as a result of crowding or a nutritional deficiency.

The bisexual flowers of *Haloragis*, *Gonocarpus*, *Haloragodendron* and *Glischrocaryon* are protandrous; the petals and dehisced anthers being shed before the styles intrease in size and become receptive. The situation in *Proserpinaca*, *Laurembergia* and *Meziella* is unknown. In *Myriophyllum* the female flowers develop in the lower part of the inflorescence before the male flowers in the upper part, and the plants are apparently protogynous.

Primary bracts.

This term is used in the present treatment for the bract- or leaf-like structures on the rachis of the inflorescence. They subtend a partial inflorescence consisting of a simple or compound dichasium. Where the subtended axis bears more than one (compound) dichasium (i.e. is a side branch with two or more dichasia) it is here termed a lateral inflorescence, and the subtending structure called a leaf. Primary bracts are usually strongly reduced towards the apex of the inflorescence but at the base may be almost indistinguishable from the upper leaves. In plants with alternate leaves, the primary bracts are also alternate, but in those with opposite leaves the primary bracts may be alternate or opposite. The primary bracts, in the sense used here, are the same as the 'floral leaves or bracts' of Bentham (1864) and the 'bracteae' of Schindler (1905).

Secondary bracts.

This term refers to the pair of small membranous bracts (= bracteoles) borne on the pedicel of the single flower in *Gonocarpus*, *Myriophyllum*, *Meziella* and some species of *Proserpinaca*, and to the homologous bracts subtending the first branching of a simple or compound dichasium in other genera. They are usually much smaller than the primary bracts.

Tertiary, quaternary bracts.

These are the bracts subtending the second and subsequent branchings of compound dichasia in the genera *Haloragis*, *Glischrocaryon* and *Haloragodendron* which often have large fascicles of flowers in the axils of the primary bracts. The highest order bracts often lack a flower in their axils, or at most, subtend a precociously aborted flower.

Number of flower parts.

The flowers of Haloragaceae are basically tetramerous, with four sepals, petals, styles and carpels, and eight stamens. No cases of 5-merous flowers are known in the family, apart from some monstrous examples in *Haloragis acutangula*. However, reduction in number of parts is fairly common. All species of *Proserpinaca*, *Gonocarpus hexandrus*, *Haloragis gossei*, *H. trigonocarpa*, *H. tenuifolia* and some flowers of *H. digyna* are reduced proportionately to a trimerous plan, while several species of *Myriophyllum*, *Haloragis brownii*, *Glischrocaryon behrii* and some flowers of *Haloragis digyna* are bimerous. In *Haloragis serra* and *H. scoparia* the flowers are tetramerous except for the bilocular ovary, and in *H. eichleri* the otherwise tetramerous flower has an ovary in which one of the four locules fails to develop further during fruit formation. In *Gonocarpus nodulosus*, *Gonocarpus* ('*Haloragis*') *isomerus* and some species of *Myriophyllum* and *Laurembergia* the tetramerous flowers have only four, not eight, stamens.

Sepals.

These are present in the male and/or bisexual flowers of all species and persist in the fruit. They are absent only in the female flowers of *Myriophyllum*. Variation in their shape occurs from lanceolate to deltoid, ovate or cordate, and a median rib, representing the median sepal vascular trace may or may not be apparent. In some species, particularly in those of *Gonocarpus* the outer surface of the sepals may bear basal calluses (small swellings) in median or lateral positions. The shape, size and ornamentation of the sepals, while of unknown significance, are usually constant within a species, and can be useful taxonomic characters at this level.

Petals.

The petals in Haloragaceae are characteristically folded conduplicately, keeled, hooded at the apex and shortly unguiculate at the base. They reflex strongly soon after anthesis and are shed with the stamens immediately after pollen dispersal. In *Glischrocaryon* they are bright yellow, as is the rest of the flower, but with the exception of this genus and *Haloragodendron*, the petals are usually green or reddish and probably have little function in attracting pollinators. In *Haloragodendron* the petals are usually creamy white in colour, and in common with those of *Glischrocaryon* are navicular (i.e. tapering towards the tip) rather than abruptly hooded in bud, and in some species of *Haloragodendron* (e.g. *H. lucasii*) are almost planar in the fully developed flower. *H. lucasii* is also noteworthy for the fact that its petals are twisted in bud, a condition that exists nowhere else in the family. Petals are absent in the female flowers of *Myriophyllum* and *Laurembergia*, and rudimentary or absent in the (bisexual) flowers of *Proserpinaca*.

Stamens.

In Haloragaceae the stamens are typically twice the number of the sepals, petals and styles, with large oblong four-locular basifixed anthers on very short delicate filaments. In *Proserpinaca* the anthers are ellipsoid on relatively long filaments, and in this genus, as well as in *Haloragodendron* and *Glischrocaryon* the connective is produced above the pollen sacs to form a short apiculum. The antipetalous whorl of stamens is absent or rudimentary in *Proserpinaca*, *Meziella*, *Gonocarpus isomerus* and some species of *Myriophyllum* and *Laurembergia*, while the antisepalous whorl of stamens is abortive in *Gonocarpus nodulosus*.

Styles.

The styles in all species are the same in number as the locules and are free, with capitate or sub-globose, ± fimbriate stigmas.. Development and maturation of the styles is delayed in bisexual flowers until the petals and stamens have been shed. The point of separation of the styles is just above the placental network of vascular traces, and some differences in mode of separation were noted during anatomical studies. In *Haloragis* (and *Gonocarpus micranthus*) the styles separate first in the central part of the stylar column, remaining attached together on their outer margins until the radial walls are completely separated. This results in the formation of a hollow column at the base of the styles. In *Haloragodendron* and *Glischrocaryon* the reverse is the case, where separation begins from the outside of the column, resulting in a solid, fluted column at the base of the styles. In *Gonocarpus* (with the exception of *G. micranthus*) the styles separate completely and simultaneously, with no stylar column or only a solid, round column.

Ovary.

The ovary is fully inferior in all members of Haloragaceae, although the female flowers of *Myriophyllum*, which lack perianth and stamens, can only be considered inferior by analogy with other genera and the male flowers on the same plant. The number of locules is usually 4, but reduction to 3 or 2 occurs in some genera and species. In *Glischrocaryon* the ovary is effectively 1-locular by failure of the septa to develop, and in *Gonocarpus* the septa are only weakly developed (see below under Septa). Most literature reports give the number of ovules per locule as one in this family. However, it has become apparent during anatomical studies that in many (but not all) species of *Haloragis*, *Gonocarpus*, *Glischrocaryon*, *Haloragodendron* and *Proserpinaca* two ovules per locule are differentiated, but only one of the two develops fully and becomes vascularized. There is apparently no control over which of the two will develop; the process is random. In the few species of *Myriophyllum* and *Laurembergia* examined, there has been only one ovule per locule differentiated, but a much wider survey is still needed in these genera.

Septa.

The characteristics of the septa, in conjunction with the development of the seeds, provide some of the most reliable distinguishing features of the genera. In *Haloragis* the septa are solid and continuous for the entire length of the ovary, and consist of about six layers of cells. Each locule has a lining or epidermis of very small cubical cells, with about four layers of closely packed parenchyma making up the bulk of the septum. In the fruit the septa maintain the same position as in the flower, the individual cells, particularly the lining cells, become lignified and the pith in the placental column breaks down leaving a hollow tube ('columella').

In *Haloragodendron* the structure of the septum is very similar to that in *Haloragis*, although the packing cells may consist of up to seven layers. During fruit development only the lining cells become lignified, resulting in a flexible septum which is pushed to one side by the developing single seed. The pith in the placental column does not break down as in *Haloragis*.

Gonocarpus has a greatly reduced septal structure. There is little or no evidence of any septum in the middle of the ovary, the placental supply passing upwards as a free cord. At the top and bottom of the ovary four locules are formed by an insubstantial septum consisting of loose aggregations of cells reminiscent of fungal hyphae or spongy parenchyma of leaves. This weakly developed septum is easily crushed by the single seed in the fruit.

Septa are completely absent in the ovaries of most flowers of *Glischrocaryon*, but in *G. flavescens* incomplete septa may be present at the extreme top and bottom of the ovary and as small ridges running down the inner wall. These septa are similar in structure to those of *Haloragis* and *Haloragodendron* and their lining cells become very heavily lignified in the fruit.

Laurembergia completely lacks septa in the ovary, while *Proserpinaca* has septa apparently agreeing well with those in *Haloragis*. In *Myriophyllum* the septa are relatively thick, and become heavily lignified throughout before the fruit splits along them into nutlets. The situation in *Meziella* is unknown apart from Schindler's statement that the ovary is four locular with four ovules.

Pollination.

Haloragaceae is usually considered to be anemophilous, judged on its reduced, insignificant flowers, large anthers borne on weak filaments, and fimbriate stigmas. Schindler (1905) and Praglowski (1970) considered that *Glischrocaryon* and the species of *Haloragis* now placed in *Haloragodendron* were probably entomophilous, basing this judgment on the showy petals of these plants. Field observations during the present study, as well as collectors' notes, have revealed that bees are attracted by the abundance of pollen to flowers of at least some species of *Haloragis, Gonocarpus* and *Myriophyllum* (particularly *H. acutangula, G. elatus, M. propinquum*). Thus while anemophily may be the usual situation in this family entomophily is also present.

Fruit.

The fruits of *Myriophyllum* split septicidally at maturity to form (2-3-)4 nutlets. With this exception the fruits of Haloragaceae are indehiscent. In *Gonocarpus* and perhaps *Laurembergia* the fruit differs from the ovary in its more woody nature, but hardly at all in size or shape. In all other genera there is at least a two-fold and often three- to five-fold increase in the size of the fruit over that of the ovary. This is particularly important as a distinguishing character between *Gonocarpus* and *Haloragis*.

There is considerable variety of form and sculpturing in the fruits of the Haloragaceae, and this has been used by various authors in distinguishing species (and to a lesser extent, genera; e.g. de Candolle (1828)). All species of *Glischrocaryon,* most of *Proserpinaca* and *Haloragodendron* and some species of *Haloragis* and *Myriophyllum* have winged fruits, while species of *Haloragis, Gonocarpus, Laurembergia* and *Myriophyllum* are noted for the variety of tubercular, rugose, costate and channelled ornamentations of their exocarp. While these markings are usually constant within a species, in some species of *Haloragis* (e.g. *H. acutangula, H. erecta, H. odontocarpa, H. aspera*) a marked degree of fruit polymorphism is found even in small populations. This has been catalogued in the present study by recognizing a number of formae based on fruit characters alone (see under species cited above for further discussion).

The nature of the pericarp also varies considerably. In *Gonocarpus* the wall of the fruit is relatively thin and submembranous, and can be readily crushed between the fingers. In *Haloragis* the fruit consists of an inner (endocarp) layer which is extremely woody, with an outer "skin" (exocarp) closely appressed. In some species of *Haloragis, Glischrocaryon* and *Haloragodendron* the exocarp is habitually or occasionally extremely swollen and spongy in texture, with a normal woody endocarp. The function or significance of the swollen exocarp is not known.

Seed.

The number of seeds developed per fruit varies with the genus. In *Haloragis* (with the exception of *H. eichleri*) all locules develop fully in the fruit and each has the potential to contain a seed, resulting in a possible four seeds per fruit (in fact many fruits contain only one, two or three seeds, but the empty locules still develop normally). In *Haloragodendron* only one of the four functional ovules develops to a seed, suppressing the growth of any other fertilized ovules at an early stage. The single seed occupies the whole fruit, displacing the septa to one side. Similarly, in *Glischrocaryon, Gonocarpus* and *Laurembergia* only a single ovule per fruit develops to form a seed, and fills the whole fruit. In *Proserpinaca* (and *Haloragis eichleri*) there is the potentiality for a seed to develop in each locule, but if one (or more) locules are empty then their further development is retarded, and the fruit develops irregularly.

V. FLORAL VASCULAR ANATOMY.

A survey was made of the floral vasculature of a range of species of Haloragaceae and putatively related families in the hope that additional characters could be found that would be of use in determining species, genus and family relationships. The species examined and the location of voucher specimens are given in Table I.

Where possible flowers and buds collected in the fresh state and preserved in F.A.A. for at least 24 hours were used. This material was dehydrated in a T.B.A. series, embedded in paraffin and serial sections cut at 10-12μ. The sections were stained with safranin-fast green and mounted in XAM. Where pickled material was not available, herbarium material was rehydrated by the method of Cunningham (1969). After rehydration and washing, the material was placed in F.A.A. for 12 hours and then treated as for fresh preserved flowers. The results obtained by this method were satisfactory, although cell detail was not quite as good as that in fresh material. Flowers and buds rehydrated from herbarium material are marked with an asterisk in Table I.

The large number of species of Haloragaceae sectioned makes it difficult to present the patterns of variation through the family in a surveyable manner. For this reason the descriptions below start, in each genus, with a general account, followed by notes on deviations from this pattern in individual species. In other families, where a more restricted range of material was studied, a brief description of the species examined is followed by a discussion of reports of other workers, where these reports are available.

Haloragaceae.

Haloragis

The vascular tissue enters the flower as a single solid bundle, more or less circular in cross-section, and divides radially into 8 bundles, 4 antisepalous and 4 antipetalous. At the base of the locules the antisepalous bundles each give rise to an inner branch, and these fuse and enter the columella as a single placental bundle. The anti-petalous bundles and the remainder of the antisepalous bundles continue upwards through the ovary wall until the top of the locules, where the antisepalous bundles split off an inner and an outer branch, the anti-petalous bundles forming an inner branch only. The remainder of the antisepalous and antipetalous bundles fuse laterally to form an annulus which passes between the branches of the antisepalous bundle and outside the branch of the antipetalous bundle. The outer branch of the anti-sepalous bundle passes into the sepal as the median sepal trace, while the inner branch enters the adjacent stamen as the antisepalous stamen trace. Above the annulus the branch of the antipetalous bundle divides simultaneously into three radially arranged traces. The outer and central branches are the largest and form the petal trace and antipet-alous stamen trace respectively. The inner branch enters the base of the style as the dorsal stylar trace.

At about the same level as the annulus the placental bundle div-ides into four more or less horizontal arms running along the top of the septa towards the sepals. Each branch divides dichotomously near the outer wall of the locules and each branch then divides again, the outer sub-branch passing obliquely upward around the outer wall of the locule to fuse with its adjacent sub-branch and the dorsal stylar trace to form a compound dorsal stylar bundle, while the inner sub-branches travel around the inner wall of the locule, adjacent traces fusing to form 4 complete circumlocular traces. Usually 2 ovules are differentiated in each locule, the placentation being pendulous, from the radial walls. One ovule aborts at a very early stage and is not vascularized. The other is supplied with an ovular trace from the inner side of the circumlocular trace.

No lateral stylar traces are formed from the placental network, the styles being served only by the compound dorsal stylar bundle which runs the length of the style and may branch somewhat towards the tip.

H. exalata var. *exalata*.

The vascular plan of this species agrees with the general plan for the genus with the exception of the dorsal stylar trace. In this species the portion of the circumlocular trace on the outer side of the locule is absent, or very weakly developed, with the result that the entire dorsal stylar bundle is derived from the innermost branch of the antipetalous bundle. Two ovules per locule are differentiated, but one aborts at an early stage of development and is not vascularized. Two lateral sepal traces per sepal are derived in the usual manner from the annulus.

H. erecta. (Fig. 4)

This species conforms closely with the generic pattern. It differs in having the columellar bundle derived simultaneously with the antisepalous and antipetalous bundles from the pedicel bundle. As in *H. exalata*, the outer part of the circumstylar trace is not, or only very weakly developed. Two ovules per locule are differentiated, but one aborts at a very early stage and is not vascularized. Two lateral sepal traces per sepal are derived from the annulus.

H. eichleri (Fig. 2)

The floral vasculature of this species follows the general generic pattern. Only one ovule per locule is differentiated, and two lateral sepal traces per sepal are derived from the annulus. The annulus in this species is slightly weaker than normal in *Haloragis*.

H. odontocarpa f. pterocarpa.

The vascular structure of this species fits almost exactly the general structural plan for the genus. The only anomalous feature occurs in the vascularization of the styles, where in addition to the normal dorsal stylar trace, an extremely small lateral stylar trace is derived from the placental network. It is apparently cut off at the first dichotomy of each of the four major branches of the columellar bundle, towards the outer edges of the septa. Each trace then travels upward into the base of the stylar column, and finally divides into two branches before entering adjacent styles. Each style thus has a compound dorsal bundle plus two lateral traces. Each sepal has two lateral sepal traces derived in the normal way from the annulus, but these peter out just above the base of the sepal. Apparently only one ovule per locule is differentiated.

H. gossei (Fig. 15)

This species conforms to the general pattern except for modifications caused by its trimerous floral plan, and the presence of the large wings. The vascular structure reflects the reduction in gross morphology from a basic number of four parts to a basic number of three. The placental bundle is formed from the antisepalous traces in the normal way but the three traces remain more or less distinct throughout the length of the columella. The wings are vascularized by 4-5 lateral traces derived from the antipetalous bundle. As the traces move out into the wing they divide and anastomose, decreasing in size and forming no distinct marginal vein. Only 1 ovule is differentiated in each locule. Two lateral sepal traces are cut off from the annulus in the normal way.

H. trigonocarpa. (Fig. 4, 15)

Along with *H. gossei,* this species forms a distinct group within the genus, but differs from *H. gossei* in several aspects of its floral vascular anatomy. As in *H. gossei* the vascular framework is built on a trimerous pattern, but the antisepalous bindles consist of two more or less distinct, tangentially arranged, parallel vascular strands, and the antipetalous bundles of three similarly arranged strands. At the level of the annulus the two antisepalous strands each form an inner and outer branch, the two inner branches fusing to form the antisepalous stamen trace, the outer branches fusing with each other and with a branch from each of the adjacent lateral antipetalous bundles to form the median sepal trace. The remainder of the lateral antipetalous bundle fuses with the equivalent branch of the other lateral bundle within the same antipetalous bundle to form the dorsal stylar trace. This then fuses with elements of the placental network in the normal way to form the compound dorsal stylar bundle. The median strand of the antipetalous bundle divides to form the petal trace and the antipetalous stamen trace.

H. trigonocarpa has no lateral sepal traces. The wings are vascularized by a series of 3-4 lateral veins derived from all three strands of the antipetalous bundle. The lateral veins fuse along the margin of the wing to form a distinct intra-marginal vein. As in *H. gossei* the placental bundle consists of three distinct strands for its entire length. Two ovules per locule are differentiated but one aborts and is not vascularized.

H. acutangula (Fig. 3)

This species agrees in its floral vascular anatomy with the general pattern for the genus, except in having (in most cases) only one ovule differentiated per locule. Each sepal has two lateral sepal traces (rarely none), derived from the annulus.

H. aspera

This species deviates from the general plan only in that the placental bundle consists of four more or less distinct strands for its entire length. The abortive ovule in each locule is weakly vascularized. Two lateral sepal traces per sepal are derived from the annulus.

H. uncatipila

This pecies agrees in all respects with the general generic pattern. Two ovules per locule are differentiated, but only one is vascularized and functional. Two lateral sepal traces per sepal are derived from the annulus.

H. aculeolata

The floral vasculature of this species agrees with the general generic pattern except as modified by the reduction of the flower from a 4-merous to a 2-3-merous condition. There is also some disruption in the organization of the stylar trace. In one flower, one of the dorsal stylar bundles was derived from the antisepalous bundle instead of the antipetalous bundle, and in another flower, the dorsal stylar trace was formed entirely from the branches of the placental network. Two ovules per locule are differentiated, and both are vascularized. Two lateral sepal traces per sepal are derived from the annulus.

H. heterophylla (Fig. 1)

This species follows the general plan for the genus in its floral vasculature. Two ovules per locule are differentiated but the abortive one is not vascularized. Two lateral sepal traces per sepal are derived from the annulus.

H. myriocarpa (Fig. 3)

In this species the antisepalous, antipetalous and placental bundles depart more or less simultaneously from the pedicel bundle, although throughout its length the placental bundle consists of 4 distinct strands. The dorsal stylar trace from the placental network does not fuse completely with the branch from the antipetalous bundle, but both divide in the upper part of the style to form lateral stylar traces. Two ovules per locule are differentiated, one ovule aborting at an early stage of development. However, the abortive ovule may be faintly vascularized. Each sepal is supplied with two lateral sepal traces.

H. digyna

Both bimerous and trimerous flowers are found on the same plant in the species, with the resultant difference in number of antipetalous and antisepalous strands. Furthermore, in most of the flowers sectioned, all but one of the locules had aborted at an early stage, causing severe distortion to the vascular system. As herbicide damage is suspected, no importance is attached to the deformed flowers. In a normal bimerous flower it was found that the basic pattern was as for the genus, except in the placental system. Here four distinct traces run the length of the ovary, with fusion in pairs at the top between the two strands adjacent to each locule. A trace to the ovule (1 per locule) is then formed from the fusion strand, the remainder of the vascular material then dividing and passing around the locule wall to fuse with the dorsal stylar trace in the normal way.

H. brownii (Fig. 15)

The vascular pattern of the flower of this species deviates further from the general pattern for the genus than does that of any other species, probably as a result of the reduction in number of parts. The placental bundle is very small. At the top of the locules it forms two horizontal arms which travel along the septa before dividing dichotomously at the outer limits of the locules. The branches then turn slightly upwards and return around the inner side of the locules dividing again, in a more or less vertical plane. The lower branches of this second dichotomy continue around the inner wall of the locule to form the inner part of the circumlocular trace, while the upper branches travel obliquely up and around the base of the style to fuse with each other and with a branch of the antipetalous bundle to form the compound dorsal stylar trace in the normal way. At the second dichotomy, at either end of the circumlocular trace, a small vertical trace is also cut off which travels upwards unbranched as a lateral stylar trace. The lateral stylar traces of *H. brownii* thus differ from those of

H. odontocarpa, *Haloragodendron* and *Gliechrocaryon* where the traces originate from the first dichotomy and divide to pass into adjacent styles. *H. brownii* also has a very weakly developed annulus, which plays no part in the vascularization of the sepals. Instead the antipetalous bundle forms an outer branch just below the annulus (*H. brownii* differing in this respect from all other species of *Haloragis*) and this branch divides laterally just above the annulus to pass into opposite sepals as lateral sepal traces. The lateral sepal traces may divide again almost immediately, so that each sepal has two to four lateral sepal traces. The median sepal trace originates from the outer branch of the antisepalous bundle in the normal way. Two ovules per locule are differentiated, but one aborts at a very early stage and is not vascularized.

Haloragodendron

The vascular tissue enters the flower as a single solid bundle from the pedicel. At the base of the locules it divides radially to form eight bundles, four antisepalous bundles alternating with four antipetalous bundles. The remainder of the vascular tissue continues upwards and enters the columella as four more or less distinct placental bundles.

The antisepalous and antipetalous bundles travel upward through the outer ovary wall until just below the base of the sepals. At this point the antisepalous and antipetalous bundles divide to form an inner and an outer branch, the remainder of the vascular tissue fusing laterally to form an annulus which passes between the inner and outer branches. The outer branches of the antisepalous and antipetalous bundles pass into the sepals and petals as the median sepal trace and the petal trace respectively. The inner branch of the antisepalous bundle passes into the adjacent stamen as the antisepalous stamen trace, while the inner branch of the antipetalous bundle divides again, the outermost sub-branch forming the antipetalous stamen trace, the innermost sub-branch entering the stylar column as the dorsal stylar trace.

The placental bundle travels some distance up into the stylar column before dividing to form four more or less horizontal branches. These branches pass along the tops of the septa before branching dichotomously near the outer walls of the locules. The secondary branches divide again, one tertiary branch travelling horizontally around the inner wall of the locule and fusing with its adjacent equivalent branch, the other tertiary branch turning vertically upwards and entering the style as a lateral stylar trace. The ovule trace originates at the second dichotomy of the placental network. Thus in *Haloragodendron* no vascular tissue derived from the placental network passes around the outer wall of the locule, and the dorsal stylar trace consists only of the branch from the antipetalous bundle. The lateral sepal traces are derived from the annulus.

H. racemosum (Fig. 5, 16)

The major difference between the vascular pattern in this species and that of the generalized type, lies in slight modification to the placental network. Only one functional ovule per locule is differentiated and these are so arranged that they are vascularized by two opposite primary branches. These two branches pass along the top of the septa in the normal way, but at the first dichotomy, the secondary branches go directly to the ovules. At the same point a vertical bundle is cut off which divides immediately to form lateral stylar traces for adjacent styles. The other two primary branches pass along the septa to form lateral stylar traces only. Thus in this species there has been a total suppression of the circumlocular tertiary branches of the placental network. The number of lateral sepal traces varies in the same flower from four to six. Two ovules per locule are differentiated, one slightly higher than the other, but only the lower one develops to become vascularized. Only one of the four functional ovules in each flower develops to form a seed.

H. baeuerlenii (Fig. 6, 16)

This species agrees with the general generic description in all details. Only one ovule per locule is differentiated. No lateral sepal traces exist. The lateral stylar traces in this species are weak and only extend for a short distance into the styles.

H. monospermum

This species agrees well with the general pattern, differing only slightly in the derivation of the antipetalous bundles. At the base of the locules apparently only the placental bundle and the four anti-sepalous bundles are formed from the pedicel bundle. As the antisepalous bundles move outwards they cut off a lateral bundle on either side, and these fuse in adjacent pairs to form the antipetalous bundles. Two ovules per locule are differentiated, one slightly above the other. The upper one aborts at an early stage and is not vascularized, or has only a very faint trace. About four lateral sepal traces per sepal are cut off from the annulus.

H. glandulosum (Fig. 7)

The floral vasculature of this species agrees with the general generic pattern except that it lacks lateral stylar traces. Thus the placental supply is completely used up in supplying the ovules. Only one ovule per locule is differentiated, and no lateral sepal traces are formed from the annulus.

Glischrocaryon

Vascular tissue enters the flower as a single solid cylinder from the pedicel. Below the locules eight radiating bundles are formed, four antisepalous bundles alternating with four antipetalous bundles. The remainder of the vascular tissue passes on upward into the columella as a single placental bundle. After travelling up through the outer walls of the ovary, the antisepalous and antipetalous bundles divide just below the top of the locules, the antisepalous bundles forming an inner and an outer branch, and antipetalous bundles forming inner branches only. The remainder of the vascular tissue fuses laterally to form an annulus which passes between the branches of the antisepalous bundle and outside the antipetalous bundle branch. The outer branch of the antisepalous bundle enters the sepal as the median sepal trace while the inner branch forms the antisepalous stamen trace. The branch of the antipetalous bundle divides into three radially arranged strands, the outermost forming the petal trace, the central one entering the adjacent stamen as the antipetalous stamen trace, and the innermost passing into the stylar column as the dorsal stylar trace. Slightly above the level of the annulus, the placental bundle divides to form four more or less horizontal branches which travel outwards along the top of the septa. Near the outer walls of the locules the primary branches divide dichotomously, the secondary branches travelling around the outer wall of the locules to fuse with their adjacent equivalent branches, and with the dorsal stylar trace to form a compound dorsal stylar bundle. Lateral stylar traces are cut off either at the first dichotomy as a single bundle which divides as it travels upwards, with a branch passing into two adjacent styles, or else the lateral stylar traces are distinct from the beginning and originate independently from the secondary branches, just after these have separated. The lateral sepal traces arise from the annulus. As there is no inner circumlocular tertiary branch of the placental network, the ovular traces are cut off from the primary branches just before they fork.

G. flavescens (Fig. 15)

This species agrees closely with the general pattern of floral vascular anatomy. Two ovules per locule are differentiated but one aborts at an early stage and is not vascularized. The lateral stylar traces can be of either of the two types described in the general account. Four lateral sepal traces per sepal are formed.

G. aureum var. *angustifolium* (Fig. 8)

This taxon agrees well with the general pattern. Two ovules per locule are differentiated but one aborts at an early stage and is not vascularized. The lateral stylar traces originate as a single bundle at the dichotomy of the primary branches of the placental network and divide to pass into adjacent styles. Five or six lateral sepal traces per sepal are formed.

G. behrii

Except in its reduction from a 4-merous to a 2-merous plan, the floral vascular structure agrees exactly with that of the other species. Two ovules per locule are differentiated, but one aborts before being vascularized. Four to six lateral sepal traces are formed. The lateral stylar traces arise independently from the secondary branches of the placental network.

Gonocarpus

The vascular tissue enters the flower as a single solid bundle. Below the locules eight lateral bundles are cut off, four antisepalous bundles alternating with four antipetalous bundles, these bundles turning upward and travelling through the outer wall of the ovary. The remainder of the pedicel bundle continues upwards into the columella as the placental bundle.

At the top of the locules the single placental bundle divides into four more or less horizontal arms which travel across the top of the ovary along the septal ridges. At the outer edges of the locules, each arm divides dichotomously, and the secondary branches divide again, the two tertiary branches travelling around the inner and outer margins of the locules respectively, and fusing with their equivalent adjacent branches to form a complete circumlocular ring. Ovule traces originate at or near the second dichotomies and travel downwards into the 1 or 2 ovules per locule.

At, or slightly below, the level of the placental network, the antisepalous bundles form an inner and an outer branch while the antipetalous bundles form an inner branch only, the remainder of the antisepalous and antipetalous bundles fusing laterally to form an annulus which passes between the branches of the antisepalous bundles and outside the branch of the antipetalous bundle. The outer branch of the antisepalous bundle passes into the sepal as the median sepal trace, while the inner branch enters the adjacent stamen as the antisepalous stamen trace. Above the annulus, the single branch of the antipetalous bundle divides more or less simultaneously into 3 radially arranged traces. The outermost enters the petal as the petal trace, the central one enters the adjacent stamen as the antipetalous stamen trace, and the innermost forms the dorsal stylar trace, which fuses with the outermost tertiary branches of the placental network to form a compound dorsal stylar bundle. Lateral sepal traces are formed from the annulus. Lateral stylar traces are usually absent, but if present, they are very small and originate at the second dichotomy of the placental network, or from either the inner or outer tertiary branches.

G. micranthus

subsp. *micranthus*

The flower of this plant conforms to the general pattern, except that no inner tertiary branch of the placental network is formed, and the outer branch is very weakly developed. Two ovules per locule are differentiated, but one aborts at an early stage and is not vascularized. The trace for the other ovule departs directly from the primary branch of the network at the first dichotomy. No lateral sepal traces are formed.

subsp. *ramosissimus* (Fig. 9)

The pattern of the vasculature is as for subsp. *micranthus*, but only one ovule per locule is differentiated.

G. teucrioides (Orchard 1810) (Fig. 9)

As for the general scheme. The petal trace is differentiated slightly below the annulus instead of above. Only one ovule per locule is differentiated but a very small stub of vascular tissue exists in the position that would have been occupied by a second ovule. Two lateral sepal traces per sepal are formed. There are no lateral stylar traces.

G. teucrioides and *G.* sp. aff.*teucrioides* (Orchard 2347 & 2583)

These species conform with the general pattern except that the inner tertiary branches of the placental network are very weakly developed. Two ovules per locule are formed, but one aborts at an early stage. However, the abortive ovule retains a very weak vascular trace. No lateral stylar or sepal traces are formed.

G. elatus

The vascular pattern of this species agrees exactly with the general pattern. Two ovules per locule are differentiated, but one aborts and is unvascularized. There are two lateral sepal traces, but no lateral stylar traces.

G. pycnostachyus (Fig. 15)

This species exactly conforms to the vascular pattern for the genus. Two ovules per locule are differentiated, but one aborts and is not vascularized. Four lateral sepal traces per sepal are formed (none in Eichler 20096), but no lateral stylar traces.

G. tetragynus

Three different patterns have been found in plants of this species.

Type 1. (Orchard 2388, Eichler 20717). These flowers conform to the general pattern of floral vasculature in all respects. Only one ovule is differentiated per locule. No lateral sepal or lateral stylar traces are formed.

Type 2. (Orchard 1824). Flowers of this plant differ from the typical vascular plan only in the structure of the placental bundle. In the lower half of the ovary this bundle is the single solid cylinder normal for the genus. At about the midpoint of the ovary, four distinct lobes can be distinguished, and these spread until in the upper $\frac{1}{3}$-$\frac{1}{4}$ of the ovary, four distinct placental traces exist which diverge to form the primary branches of the placental network. Two ovules are differentiated in each locule but one aborts at an early stage. However, all eight ovules are vascularized, the traces to the abortive ovules being somewhat smaller. Two lateral sepal traces per sepal are formed, but no lateral stylar traces.

Type 3. (Orchard 2394). The flowers of this plant agree in their vascularization with the general pattern except that they have very indistinct lateral stylar traces originating at about the position of the second dichotomy of the placental network. Two ovules per locule are differentiated and vascularized, but one aborts at an eary stage. No lateral sepal traces are formed.

G. verrucosa

This species differs from the general pattern of vascularization only in possessing very faint lateral stylar traces arising from about the position of the second dichotomy of the placental network. Two ovules per locule are differentiated and vascularized, but one aborts at an early stage. No lateral sepal traces are formed.

G. nodulosus (Fig. 15)

The vascular system of this species is modifed because of the lack of the antipetalous whorl of stamens. This results in the inner branch of the antipetalous bundle having only two branches; the petal trace and the dorsal stylar trace. There is no residual vascular stub at the position of the missing stamen. The vascular pattern is otherwise as for the generalized generic scheme. Two ovules per locule are differentiated but one aborts at an early stage and is not vascularized. No lateral sepal traces are formed.

G. cordiger

This species agrees with the general description, except for its lack of an inner tertiary branch of the placental network. The ovule traces depart directly from the primary branches. Two ovules per locule are differentiated, but one aborts at an early stage and is not vascularized. Two lateral sepal traces per sepal are formed.

Laurembergia (Fig. 10, 11)

In the female flowers the vascular tissue enters from the pedicel as a single solid cylindrical bundle. Just below the locules eight radiating bundles are cut off, four antisepalous bundles alternating with four antipetalous bundles. The remaining vascular tissue continues upward into the columella as the placental bundle. The eight outer bundles travel upwards through the ovary wall to the top of the locules, where the antisepalous bundles pass into the sepals as the median sepal traces while the antipetalous bundles travel into the styles as the dorsal stylar traces. At about the same level the placental trace divides to form four horizontal branches opposite the sepals. These branches travel outwards to near the outer margin of the locules where they divide dichotomously. The secondary branches pass around the outside of the locules, fusing with their adjacent equivalent branch and with the dorsal stylar trace to form a compound dorsal stylar bundle. In the absence of the circumlocular tertiary branches of the placental network, the ovular traces come from the primary branches. Only one ovule per locule is differentiated. There are no annulus, lateral sepal traces or lateral stylar traces.

The male flowers have a similar vascular pattern to the female flowers up to the level of the top of the locules. At this point the antipetalous bundles pass into the petals as the petal traces, while the antisepalous bundles divide to form an inner and an outer branch. The outer branch passes into the sepals as the median sepal trace while the inner branch forms the stamen trace. At the same level the placental trace forms four branches which pass into the styles as dorsal stylar traces. There are no annulus, lateral sepal traces or lateral stylar traces.

L. tetrandra

The male flowers agree exactly with the general description. Four ovules (one per locule) are differentiated in the female flower, but only one develops sufficiently to be vascularized. The secondary branches of the placental network are only weakly developed; the dorsal stylar bundle is formed almost entirely from the dorsal stylar trace.

L. repens

This species agrees well with the general description. Occasionally the antisepalous bundle forms an inner branch which enters rudimentary staminodes. One ovule per locule is differentiated and vascularized. Only one ovule per flower forms a seed.

Proserpinaca

The vascular tissue enters the flower from the pedicel as a single solid cylindrical bundle. Below the locules six radiating bundles are cut off, three antisepalous bundles alternating with three "antipetalous" bundles. (Although there are no petals, the term antipetalous bundles is used here to describe the bundles homologous with the antipetalous bundles in the other genera, to facilitate comparison with these other genera). The remainder of vascular tissue continues into the columella as three distinct placental bundles, arranged opposite the septa.

After traversing the outer wall of the ovary, the antisepalous bundles divide to form an inner and an outer branch, while the antipetalous bundles form an inner branch only. The remaining tissue in the six bundles fuses laterally to form an annulus. The outer branch of the antisepalous bundle enters the sepal as the median sepal trace, while the inner branch forms the (antisepalous) stamen trace. The branch of the antipetalous bundle passes into the style as the dorsal stylar trace. Before doing so it may form very weak branches to the positions that would have been occupied by the petal and antipetalous stamen.

Towards the top of the locules the three placental traces gradually diverge, passing outwards through the septa until near the outer limit of the locules. They then divide dichotomously, each of the secondary branches dividing again almost immediately. The outermost tertiary branch travels around the outer wall of the locule to fuse with its adjacent equivalent branch and with the dorsal stylar trace to form a compound dorsal stylar bundle. The inner tertiary branch travels around the inner wall of the locule and fuses with its adjacent equivalent branch, to complete the circumlocular trace. The ovule traces are formed from the inner portion of this ring. Lateral sepal traces arise from the annulus.

P. pectinata

The flowers of this species match the general description well. No traces to the position of the petals or antipetalous stamens are formed, nor are there any lateral stylar traces. Only a single ovule is differentiated in each locule. Two lateral sepal traces per sepal are formed.

P. palustris var. *crebra* (Fig. 16)

This species conforms well with the general description. A very weak petal trace is formed from the antipetalous bundle just below the annulus, but the trace does not enter the rudimentary petal. A similar weak trace is formed just above the annulus, to supply the antipetalous stamen. At the second dichotomy of the placental network, a small vertical trace is cut off which passes into the style as a lateral stylar trace. Two ovules per locule are differentiated, but one aborts at an early stage and is not vascularized. Four lateral sepal traces to each sepal are formed from the annulus.

P. platycarpa

This species agrees well with the general description. The placental traces are fused in the lower half of the ovary, but separate at about the midpoint and thence behave in the normal manner. The rudimentary petal and antipetalous stamen are both vascularized by weak traces arising from the antipetalous bundle, just above the annulus. The outer tertiary branch of the placental network is only weakly developed and no lateral stylar traces are formed. Two ovules per locule are differentiated, but one aborts at an early stage and is not vascularized. Two lateral sepal traces per sepal are cut off from the annulus.

Myriophyllum

Male flowers. Vascular tissue enters the flower as a single solid bundle. Almost immediately it divides to form a ring of eight bundles, four antisepalous bundles alternating with four antipetalous bundles. The antisepalous bundles pass undivided into the antisepalous stamens (the sepals are not vascularized). The antipetalous bundles each divide tangentially, the outer branch passing into the petals, the inner branch into the antipetalous stamens.

Female flowers. The vascular tissue enters the flower from the pedicel as a single solid bundle which passes upwards through the central axis to the top of the locules where it splits into eight radially arranged bundles, two opposite each locule. The two branches pass around the radial walls of the locule and reunite on the outer wall, where the combined bundle forms a single ovular trace which passes downwards into the ovule, and an upper dorsal stylar trace.

The above descriptions are based on sections of male flowers of *M. propinquum* and *M. elatinoides*, and female flowers of *M. propinquum*.

Interpretation.

1. Carpel Theory.

Under this theory the pattern of floral vasculature in, for example, *Haloragis*, can be interpreted as follows:

The flower contains four carpels fused to each other and to the lower parts of the perianth and staminal whorls. The placental bundle is the result of fusion of the ventral or intramarginal veins of the carpels; their true nature is shown by their division in the placental network at the top of the ovary. The dorsal bundle of the carpel is fused to the petal trace and antipetalous stamen trace up to the level of the annulus, where it diverges and enters the style. The traces from the placental network that fuse with the dorsal bundle are probably lateral carpel bundles. Their absence in *Haloragodendron*, or their conversion into lateral stylar bundles, or even the presence of extra strands forming lateral stylar bundles, is then understandable as the suppression or multiplication of lateral carpel bundles. The ovules are supplied from the inner branch of the circumlocular ring in *Haloragis* and this branch is interpreted as the fusion of the two intramarginal traces of the carpel.

The annulus, a constant and major feature of the floral vasculature of most genera, is probably the result of fusion of lateral traces from the sepals and petals which formerly supplied individual lateral sepal traces. Its absence in *Laurembergia* and *Myriophyllum*, where the sepals are very small, is therefore not surprising.

On this interpretation of the vasculature, considerable fusion of adjacent vascular strands has taken place during the evolution of the flower. The stamen traces have fused in all cases to the adjacent sepal and petal traces, and the dorsal carpel traces have also fused to the petal traces. With few exceptions, the eight ventral carpel traces have fused to form a single bundle, and often the adjacent lateral carpel traces have also fused to the placental bundle. A further fusion between parts of the sepal and petal traces has also occurred in the formation of lateral sepal traces via the annulus.

The structure of the male flower in *Myriophyllum* arises by complete suppression of the carpels, and that of the female flower by suppression of the perianth, stamens and dorsal carpel bundles. In *Laurembergia* reduction has not proceeded quite so far; the dorsal carpel bundle is still present in the female flowers.

2. Gonophyll Theory.

The floral vasculature of *Haloragis* can be interpreted readily according to Melville's (1962, 1963) theory of flower structure.

In Melville's view, the placental network represents the fusion of four dichotomously branching fertile branch systems, borne on four sterile tegophylis now represented by the styles and dorsal stylar bundles. Each of the fertile branches bears a single (or rarely, two, with one abortive)ovule. The petals and sepals are each androphylls, with their attached anther. As in the carpel theory, the annulus must be interpreted as the fusion between branches from adjacent petal and sepal traces that formerly existed as distinct lateral sepal traces. The flower therefore consists of four gynophylls surrounded by eight androphylls.

The fusions necessary for this interpretation are mainly those of the four fertile female branches, and the further fusion between the gyno-tegophylls and the (petal) androphylls.

No difficulties exist in extending this interpretation to the flowers of *Gonocarpus*, *Glischrocaryon*, *Haloragodendron* and *Laurembergia*. In *Myriophyllum* it is necessary to propose the suppression of the dorsal tegophyll bundle in the gynophylls of the female flower, and the (sepal) androphylls in the male flower.

<u>Summary of variation in Haloragaceae.</u>

The pattern of floral vasculature can be equally well explained by either the Carpel or Gonophyll theories, and Haloragaceae provides no new evidence that can be used to support or refute either theory. This evidence will probably have to come from more primitive families.

The floral vasculature of *Haloragis* and *Gonocarpus* is practically identical and provides very little new evidence that can be used to separate the genera. The only difference of note is the weaker development of the annulus in *Gonocarpus*.

In *Haloragodendron* the annulus is more strongly developed than in any other genus. This genus also differs from *Haloragis* and *Gonocarpus* in that the dorsal stylar trace receives no contribution from the placental network; the branches normally involved either form lateral stylar traces or are absent. These differences provide additional evidence supporting the removal of *Haloragodendron* from *Haloragis*.

Glischrocaryon agrees closely in the pattern of its floral vasculature with that in *Haloragis* and *Gonocarpus*. The main differences are in the failure of the inner branch of the circumlocular ring to develop, and in the formation of lateral stylar traces from the first or second dichotomies of the placental network. The lateral stylar traces are additional to the branches of the network which fuse with the dorsal stylar trace.

Proserpinaca agrees with *Haloragis* and *Gonocarpus* in its floral vascular pattern. *Laurembergia* has a floral vasculature which reflects the reduction in size and complexity of its flowers. The female flowers are almost identical to the bisexual flowers of *Glischrocaryon*, but with the petal and stamen traces absent. The male flowers have a vascular pattern agreeing with that in the other genera, but with the placental network and antipetalous stamen traces absent.

In *Myriophyllum*, probably partly because of its reduced flowers and partly because of its aquatic habitat, there is a further reduction in floral vasculature. The male flowers are similar to those in *Laurembergia*, but the female flowers have completely lost the peripheral ring of bundles, and the placental network has been considerably reduced. The pattern of vascularization is, however, still basically similar to that in the other genera.

The pattern of floral vasculature is thus useful in providing extra evidence for generic delimitation, although the overall pattern for the family is similar, and the differences between genera are, on the whole, small. While differences exist between species within a genus, they are not sufficiently constant for taxonomic purposes.

A survey has also been made of the floral vascular patterns of families previously suggested as possibly or probably closely related to Haloragaceae. It was hoped that the floral vasculature of these families might provide additional evidence for or against a close relationship. The results of this survey, based partly on new investigations, partly on literature reports, are discussed below.

Gunneraceae (Fig. 10, 16)

Gunnera macrophylla. The single solid vascular bundle entering the base of the flower divides immediately to form four equally spaced strands which travel upwards through the wall of the ovary to the top of the locule. At this level, one pair of diametrically opposed bundles (the "antipetalous" bundles), each cut off an inner trace. These two traces fuse and pass downward into the single ovule as the ovular trace. The remainder of the two "antipetalous" bundles pass upwards into the stamens. One of the two antisepalous bundles cuts off an inner strand which passes more or less horizontally into the axis of the flower, just above the ovular traces, before turning upwards and dividing to pass into the base of the styles. The remainder of the antisepalous bundles enter the sepals as median sepal traces. In the female flowers, the pattern is identical with the exception that the antipetalous bundles are completely used up to form the ovular trace. There is no vascular stub in the position normally occupied by the stamens.

Gunnera manicata. Described by Saunders (1939). This is apparently the only other member of the family to have been investigated. Saunders' species differed considerably from *G. macrophylla*. The branch from the antisepalous bundle is reported to enter the ovule, the styles being unvascularized. There was no mention of the branches from the "antipetalous" bundles, which in *G. macrophylla* form the ovular traces. In the female flowers vascular stubs are reported, going to the positions of the missing stamens. Saunders describes petal traces derived from the antipetalous bundle in *G. petaloidea*.

The floral vasculature of *Gunnera* is so reduced as to be useless for comparison with Haloragaceae.

Trapaceae (Fig. 13)

Trapa bicornis. The vascular tissue enters the base of the ovary from the pedicel as a solid ring which soon splits into 8 separate strands in the ovary wall. The ovary is more or less square in section with a diagonal septum. The antisepalous strands at the ends of the septum each cut off an inner trace part of which enters the septum as placental traces, the remainder forming an inner antisepalous trace. The outer antisepalous trace soon diverges and passes into the sepal. The inner antisepalous traces pass into the two adjacent stamens as staminal traces. The remaining six original bundles link up to form a more or less complete annulus from which the petal traces and remaining two sepal (spine) traces and staminal traces diverge. The remaining annulus tissue passes upwards into the style as a ring of about 16 traces. The placental bundles fuse near the top of the ovary and send a branch into each ovule.

Trapa, in its possession of an outer annulus formed from the petal and sepal traces, resembles both Haloragaceae and Onagraceae, among others. In its placental supply *Trapa* differs considerably from Haloragaceae, and agrees closely with the pattern on Onagraceae. Thus, in their floral vasculature, Trapaceae are more closely allied to Onagraceae than to Haloragaceae.

Onagraceae

The floral vasculature of this family was studied extensively by Bonner (1948) and Baehni & Bonner (1948, 1949). Their observations were confirmed by Eyde (1967) and by an investigation of *Fuchsia* in the present study. The vascular pattern is remarkably constant, in its major features, throughout the family and can be generalized as follows:

The vascular supply enters the flower from the pedicel as a single bundle which divides immediately to form eight peripheral strands, four opposite the sepals, four opposite the petals. The antisepalous strands are usually ± double, and as these travel upwards through the ovary wall, the inner strand sends traces through the septa to the ovules. At the top of the locules the antipetalous strands each cut off an inner trace, and these enter the style. At the point of insertion of the petals, the antisepalous and antipetalous strands cut off stamen traces on their adaxial faces, simultaneously forming lateral branches which link up to form an annulus. The remainder of the antisepalous strand becomes the median sepal trace, while the antipetalous strand divides tangentially, the innermost trace entering the petal, the outermost becoming lateral sepal traces. The glandular disc which surmounts the ovary in many species is vascularized by small traces from the eight peripheral strands.

The placentation of the ovules, via the septa from a peripheral bundle, is uniform throughout the family, even in those genera such as *Circaea* where there is only one ovule per locule. Onagraceae thus differ considerably from Haloragaceae in this respect, and also in the derivation of at least part of the lateral sepal supply from the antipetalous strand. The two families agree, however, in their possession of an annulus formed from the antipetalous and antisepalous strands.

Lythraceae

Bonner (1948) examined the floral vasculature of *Lythrum*, and material of *Heimia* and *Pemphis* was available in the present study. These genera all agree in their major vascular pattern and are described together below. Lythraceae differ from the other families under consideration in their superior ovary, but are included because of their generally accepted relationship to Onagraceae, and hence to Haloragaceae.

In Lythraceae the vascular tissue enters the flower as a ring of up to about 12 strands, antisepalous ones alternating with antipetalous ones. The antipetalous strands cut off inner traces at the base of the ovary and these travel upwards through the wall of the ovary into the style. At about the same level the antisepalous strands give rise to a large number of ovular traces which travel upwards through the central placenta to the ovules. Slightly above this level, all of the peripheral strands form stamen traces, before passing upwards through the floral tube into the sepals and petals. However, just before entering these organs, the antisepalous and antipetalous strands cut off weak lateral branches which link up to form an annulus. No lateral sepal traces are formed.

Bonner (1948) considered that the basic floral vascular pattern in Lythraceae was the same as that in Onagraceae, after allowance was made for the position of the ovary, and this judgment seems justified. The placentation pattern in Lythraceae does not support the suggestion of close affinity between that family and Haloragaceae, although both have the annulus structure formed by the peripheral strands.

Araliaceae

Material of *Tieghemopanax* and *Boerlagiodendron* was available during the present study, but the latter genus, because of its large flowers, has an extremely complicated vasculature and was discarded for comparative purposes. The pattern of vascular traces in *Tieghemopanax* is described below.

The vascular tissue enters the flower from the pedicel as a ring of 10 bundles. Just below the locules the inner ring of original bundles cut off eight outer bundles and in the resulting redistribution the flower has a peripheral ring of 10 bundles and 2 transversely arranged placental bundles in the septum between the 2 locules. All 12 bundles pass upwards undivided until near the top of the locules where the placental bundles fuse with each other and with traces from the 8 adjacent peripheral bundles, the resulting single bundle then dividing in two so that a branch lies alongside each locule. Each of these branches then sends a trace to the single ovule in the adjacent locule, before dividing again and sending branches obliquely around the top of the locule. These ultimate branches link up to form dorsal stylar traces. The remaining tissue in the peripheral bundles passes upwards into the petals and stamens.

The pattern outlined above agrees well with that described by Philipson (1967) for *Hedera* and *Pseudopanax*, differing mainly in the failure of the dorsal bundle of the carpel in *Tieghemopanax* to link up with the dorsal stylar trace formed from the placental (= ventral) bundles. Philipson's account of *Hedera* agrees with that of Singh (1954), although different species were involved.

The dividing and reuniting of the placental bundles in the above genera very closely resembles that found in most Haloragaceae, but the other distinctive feature of the latter family, the annulus formed by the petal and sepal traces, is absent.

Apiaceae

The vasculature of the flowers (and fruits) of this family has been investigated by Jackson (1933) and Tseng (1967). Because the flowers are so small, the vascular arrangement is fairly simple, but is remarkably constant throughout the family.

The general pattern is for the vascular tissue to enter the flower from the pedicel and form a ring of about five strands which divide at the base of the ovary to form a peripheral ring of ten strands and a placental strand. The placental strand is made up of four traces which are fused to varying degrees in the different genera. At the top of the ovary all four placental strands are usually distinct. The two strands opposite each locule then fuse with each other and with branches from the two adjacent "lateral strands" (from among the peripheral bundles), and the fusion bundle sends a trace down into the ovule. The remaining tissue divides and travels around the locule to where it fuses with a branch from the dorsal bundle to form the stylar trace. The peripheral bundles pass alternately into the petals and stamens.

The splitting and fusion of the placental bundles in Apiaceae bears some resemblance to the formation of the placental network in Haloragaceae, although the pattern in Apiaceae is less complicated. The contribution to the placental supply by the peripheral bundles and the lack of an outer annulus in Apiaceae are further points of dissimilarity to Haloragaceae.

Rhizophoraceae (Fig. 14)

The two species described below are apparently the first members of this family to be investigated from the point of view of floral vascular anatomy.

Rhizophora mucronata. Vascular tissue enters the flower from the pedicel as a ring of 35-40 discrete bundles. At the base of the locules these bundles arrange themselves into an inner and an outer ring, and towards the top of the locules the inner ring of bundles fuse laterally to form a "girdle" as in Combretaceae. This girdle gives rise to a placental strand at either end of the septum, and these strands divide longitudinally before joining together in the centre of the septum. The fused placental bundle then cuts off a trace to each of the four pendulous ovules. The remainder of the "girdle" passes upwards into the style as a ring of 10-15 traces, which may then divide further.

Of the outer ring of bundles, eight become larger by fusion with adjacent traces, forming antisepalous and antipetalous bundles, with some small intermediate traces remaining distinct. The antisepalous bundles divide tangentially to form an antisepalous stamen trace on the inside and a median sepal trace on the outside. The antipetalous bundles divide tangentially to form (from the inside moving outwards), an antipetalous stamen trace, a petal trace, and a bundle which divides further before passing into the two adjacent sepals as lateral sepal traces. Although the antisepalous and antipetalous bundles are described above as dividing, the fusion between the traces is usually minimal or even ± absent in many cases, and the stamen, petal and median sepal traces are effectively distinct from the base of the flower. The small intermediate traces that remained between the antisepalous and antipetalous bundles become lateral sepal traces. It is interesting to note that the petal trace appears to be double at the base of the petal, although it fuses higher up before giving rise to lateral traces.

Bruguiera exaristata. Vascular tissue enters the base of the flower as a ring of about 18-20 discrete bundles, which by radial divisions form a ring of 9 antipetalous bundles alternating with groups of three smaller bundles. Of these three, the centre one becomes the antisepalous bundle. All of the traces move upwards in the ovary wall, until near the top of the locule the antipetalous and antisepalous bundles divide tangentially, and the inner branches so cut off fuse laterally to form a "girdle" around the locule. From the girdle three strands travel down the wall of the ovary to the base of the locule, where they fuse to form a hollow cylinder of placental tissue which ascends the placental column. At the point of attachment of the ovules, the placental trace divides into six horizontal branches, one of which enters each ovule. The remaining vascular tissue in the girdle travels upwards into the base of the style as about eight traces all except 3 of which soon peter out.

The antisepalous and antipetalous bundles divide tangentially as they enter the floral tube, and the inner branches form the stamen traces. The outer branch of the antisepalous bundle becomes the median sepal trace, but the outer branch of the antipetalous bundle divides tangentially again. The inner branch of this division forms the petal trace, while the outer branch divides twice more, sending two traces into each of the adjacent sepals as lateral sepal traces.

The two distinctive features of the floral vasculature of Haloragaceae are absent in Rhizophoraceae, except in so far as the girdle may be homologous with the placental network. In addition, the contribution which the petal trace makes to the adjacent sepals in both *Rhizophora* and *Bruguiera* is unparallelled in Haloragaceae. A relationship between these two families is therefore not supported by floral vasculature.

Combretaceae

The floral vascular anatomy of members of this family has been studied recently by Tiagi (1969) and Venkateswarlu & Prakash Rao (1970). The former investigation involved seven species, five of which were also included among the twenty of the latter work. One species, *Lumnitzera littorea,* was examined in the present study. The results of all three investigations agree in showing an extremely uniform floral vascular pattern throughout the family.

With minor variations the vascular pattern is as follows. Four or five (in 4-merous or 5-merous flowers respectively) main vascular strands enter the base of the flower as antisepalous strands and travel upwards through the wall of the ovary to near the top of the single locule. Here they each cut off an inner trace, and these traces fuse laterally to form a ring. The "carpellary ring" (Tiagi, 1969) or "girdle" (Venkateswarlu & Prakash Rao, 1970), gives rise to a single trace to each ovule from its lower surface and (usually) an equal number of stylar traces from its upper surface. The remainder of the antisepalous strands pass upwards into the floral tube, where the petal strands are formed by fusion of lateral branches from adjacent antisepalous strands. At about the same level, the antisepalous stamen traces and antipetalous stamen traces arise on the inner side of the antisepalous and petal traces respectively. The remaining part of the antisepalous and petal bundles travel upwards into the sepals and petals, where each may branch further to form lateral traces within their respective organs.

There is no annulus as in Haloragaceae, but the "girdle" of Combretaceae may be homologous with the placental network of Haloragaceae modified because of the absence of a central placental strand.

Cornaceae (Fig. 7)

Cornus alba. A single solid bundle enters the flower from the pedicel and divides to form eight equally spaced bundles. One diametrically opposed pair opposite the septum immediately cut off small inner bundles (the placental bundles) which travel upwards through the ovary. All bundles in the ovary wall, with the exception of the placental traces, are more or less double at irregular intervals. At the top of the ovary the placental bundles send a trace inwards along the top of the septum, each trace dividing dichotomously. Each branch of the placental trace fuses with the opposite branch before entering the ovule. The remainder of the placental bundles travel upwards into the style. Of the outer ring of bundles, four enter the petals where they divide to form five to seven major petal traces, while the other four bundles, after cutting off very small traces to the vestigial sepals, enter the stamens. The two stamen bundles alternating with the stylar traces also form small traces to the style, which thus has four traces. The disc is unvascularized.

The arrangement outlined above agrees with that found in other species of *Cornus* by Horne (1914), and Wilkinson (1941) and in *Thelycrania* by Philipson (1967). Both Philipson and Eyde (1967) examined the affinities of Cornaceae and satellite genera on the basis of, among other things, floral vascular anatomy. Eyde rejected a close affinity between Cornaceae s. str. and the families Caprifoliaceae, Hydrangeaceae, Styracaceae, Symplocaceae, Escalloniaceae, Diapensiaceae, Aquifoliaceae and Araliaceae, whereas Philipson, although mainly considering the position of *Griselinia*, appeared to favour a fairly close relationship between most of the above families.

In comparing Cornaceae with Haloragaceae, a comparison not made by Eyde or Philipson, it appears that the branching placental supply in e.g.*Cornus* noted particularly by Wilkinson (1944) bears some resemblance to the placental network in Haloragaceae. The major difference is that the placental bundle in Haloragaceae is axial whereas in *Cornus* the bundles are displaced to the ends of the septum. Cornaceae, however, lack the annulus formed in Haloragaceae by fusion of the sepal and petal bundles. This is not surprising as the main function of this structure appears to be the formation of lateral sepal traces, which are not required in the minute sepals common in Cornaceae.

Cornus and its allies are basically northern Hemisphere plants whereas Haloragaceae is basically southern Hemisphere in distribution. It, therefore, seemed logical to search among southern Hemisphere Cornaceae for possible Haloragacean relationships. In this respect the anomalous genera *Griselinia* and *Corokia* which are often placed, at least tentatively, in Cornaceae are worth consideration.

Griselinia

Species of this genus have been studied by Horne (1914) and Philipson (1967). Although these accounts differ in some details (Horne describes the ovular trace as being formed by fusion of three strands from the "girdle", while Philipson describes it as always single), the basic pattern is the same in both accounts.

The vascular supply enters the flower from the pedicel as a ring of 10 bundles which travel upwards through the ovary wall to about the top of the locule. Here they each cut off an inner branch and these fuse laterally to form a "girdle". From the "girdle" one (or three?) traces descend into the single ovule, and three traces pass upwards into the styles. The remaining vascular tissue in the outer ring of bundles enters the perianth and stamens when these are present.

Both Horne and Philipson saw similarities between *Griselinia* and *Melanophora* (Cornaceae) but differed in their placement of the genus. Horne considered that *Griselinia* had floral vasculature compatible with inclusion in Cornaceae, whereas Philipson, in considering other anatomical features, thought that the genus occupied an isolated position between Escalloniaceae and Cornaceae-Araliaceae. Its possible similarity to Haloragaceae was not considered by either author.

The two outstanding features of floral vasculature in Haloragaceae, the outer annulus and the placental network, are not found in *Griselinia*, except in so far as the "girdle" can be considered homologous with the placental network. Even if this is correct, the extreme reduction of the ovary and perianth, and the well-developed tendency towards unisexual flowers in *Griselinia* make this genus much advanced over the more primitive genera of Haloragaceae. The possibility of *Griselinia* being ancestral to Haloragaceae is therefore unlikely, but it may still be related.

Corokia buddleoides (Fig. 12)

The vascular tissue of the pedicel consists of a ring of about 10 strands. At the base of the ovary they are rearranged to form a ring of 10 in the ovary wall (5 antisepalous strands alternating with 5 antipetalous strands) with 2 placental strands in a plane at right angles to the two locules. All 12 strands pass upward through the ovary unbranched until near the level of attachment of the ovules (one, pendulous, per locule). Here each of the outer ring strands cuts off a trace on the innermost side, and these fuse with each other and with the placental strands to form a circumlocular annulus. Two branches from this annulus travel across the top of the septum, fork and send a branch of each into each ovule. The remainder of the annulus passes upwards into the style as an irregular ring of traces, all but two of which peter out in the "disc" region. The other two, in the plane of the locules, form the stylar traces. The remaining part of the outer ring strands do not form an annulus as in Haloragaceae, but instead the antipetalous strands pass undivided into the petals, where they subsequently cut off two lateral petal traces, while the antisepalous strands cut off an inner trace to the stamens before becoming undivided median sepal traces. Occasional tetramerous flowers occur, and the vasculature of these is identical with the 5-merous flowers until the point of departure of sepal, petal and stamen traces, where the extra strand is divided up between adjacent organs.

This account, prepared from serial sections during the present study, agrees well with the accounts of Eyde (1966) and Horne (1914) except that the axial bundle observed by these authors was not present in the example described above. However, Eyde (p.840) mentions that in rare cases the axial strand is absent in *C. cotoneaster*. Philipson's (1967) account of the vasculature of *C. cotoneaster* differs considerably from all the above accounts, perhaps because he considered only unilocular flowers. Consequently, his examples lacked the axial bundle and also one of the placental bundles. Eyde found that the stylar supply was derived directly from two of the peripheral bundles without any fusion with the placental supply, but Philipson shows (fig. 10) the stylar supply fused with the placental ring. Philipson also shows the ovule trace coming from the ventral (or placental) bundle below the attachment of this bundle to the placental annulus. In Eyde's and in the present study the ovular trace(s) come from this annulus.

Philipson interpreted the vascular pattern of *Corokia* as indicating an affinity with Escalloniaceae. Eyde interpreted his findings as indicating an affinity with *Argophyllum* (Saxifragaeae s.l.). Horne retained *Corokia* in Cornaceae, but as an "outlying form to *Cornus* that ... had an independent origin". The present study shows that the derivation of the placental supply has more similarity to that in *Cornus* than described in previous discussions, and a relationship between the two cannot be discounted on this basis.

Similarly, the placental supply in *Corokia* bears a close resemblance to that in Haloragaceae although *Corokia* lacks the other distinctive feature (the outer annulus) of Haloragaceae. It seems appropriate to mention here that one of the other distinctive features of *Corokia*, the presence of abundant tannin in the flower, is also commonly found in Haloragaceae. The resemblance on other characters (trichomes, fruits and corolline ligules) is, however, not maintained. The evidence from the vascular anatomy and the tanniniferous cells of the flowers suggest that a possible affinity between *Corokia* and Haloragaceae is not ruled out, although its likelihood is reduced by other evidence.

Callitrichaceae (Fig. 11)

Callitriche stagnalis.

The male flower consists of a single stamen in the axil of an upper leaf. It is vascularized by a single unbranched strand which arises from the solid axial stele. The female flower has a single bundle passing unbranched from the pedicel through the axis of the flower. At the top of the locules it cuts off two lateral traces before dividing into four ovular traces, each of which serves a single ovule. Above the ovules, the two lateral traces converge somewhat before passing into the styles.

Callitriche sonderi

As for *C. stagnalis*

Apparently the only other report on the floral vascular anatomy of this family is that of Saunders (1939). No species were mentioned, but the description is basically the same as the present one. The single placental bundle in the lower part of the flower was not noted by Saunders, who described the four traces as traversing the whole flower. She also did not recognize the origin of the stylar traces in the placental bundle.

The extreme reduction of the flowers of this family is reflected in the reduction in floral vasculature. The vascular pattern is too simplified to be of use in comparison with Haloragaceae.

Aquifoliaceae

Apparently the only study of floral vasculature in this family is that of Copeland (1963). Unfortunately the species investigated bore only unisexual flowers with an extremely generalized and simplified vascular pattern which is of little use for comparison with Haloragaceae.

Celastraceae, Theligonaceae, Datiscaceae, Hippuridaceae, Ceratophyllaceae.

No accounts of the floral vasculature of members of these families could be located, and no material was available for investigation.

In summary, the two outstanding features of the floral vasculature of Haloragaceae are the placental network at the top of the ovary and the annulus formed by the peripheral bundles. The relationships of other groups to Haloragaceae can be assessed, in part, by the extent to which these other groups possess or lack a placental network and annulus. On this basis, the postulated relationship between Haloragaceae and Lythraceae, Onagraceae, Trapaceae, Rhizophoraceae, Combretaceae and *Griselina* is not supported, whereas the relationship between Haloragaceae and Araliaceae, Apiaceae and Cornaceae (including *Corokia*) is supported by this evidence. The floral vasculature of Gunneraceae and Callitrichaceae is too simplified to be of use in discussions of relationships.

TABLE 1.

List of vouchers for floral vascular anatomy.

Unless stated otherwise, only one flower of each collection was sectioned. An asterisk (*) signifies that material from herbarium sheets was used; all other material was preserved in F.A.A.

Name	Collection	Voucher
Haloragis		
H. exalata		
var. *exalata*	Orchard 2011, Moleside Ck.,Victoria	AD
H. erecta		
ssp. *erecta*	Orchard 2417, Cultivated, Adelaide Bot.Gdn.	AD
	Sneddon s.n., Nth.Id., New Zealand	WELT
H. eichleri	Eichler 20806, Robe, S.A.	AD
H. odontocarpa		
f. *pterocarpa*	Henderson s.n., 50 km N. Barmera, S.A.	AD
	Orchard 1859, 3 km S. Waikerie, S.A.	AD
H. gossei	Nelson 1738, 1½ mls. N. Connors Well, N.T.	AD
H. trigonocarpa	Orchard 1263, 31 km N. Widgiemooltha, W.A.	AD
H. acutangula		
f. *acutangula*	Orchard 1871, 18 km E. Murray Bridge, S.A.	AD
	Orchard 2821, 5 km S.W. Edithburgh, S.A.	AD
	Orchard 2824, 2 km W. Wattle Point, S.A.	AD
	Orchard 2852, 3 km N.E. Stenhouse Bay, S.A.	AD
	Orchard 2860, Brown's Beach, S.A.	AD
	Orchard 2867, Hardwicke Bay, S.A.	AD

Name	Collection	Voucher
H. acutangula		
f. *tetraptera*	Orchard 1853, 16 km W. Waikerie, S.A.	AD
	Orchard 1873, 15 km S. Waikerie, S.A.	AD
	Orchard 2812, 4 km W. Pine Point, S.A.	AD
H. aspera	Orchard 2587, 10 km S.E. Curramulka, S.A.	AD
H. uncatipila	Orchard 900, 24 km N. Tennant Ck. N.T.	AD
H. aculeolata	Orchard 1725, Loc. 1160, Shire of Oldfield, W.A.	AD
H. heterophylla	Orchard 2636, Wulgulmerang, Vict.	AD
H. myriocarpa	Beauglehole 33405, Kentbruck Heath, Vict.	BEAUG
H. digyna	Copley 2978, 16 mls. E. Yeelanna, S.A. (8 flowers)	AD
H. brownii	Orchard 2018, Long Swamp, Vict.	AD
Haloragodendron		
H. baeuerlenii	Beauglehole 33376, Suggan Buggan, Vict.	AD
	Orchard 2647, Mt. Wheeler, Vict.	AD
	Orchard 2785, Ballantyne Hills, Vict.	AD
H. racemosum	Orchard 1285, Boyatup Hill, W.A. (4 flowers)	AD
H. monospermum	Orchard 2389, Corang River, N.S.W.	AD
	* Wrigley CBG023487, Corang River, N.S.W.	CBG
H. glandulosum	Eichler 21106, Kundip, W.A.	AD
Glischrocaryon		
G. behrii	Orchard 1805, 3½ miles S. Monarto South, S.A. (4 flowers)	AD
	Orchard 2586, 10 km S.E. Minlaton, S.A.	AD

Name	Collection	Voucher
G. aureum var.		
angustifolium	Orchard 1703, Location 1163, Shire of	
	Oldfield, W.A. (3 flowers)	AD
G. flavescens	Orchard 1227, Location 1105, Shire of	
	Esperance, W.A.	AD
	Orchard 1799, 26 m. N. of Minnipa, S.A.	AD
Gonocarpus		
G. micranthus		
ssp. *micranthus*	Orchard 1905, Glenelg River, Vict. (5 flowers)	AD
	Sneddon s.n., North Isl. N.Z.	WELT
ssp. *ramosissimus*	Orchard 2383, Evans Head, N.S.W.	AD
G. teucrioides	Orchard 1810, 10 km S.E. Finnis, S.A.	AD
	Orchard 2583, 6 km N.W. Stansbury, S.A.	AD
G. sp. (affin.		
teucrioides)	Orchard 2347, Springbrook, Qld.	AD
G. elatus	Orchard 1823, 1 km from Cherryville S.A.	AD
	Orchard 2780, Bald Hill, Vict.	AD
G. pycnostachyus	Orchard 1079, 12 km S.E. Condingup Peak W.A.	AD
	Eichler 20096, Hig Is., Duke of Orleans Bay	
	W.A.	AD
G. tetragynus	Orchard 1824, Montacute road, S.A.	AD
	Orchard 2388, 6½ km S. Coff's Harbour, N.S.W.	AD
	Orchard 2394, River Corang, N.S.W.	AD
	Eichler 20717, Atherton State Forest	
	Res. 194, Qld.	AD

Name	Collection	Voucher
G. verrucosus	Orchard 2385, 5 km S. Yamba, N.S.W.	AD
G. nodulosus	Orchard 1080, 12 km S.E. Condingup Peak, W.A. (3 flowers)	AD
G. cordiger	* Pritzel 145, Darling Range, W.A. (2 flowers)	AD
G. procumbens	Sneddon s.n., North Island, N.Z.	WELT
<u>*Proserpinaca*</u>		
P. platycarpa	* Killip 41122, Florida Keys, U.S.A.	US
P. palustris var. *crebra*	* Cook & Griggs 429, Guatemala	US
P. pectinata	* Chickering US1383839, Manchester, New Jersey, U.S.A.	US
<u>*Laurembergia*</u>		
L. repens ♀	* Hildebrandt 3647, Madagascar (3 flowers)	US
L. tetranda ♀	* Hatschbach 5133, Parana, Brazil	US
♂	* Hatschbach 5133, Parana, Brazil	US
<u>Trapaceae</u>		
Trapa bicornis	Tun-Yee, Mandalay, Burma	AD
<u>Cornaceae</u>		
Cornus alba	Orchard 2589, Cultivated, Adelaide	AD
Corokia buddleoides	Sampson s.n., Wellington, New Zealand (2 flowers)	WELT
<u>Rhizophoraceae</u>		
Rhizophora mucronata	Darbyshire 620, Kanosia, Papua	CANB
Bruguiera exaristata	Schodde 2735, Ding Hou, Papua	CANB

Name	Collection	Voucher
Combretaceae		
Lumnitzera		
littorea	Hoogland 4377, Papua	CANB
Araliaceae		
Tieghemopanax		
sambucifolius	Schodde 3244, Barrington Tops, N.S.W. (2 flowers)	CANB
Gunneraceae		
Gunnera		
macrophylla ♀	Hoogland 9551, Terr. of New Guinea (2 flowers)	CANB
" " ♂	Hoogland 9551, Terr. of New Guinea (2 flowers)	CANB
Callitrichaceae		
Callitriche		
stagnalis	Ising s.n., Mt.Lofty Ra., S.A. (4 flowers)	AD
	Orchard 2590, Waite Institute, S.A. (2 flowers)	AD
Callitriche		
sonderi	Eichler 13798, 6.5 km W. Berri, S.A. (2 flowers)	AD

VI. WOOD ANATOMY.

This aspect of the Haloragaceae has been almost completely neglected in the past, probably because the family has often been described as herbaceous. The structure of the xylem is dealt with in five lines by Metcalf & Chalk (1950).

To determine whether the secondary xylem of these plants could provide characters useful in phylogenetic considerations, a pilot survey of some aspects of wood anatomy was carried out during the present study. This survey included wood from the stems and roots of a number of species from the four main woody genera, *Haloragis*, *Gonocarpus*, *Haloragodendron* and *Glischrocaryon*, but is far from being complete. The species chosen were limited by availability, but an effort was made to cover the range of variation in each genus. The wood was either collected fresh and stored in F.A.A. until required, or taken from dried collections and soaked for several days in F.A.A. before use. The material was transferred to 70% ethanol 24 hours before sectioning on a sledge microtome at 10-30μ. Transverse, radial longitudinal and tangential longitudinal sections were cut from each sample, stained in safranin - fast green and mounted in XAM. In general, the wood was found to be ring-porous, with scanty or no wood parenchyma, exclusively bordered pits and both uniseriate and multiseriate, homogeneous and heterogeneous rays. Because of apparent differences between genera in the structure of their wood rays, this was the aspect studied in most detail. It was found that in all cases the structure of the wood rays tended to be more primitive in the root than in the stem of the same plant, and that the outer parts of the stem or root had a more primitive ray type than the inner parts (judged on the criteria proposed by Kribs, 1935). These findings agree with the general principles described by Barghoorn (1941). Descriptions of the wood ray structure in the various genera follow.

Haloragis (Plates 1 - 3)

(1) Stem: In the inner parts the rays are usually all uniseriate and homogeneous, composed of vertically elongated cells 2-5(-10) times as high as long. This is the type omitted in Kribs's classification, but described by Barghoorn (1941). In the outer parts of the stem the rays are a mixture of uniseriate homogeneous and bi- or multi-seriate heterogeneous types (Kribs's Heterogeneous Type II B). Very few cells, even of the multiseriate rays are markedly radially elongated; most are ± isodiametric, with those of the uniseriate rays and at the margins of the multiseriate rays vertically elongated by up to five times their radial length.

(2) Root: The rays are a mixture of uniseriate homogeneous and multi-seriate heterogeneous types (Kribs's Heterogeneous Type I). The uniseriate rays are composed of vertically elongated cells about 2-3 times as high as their radial length, while the multiseriate rays have isodiametric or slightly radially elongated cells in the multi-seriate part, with a jacket and high uniseriate wings of cells similar to those of the uniseriate rays.

Haloragodendron (Plates 4 - 6)

(1) Stem: The rays are a mixture of homogeneous uniseriate and multiseriate types, composed entirely of vertically elongated cells 2-3 times as high as their radial length. This arrangement does not

fit into Kribs's classification, but as most of the multiseriate rays are only 2-3(-5) cells wide with very long uniseriate tails, it probably comes closest to the supplementary type described by Barghoorn (1941).

(2) Root: (Based on *H. monospermum* only.) The rays consist of a mixture of uniseriate homogeneous and multiseriate heterogeneous types (Kribs's Heterogeneous Type I). The uniseriate rays are relatively scarce and composed of vertically elongated cells 2-3 times as high as their radial length. The multiseriate rays are composed of radially elongated cells with a jacket and high uniseriate tails of cells similar to those of the uniseriate rays.

Glischrocaryon (Plates 7 - 9)

(1) Stem: There is very little secondary thickening in the stems of this genus. The rays are scarce and uniseriate, consisting of vertically elongated cells 2-3 times as high as their radial length. They thus comply with Barghoorn's supplementary type.

(2) Root: The rays are nearly all multiseriate, with rare uniseriates, and composed of radially elongated cells 2-3 times as long as high, with a jacket of isodiametric or slightly vertically elongated cells (Kribs's Heterogeneous Type II B or almost Homogeneous Type II). The multiseriate rays more or less lack uniseriate wings.

Gonocarpus (Plates 10 - 12)

(1) Stem: The rays are numerous to scanty, and all homogeneous unieriate, composed of vertically elongated cells 3-5 times as high as their radial length. This corresponds to Barghoorn's supplementary type.

(2) Root: The rays are usually scanty and all uni- or bi-seriate,

composed of isodiametric or vertically elongated cells, as in the stems.

Summary.

Based on the phylogenetic series proposed by Kribs (1935) and Barghoorn (1941), *Haloragis* has the most primitive wood ray structure of the four genera studied. In the stems of *Haloragodendron* the multiseriate rays are reduced in width compared with *Haloragis* and have greatly lengthened uniseriate tails. In the roots of *Haloragodendron* the uniseriates are almost eliminated and the multiseriates again have high tails. In *Glischrocaryon* and *Gonocarpus* the multiseriate rays have been entirely eliminated in the stems, but are retained in the roots (uniseriates are rare in the root of *Glischrocaryon*). These latter two genera would therefore be considered the most advanced in their wood ray structure. The frequency with which Barghoorn's supplementary type of rays (uniseriates only, with vertically elongated cells) occurs is interesting in view of his statement that this type is found mainly in shrubby or semi-shrubby plants in which secondary activity is being reduced.

As pointed out by Bailey (1957), in using features of wood anatomy for phylogenetic considerations, the most significant correlations are the negative ones: a taxon with primitive features cannot be derived directly from one with advanced features. Therefore if Haloragaceae s. str. are monophyletic (and this seems to be the case from other evidence), then they cannot be derived directly from any group which has a consistently more advanced wood ray structure than that of the most primitive genus of Haloragaceae, namely *Haloragis*.

A summary has been made from Metcalf & Chalk (1950) of information on wood ray structure of woody families previously considered to be related to Haloragaceae. This summary is given below. Unfortunately, it has not been possible to check this information against actual material.

Onagraceae.

The rays usually consist of a mixture of uniseriate and multi-seriate types composed of isodiametric or vertically elongated cells. The wood in this family is also noted for scanty parenchyma and inter-xylary phloem.

Lythraceae.

The rays are exclusively uniseriate or up to 2-3 cells wide, homogeneous (Kribs's Type III) or heterogeneous (Kribs's Types IIB & III). Wood parenchyma ranges from scanty to abundant, and intraxylary phloem is known to occur in many genera.

Rhizophoraceae.

Uniseriate rays are rare to absent in some genera, common in others and then often composed of vertically elongated cells. Multiseriate rays are common, composed of isodiametric or procumbent cells with a jacket of ± vertically elongated cells. Wood parenchyma is typically scanty.

Combretaceae.

The rays are either exclusively uniseriate or mixed with multi-seriate types, conforming to Kribs's Homogeneous Types I and III, or heterogeneous and composed largely of isodiametric or vertically elongated cells. Both inter- and intra-xylary phloem are common in the family, and wood parenchyma is typically abundant.

Celastraceae.

The rays are either exclusively or predominantly uniseriate, homogeneous with conspicuous intercellular spaces or else a mixture of uniseriate (often rare) and multiseriate heterogeneous types conforming to Kribs's Types I, IIA and III. Wood parenchyma is usually absent or sparse.

Aquifoliaceae.

The rays consist of uniseriate types formed of high upright cells, mixed with heterogeneous multiseriate kinds, conforming to Kribs's Heterogeneous Type I. Wood parenchyma is ± abundant.

Cornaceae.

The rays conform to Kribs's Heterogeneous Type I. The uniseriate rays are composed entirely of upright cells, and the multiseriate rays have a jacket of isodiametric or upright cells. Parenchyma is common to scanty.

Araliaceae.

Uniseriate rays are usually rare to absent, composed of isodiametric or upright cells. The multiseriate rays are usually heterogeneous (Kribs's Type IIA, IIB), rarely homogeneous (Kribs's Type I), with a thin jacket of isodiametric to upright cells. Wood parenchyma is often extremely sparse.

Apiaceae.

Uniseriate rays are usually rare to absent, the multiseriate slightly heterogeneous (Kribs's Type IIB) or sometimes almost homogeneous. Wood parenchyma is scanty to vasicentric, and the development of an extrafascicular cambial ring has been reported in the stems of some species.

Datiscaceae.

The rays are either mainly multiseriate or a mixture of uniseriate and multiseriate, heterogeneous, composed of square to upright cells, with a jacket of upright cells around the multiseriates (probably Kribs's Heterogeneous Type IIB). Wood parenchyma is scanty or plentiful.

Of the families discussed above Lythraceae, Combretaceae, Apiaceae and most of Celastraceae are unlikely to represent the progenitors of Haloragaceae, judged only on the structure of their wood rays, and Araliaceae are also probably too advanced in this respect to be considered further. The presence of inter- or intra-xylary phloem in Onagraceae, Lythraceae and Combretaceae, but its absence in Haloragaceae, makes the probability of the latter family having been derived from any of the former families unlikely.

The remaining families, Cornaceae, Rhizophoraceae, Datiscaceae and Aquifoliaceae have no major dissimilarities with Haloragaceae on the points of wood anatomy discussed above, and the possibility of their relationship to that family is not precluded by this evidence.

TABLE 2.

List of vouchers for wood anatomy

(All collections are housed in AD)

Name	Collection	Stem	Root
Haloragis			
H. exalata			
var. *exalata*	Orchard 2011, Moleside Ck., Victoria	+	
H. acutangula			
f. *tetraptera*	Orchard 2413, 1 km S. Moonta, S.A.	+	+
f. *turbinata*	Orchard 2414, 1 km S. Moonta, S.A.	+	+
H. aspera	Orchard 1843, Siccus River, S.A.	+	+
H. uncatipila	Orchard 900, 24 km N. Tennant Ck, N.T.	+	+
Haloragodendron			
H. monospermum	Orchard 2389, Corang River, N.S.W.	+	
	Orchard 2391, Corang River, N.S.W.		+
H. racemosum	Orchard 1285, Boyatup Hill, W.A.	+	
Glischrocaryon			
G. behrii	Orchard 1805, 5½ km S. Monarto Sth.,S.A.	+	+
	Orchard 1808, 9 km S.E. Finnis, S.A.	+	+
	Orchard 2148, 13 km W. Kimba, S.A.	+	+
G. aureum			
var. *angustifolium*	Orchard 1120, Loc. 251, Shire of Esperance, W.A.		+
G. flavescens	Orchard 1227, Loc. 1105, Shire of Esperance, W.A.	+	+
	Orchard 2172, Yandinga Gorge, S.A.		+

Name	Collection	Stem	Root
Gonocarpus			
G. elatus	Orchard 1813, Black Hill, S.A.	+	+
G. pycnostachyus	Orchard 1079, 12 km S.E. Condingup Peak, W.A.	+	+
G. tetragynus	Orchard 1803, 5½ km S. Monarto South, S.A.		+
	Orchard 2388, 6½ km S. Coffs Harbour, N.S.W.	+	
G. teucrioides	Orchard 1868, Upper Waterfall Gully, S.A.	+	+
G. sp. (aff. *teucrioides*)	Orchard 2347, Springbrook, Qld.	+	
	Orchard 2382, Whian Whian Forest, N.S.W.	+	

VII. EMBRYOLOGY.

Most of the embryological data cited below are adapted from the summaries given by Davis (1966), with very little reference to the original papers. However, any new evidence appearing in the literature after this date has been incorporated. A major exception to this rule is the case of Haloragaceae, in which Davis included the genera *Myriophyllum, Laurembergia, Gunnera* and *Hippuris*, with the result that the embryology of this family appears extremely variable. Because of this confusion, each genus of Haloragaceae is described separately below, with reference to the relevant literature for each. The genera *Gunnera, Trapa, Hippuris* and *Callitriche*, which have sometimes been included in the family are similarly treated.

Haloragis

(*H. colensoi, H. asperrima* - Kapil (1962), Kapil & Bala Bawa (1968))

Anther wall formation is apparently of the Monocotyledonous type (from the figures of Kapil & Bala Bawa), and the mature wall consists of epidermis, endothecium, 2 middle layers and a glandular tapetum. Microspore cytokinesis is simultaneous and the pollen is shed at the 3-celled stage. The ovule is anatropous, bitegmal and crassinucellar, with porogamous fertilization. The development of the embryo-sac is of the Polygonum type, the endosperm is *ab initio* Cellular and embryogeny conforms to the Myriophyllum-variation of the Caryophyllad type. A conspicuous 2-celled suspensor haustorium is derived from the basal cell.

Laurembergia.

(*L. javanica* - Bley (1925), *L. brevipes* - Bala Bawa (1969a))

The anther wall consists of epidermis, endothecium, single middle layer and uninucleate, glandular tapetum, and judging by the figures of Bley and Bala Bawa is probably of the Monocotyledonous type. Microspore cytokinesis is simultaneous, and the pollen grains are shed at the 3-celled stage. The ovule is anatropous, bitegmal and crassinucellar, with porogamous fertilization. The development of the embryo sac is of the Polygonum type, the endosperm is Nuclear and embryogeny conforms to the Myriophyllum-variation of the Caryophyllad type. A prominent 2-celled suspensor haustorium is derived from the basal cell.

Myriophyllum

(*M. alterniflorum* - Stolt (1928), Soueges (1940); *M. intermedium* - Nagaraj & Nijalingappa (1967), Bala Bawa (1969a)).

Judging by the figures of Nagaraj & Nijalingappa and Bala Bawa, anther wall formation is probably of the Dicotyledonous type, with two to three middle layers (single middle layer - Bala Bawa) and a glandular tapetum. Microspore cytokinesis is simultaneous and the pollen grains are shed at the 3-celled stage. The ovules are anatropous, bitegmic and crassinucellar, and fertilization is porogamous. The development of the embryo sac is of the Polygonum type, ('Normal type' - Stolt), the endosperm is *ab initio* Cellular (*M. intermedium*) or Nuclear (*M. alterniflorum* Stolt) and embryogeny conforms to the Myriophyllum-variation of the Caryophyllad type. A large 2-celled suspensor haustorium is derived from the basal cell.

Gunnera

(Schnegg (1902); *G. chilensis* - Kellermann (1881), Modilewski (1908); *G. macrophylla* - Samuels (1912); *G. insignis* - Virkki (1962))

Anther wall formation and microspore cytokinesis are not described;

the pollen is shed at the 2-celled stage. The ovule is bitegmic, anatropous and crassinucellar, with porogamous fertilization. The development of the embryo sac is of the Peperomia type and the endosperm is *ab initio* Cellular. Details of embryogeny do not appear in the literature. No suspensor haustorium is formed from the basal cell.

Hippuris

(*H. vulgaris* - Unger (1849), Juel (1910, 1911), Soueges (1922))

Details of anther wall and microspore development have not been recorded; the pollen is shed at the 3-celled stage. The ovules are anatropous, unitegmic and tenuinucellar, with fertilization occurring by a lateral penetration of the embryo sac by the pollen tube. The development of the embryo sac follows the Polygonum type, the endosperm is *ab initio* Cellular and embryogeny conforms to the Onagrad type. A long haustorial suspensor is formed.

Callitriche

(Joergensen (1923, 1925), *C. vernalis* - Soueges (1952))

Anther wall development is not recorded; the tapetum is glandular, microspore cytokinesis is simultaneous and the pollen is shed at the 3-celled stage. The ovule is anatropous, unitegmic and tenuinucellar, and fertilization is porogamous. Embryo sac development follows the Polygonum type, endosperm is of the *ab initio* Cellular type with a large micropylar haustorium and a smaller hooked chalazal haustorium, and embryogeny conforms with the Onagrad type. The suspensor is very long and consists of up to 4 rows of cells.

Trapa.

(*T. natans* - Gibelli & Ferero (1891, 1891a, 1895), Ishikawa (1918), Tison (1919); *T. bispinosa* - Ghosh (1954), Ram (1956))

Anther wall formation in the species studied is probably of the Dicotyledonous type, judging by the figure of Ram, and consists of epidermis, endothecium, 2-3 middle layers and a glandular tapetum (amoeboid rarely in *T. bispinosa)*. Microspore cytokinesis is in centripetal succession and pollen is shed at the 2-celled stage, although pollen germination *in situ* is common. The ovule is anatropous, bitegmic and crassinucellar, fertilization occurring via a nucellar beak protruding between the integuments. The development of the embryo sac is of the Polygonum type, the endosperm is absent and embryogeny is of the Solanad type. *Trapa* is noted for its two extremely unequal cotyledons, and for its curious convoluted suspensor haustorium, resembling that of conifers.

Onagraceae

The formation and structure of the anther wall have not been investigated. Microspore cytokinesis is simultaneous and the pollen grains are shed at the 2-celled stage. The ovule is anatropous, bitegmic and crassinucellar. The type of fertilization is not recorded. Embryo sac development is usually of the Oenothera type, endosperm formation is Nuclear and embryogeny conforms to the Onagrad type.

Cornaceae

(Chopra & Kaur, 1965)

The formation and structure of the anther wall have not been investigated. Microspore cytokinesis is simultaneous and the pollen grains are 2-celled when shed. The ovule is anatropous, unitegmic and usually crassinucellar, with (?)porogamous fertilization. Embryo sac development usually follows the Polygonum type (Fritillaria type in *Cornus mas*), and the endosperm is *ab initio* Cellular. Embryogeny is unknown.

Lythraceae

Anther wall formation is of the Dicotyledonous type, with a glandular tapetum. Microspore cytokinesis is simultaneous and the pollen grains are 2-celled when shed. The ovule is anatropous, bitegmic and crassinucellar. Fertilization is not described. Embryo sac development follows the Polygonum type, endosperm formation is Nuclear and embryogeny conforms to the Onagrad type. A uniseriate or multiseriate suspensor is formed.

Araliaceae

Anther wall formation is not described but the tapetum is glandular. Microspore cytokinesis is simultaneous and the pollen grains are 3-celled when shed (rarely 2-celled). The ovule is anatropous, unitegmic and usually crassinucellar. Embryo sac development follows the Polygonum type, and the endosperm formation is Nuclear. Embryogeny has not been traced in detail.

Apiaceae

Anther wall development is of the Dicotyledonous type, with a glandular tapetum. Microspore cytokinesis is simultaneous and the pollen grains are shed at the 3-celled stage. The ovule is anatropous, unitegmic and usually tenuinucellar. The type of fertilization is not recorded. Embryo sac development follows the Polygonum type (rarely the Allium Drusa or Penaea type), endosperm formation is Nuclear and embryogeny conforms to the Solanad type. A long suspensor is common.

Combretaceae

Anther wall formation follows the Basic type, with a glandular tapetum. Microspore cytokinesis is simultaneous and the pollen grains are shed at the 2-or 3-celled stage. The ovule is anatropous, bitegmic and crassinucellar. The type of fertilization is not recorded. Embryo sac development follows the Polygonum type (rarely Penaea type), endosperm formation is Nuclear and embryogeny conforms to the Asterad type.

Rhizophoraceae.

The development of the anther and pollen grains has not been described. The ovule is anatropous to hemianatropous, bitegmic and crassinucellar. Fertilization is not described. Embryo sac development is of the Polygonum type and the endosperm is Nuclear, with the formation of terminal endosperm haustoria in some species. Embryogeny has not been described, but the suspensor can be massive.

Celastraceae

Anther wall development has not been studied in detail, but the tapetum is of the glandular type. Microspore cytokinesis is simultaneous and the pollen grains are shed at the 2-celled stage. The ovule is anatropous, bitegmic and either crassinucellar or tenuinucellar. Fertilization is not described. Embryo sac development follows the Polygonum type, endosperm development is initially Nuclear and embryogeny follows the Solanad or the Caryophyllad type. An aril develops from the base of the outer integument.

Aquifoliaceae

Anther wall development and structure has not been described in detail, but the tapetum is probably glandular. The pollen grains are

2-celled when shed. The ovule is anatropous, unitegmic and usually crassinucellar (rarely tenuinucellar). Fertilization is not described. Embryo sac development follows the Polygonum type, the endosperm is *ab initio* Cellular and embryogeny probably conforms to the Caryophyllad type.

Ceratophyllaceae

Anther wall structure has not been described in detail but the tapetum is amoeboid. Microspore cytokinesis is successive and the pollen grains are shed at the 2-celled stage. The ovule is orthotropous, unitegmic and crassinucellar. Fertilization is not described. Embryo sac development follows the Polygonum type, the endosperm is *ab initio* Cellular and embryogeny conforms to the Asterad type, but no suspensor is formed.

Datiscaceae

Anther wall and pollen grain development and structure have not been described. The ovule is anatropous, bitegmic and crassinucellar. Fertilization has not been described. Embryo sac development follows the Allium type, the endosperm is initially Nuclear and embryogeny conforms to the Onagrad type.

Theligonaceae

(Kapil & Rao, 1966)

Anther wall development is not described but the tapetum is glandular. Microspore cytokinesis is simultaneous and the pollen grains are 3-celled when shed. The ovule is campylotropous, unitegmic and crassinucellar (Schnarf, 1931) or tenuinucellar (Dahlgren, 1916; Kapil & Rao, 1966). Fertilization has not been described. Embryo sac development follows the Polygonum type, the endosperm is Nuclear and embryogeny conforms to the Chenopodiad type. A uniseriate, 9-celled suspensor is formed.

Discussion:

Haloragis, *Laurembergia* and *Myriophyllum* form a remarkably uniform group on embryological evidence. The only points of difference, the Dicotyledonous type of anther wall formation in *Myriophyllum* vs. the probable Monocotyledonous type in the other genera, and some variation in endosperm formation, are more than outweighed by their agreement in all other respects, including the rare Myriophyllum-variant of the Caryophyllad type of embryogeny.

Trapa differs from the *Haloragis* group in its successive microspore cytokinesis, 2-celled pollen, well-developed nucellar beak, complete lack of endosperm, Solanad type of embryogeny, and conifer-like suspensor haustorium. These differences outweigh the few similarities and along with the differences between *Trapa* and Onagraceae summarized by Ram (1956) seem to justify the recognition of the monogeneric family Trapaceae. The connection between *Trapa* and Lythraceae suggested by Miki (1959) is not strongly supported by the embryological evidence.

Gunnera differs from the *Haloragis* group in its 2-celled pollen and Peperomia type embryo sac. Although little is known of embryogeny in this genus, the figure in Modilewski (1908) certainly does not follow the Myriophyllum-variant of the Caryophyllad type. Bala Bawa (1969) considered that the embryological data combined with some morphological features, justified the separation of *Gunnera* from Haloragaceae as Gunneraceae. More detailed studies on the development of the anther wall, microspores and embryo are needed.

Bala Bawa (1969) summarized the embryological and morphological evidence pointing towards exclusion of *Hippuris* from the *Haloragis* group of genera. The former genus deviates from the latter group in its unitegmic, tenuinucellar ovule, unusual type of fertilization, Onagrad type of embryogeny and long uniseriate haustorial(?) suspensor. Soueges (1922) suggested that embryologically this genus approaches Scrophulariaceae.

Callitriche in most modern systems is removed from close proximity to Haloragaceae and placed in the Sympetalae, often near Labiatae and Verbenaceae. This position, as pointed out by Joergensen (1923), is supported by the embryological evidence. *Callitriche* differs from the *Haloragis* group in its unitegmic, tenuinucellar ovule, the development of large terminal endosperm haustoria, and Onagrad type of embryogeny.

Although *Haloragis* and its allies are usually placed in or adjacent to the family Onagraceae, this close relationship is not reflected in their embryology. Onagraceae differ from Haloragaceae s. str. in their 2-celled pollen grains, Oenothera type of embryo sac, and Onagrad type of embryogeny. Lythraceae agree with Onagraceae in most respects, but come slightly closer to Haloragaceae by the occurrence of a Polygonum type embryo sac.

Cornaceae, the family nominated by Schindler as showing, after Onagraceae, the closest resemblance to Haloragaceae, are relatively poorly known embryologically. Nothing is described of anther wall development or embryogeny. In their known features, Cornaceae differ from the *Haloragis* group in their 2-celled pollen and single integument. However, the remaining points of resemblance are so generalized that no reliable conclusion concerning relationship can be drawn.

Araliaceae and Apiaceae are almost identical embryologically and differ from the *Haloragis* group in their unitegmic, tenuinucellar (Apiaceae only) ovules and Solanad type of embryogeny. As such, these families show more dissimilarity to *Haloragis* than do Combretaceae which differ only in their Asterad type of embryogeny. The related family Rhizophoraceae is too poorly known to be adequately compared, but the few known details (with the exception of the massive suspensor) show no discrepancies with the *Haloragis* group.

Celastraceae and Aquifoliaceae have very similar details of embryology, and show the greatest similarity to the *Haloragis* group of all families considered. Aquifoliaceae have unitegmic ovules, but with this exception, at least some members of each family match the *Haloragis* group in all essential respects. They are the only two families of those considered which share with the *Haloragis* group the Caryophyllad type of embryogeny, although of a different variant.

Ceratophyllaceae differ from the *Haloragis* group in nearly all details, rendering a close relationship extremely unlikely. Similarly Datiscaceae, although poorly known, differ from the *Haloragis* group in two major respects, their Allium type embryo sac and Onagrad type embryogeny, and are thus unlikely to be closely related. Theligonaceae are also unlikely to be closely allied to the *Haloragis* group, differing in their campylotropous, unitegmic, tenuinucellar ovules and Chenopodiad type of embryogeny. On this sort of evidence, Kapil & Rao (1966) suggested that Theligonaceae was closely associated with Phytolaccaceae and Amaranthaceae.

VIII. POLLEN MORPHOLOGY.

The pollen morphology of a wide range of species of Haloragaceae has been studied by Praglowski (1970). For purposes of comparison, his generic descriptions are set out below.

Haloragis (including *Gonocarpus*)

Pollen grains usually paraisopolar, or occasionally isopolar, radially symmetrical, pertectate, predominantly 4-5-colpate (about 80% of species), or 4-5-porate (about 20% of species), crassimarginate, frequently aspidote. Seven, or more than seven aperturate pollen grains occur rarely. Anomotheme pollen grains are encountered in a number of species. NPC:443, 543, (643), (343)-(444), (544), (644), (344). - Polar axis 15-31μ, "equatorial" diameter 18-40μ. Suboblate pollen grains are most common (about 80%), oblate less common (about 18%), and oblate-spheroidal pollen grains are rare.

Haloragis subsection *Spongiocarpus* Schindler (=*Haloragodendron*)

Pollen grains isopolar, radially symmetrical, pertectate, 5-6-colpate, tenuimarginate. NPC: 543, 643. - Polar axis 19μ, equatorial diameter 22μ. Pollen grains suboblate, peritreme, in lateral view frequently slightly rectangular in shape (with flattened apocolpia). Exine of the same thickness throughout, about 2μ thick. Sexine slightly thicker than the nexine. The tectum thin, provided with comparatively distinct tectal perforations and less distinct supratectal processes. Infratectal bacula relatively distinct in optical cross section. Nexine compact, its distal surface non-smooth. Colpi about 5 × 1μ, usually slightly ingrooved.

Glischrocaryon ['*Loudonia*']

Pollen grains isopolar, radially symmetrical, pertectate, 6-colpate, usually tenuimarginate. Four colpate pollen grains rare. NPC: 643 (543). - Polar axis 16-22μ, equatorial diameter 16-27μ. Pollen grains suboblate, oblate-spheroidal, or occasionally spheroidal, usually peritreme. Exine usually equal in thickness throughout, 1.5-2.5μ thick, or occasionally slightly thicker at poles than at the equator. Sexine thicker than the nexine. Tectum thin, provided with relatively distinct perforations and less distinct supratectal processes. Infra-tectal bacula distinct in optical cross section. Nexine compact, its distal surface non-smooth. Colpi 5 × 1μ, slightly ingrooved.

Laurembergia

Pollen grains isopolar, radially symmetrical, pertectate, predominantly 5-colpate (or less frequently porate), often crassimarginate, aspidote. Four aperturate pollen grains occur commonly, six aperturate are mainly encountered in the section Ditetrapleura Schindl., three aperturate are rare. NPC 543, 443, (643)-544, 444, (644). - Polar axis 18-26μ, equatorial diameter 21-33μ. Pollen grains suboblate. An amb, intermediate between that of goniotreme and peritreme pollen grains, is most commonly encountered. Goniotreme pollen grains occasionally occur, peritreme are rare.

The total thickness of the exine at the centre of the mesocolpia in polar view (the supratectal processes included) ranges from 1-3μ.

Proserpinaca

Pollen grains isopolar, radially symmetrical, pertectate, predominantly 4-3-colpate in *P. palustris* and usually 4-porate in *P. pectinata*, NPC 443, 343, 444, (543), (544). Anomotreme grains occur. Polar axis ranges from 16-19μ, equatorial diameter from 19-22μ. Pollen grains usually suboblate, peritreme. Exine about 2μ thick, equal in thickness all around the pollen grain.

Myriophyllum

Pollen grains isopolar, radially symmetrical (except *Myriophyllum alterniflorum* and *M. muelleri*), pertectate, colpate (in about 25%), porate (in about 25%), or colpate and porate (in about 50% of species), usually aspidote, crassimarginate. Six or more than six aperturate pollen grains rare. Anomotreme pollen grains are encountered in a number of species, loxocolpate pollen grains are rare. - Polar axis 16-35μ, equatorial diameter 20-40μ. All species with exception of *M. drummondii* have suboblate pollen grains. Peritreme pollen grains occur in about half of the species and in the other half an amb, intermediate between goniotreme and peritreme, is encountered. Goniotreme pollen grains are found in *M. indicum*, and in *M. tetrandrum*.

The total thickness of the exine at the centre of the mesocolpia in polar view (supratectal processes included) ranges from 1-2.5μ. Exine equally thick throughout the pollen grain.

Gunnera

Pollen grains isopolar, radially symmetrical, semitectate, 3-colpate, crassimarginate. NPC: 343. - Polar axis 16-28μ, equatorial diameter 20-37μ, diameter of the apocolpia 8-16μ. Oblate pollen grains occur in about one half, and suboblate in the other half of the species. All pollen grains are ptychotreme. Exine varies in thickness depending upon the area of the pollen grain. Its total thickness at poles 2-4μ, from 1.5-2.5μ at the centre of the mesocolpia, and 2-3.5μ near colpi margins. Exine thickenings at the poles and in the apertural area are due to the nexine, which there is usually about twice as thick as the overlying sexine.

On the basis of pollen morphology, Praglowski concluded:

1. The species *Haloragis monosperma, H. racemosa* and *H. lucasii* more closely resemble *'Loudonia' (Glischrocaryon)* in their pollen characteristics than they do the other species of *Haloragis*, or indeed, any other members of Haloragaceae. Praglowski believed (mistakenly) that the flower morphology and mode of pollination of these three species supported the transfer. As described elsewhere, these three species, with the addition of two others not considered by Praglowski, constitute the new genus *Haloragodendron*, which, while it resembles the genus *Glischrocaryon* in some respects, is quite different in others. Praglowski's evidence provides confirmation of the distinctiveness of this new genus, originally recognized on macro-morphological grounds.

2. The exclusion of *Gunnera* from Haloragaceae is strongly supported by the evidence from pollen morphology. This exclusion is also supported by differences in embryology and macro-morphology. Although stating that the pollen morphology of *Gunnera* "does not exhibit the slightest resemblance nor affinity with the pollen morphology of the Haloragoideae" Praglowski apparently still sees Gunneraceae as related to, although more advanced than Haloragaceae by his agreement with the system proposed by Takhtajan. In the present study, a greater separation of these families is proposed.

3. The pollen morphology is very uniform between the species

within each genus, and there is a close similarity between the pollen of *Haloragis* (incl. *Gonocarpus*), *Laurembergia, Proserpinaca* and *Myriophyllum*. *Glischrocaryon* and *Haloragodendron* are distinct from the above five genera on pollen morphological grounds.

4. There is little observable difference between the pollen of *Gonocarpus* ('*Haloragis* sect. *Monanthus*') and *Haloragis* ('*Haloragis* sect. *Pleianthus*') except that the pollen of the former generally has a larger number of apertures. Praglowski considered that the difference in pollen between *H. brownii* and the other species of *Haloragis* supported the separation of that species in the genus *Meionectes*.

Erdtman (1966), on the basis of the few descriptions of pollen then available for Haloragaceae, discussed the possible relationships of the family. He considered that on the palynological evidence, the removal of *Trapa* to Trapaceae ['Hydrocaryaceae'] was justified. This genus differs from Haloragaceae s. str. in having larger grains (50-80μ) and three well-defined, more or less folded meridional crests. Erdtman saw some similarities between the pollen of this family and that of some members of Onagraceae.

The pollen of Callitrichaceae was described by Erdtman (1966) as ± spheroidal or ovoid with no distinct apertures or provided with 2-3(-4) irregular, thin, ± aperturate areas. The sexine is usually slightly thicker than the nexine, and more or less reticulate. Erdtman considered that this combination of characters was "slightly reminiscent of the grains in *Fraxinus excelsior*" but quite different from those in Boraginaceae, Euphorbiaceae, Haloragaceae and *Gratiola* (Scrophulariaceae), postulated relatives of Callitrichaceae on various other types of evidence.

According to Erdtman (1966) the pollen of Onagraceae ('Oenotheraceae') differs from that of all other families, although that of, for example, *Fuchsia* has a faint resemblance to the grains of Haloragaceae and that of other genera recalls perhaps Hydrocaryaceae (= Trapaceae), Proteaceae and Rubiaceae. The genera of Cornaceae are heterogeneous in their pollen morphology, but from the scanty descriptions provided for *Griselinia* and *Corokia* in Erdtman (1966) and Cranwell (1942) the resemblance between the pollen of these two genera and Haloragaceae is slight.

Erdtman's (1966) remarks and descriptions indicate some similarities of the pollen of the families Apiaceae, Araliaceae, Celastraceae, Combretaceae, Lythraceae and Rhizophoraceae, with that of Haloragaceae, although none of the resemblances is strong. On the other hand, the pollen of the families Aquifoliaceae, Ceratophyllaceae, Datiscaceae, Hippuridaceae and Theligonaceae has little or no affinity with that of Haloragaceae.

In summary, the pollen morphological evidence tends, on the whole, to support those hypotheses which assign Haloragaceae to an isolated position, rather than those suggesting a relationship with any one or more families. *Haloragis*, *Gonocarpus*, *Myriophyllum*, *Proserpinaca* and *Laurembergia* have fairly uniform pollen characteristics, while *Gunnera* deviates somewhat from this pattern, with perhaps some links through *Glischrocaryon* and *Haloragodendron*. The pollen grains with the greatest similarity to those of Haloragaceae are found in the Betulaceae and Ulmaceae, two families usually not considered to have affinities with this group. Neither the inclusion of *Trapa*, *Hippuris* and *Callitriche* in Haloragaceae, nor the close relationship of this family with Ceratophyllaceae, Theligonaceae, Datiscaceae or Aquifoliaceae, is supported by the evidence from pollen morphology. A slight similarity exists between the pollen of Haloragaceae and some Onagraceae (e.g. *Fuchsia*), and the pollen grains of some members of Apiaceae, Araliaceae, Celastraceae, Combretaceae, Cornaceae, Lythraceae and Rhizophoraceae have some features in common with those of Haloragaceae.

IX. CHROMOSOME NUMBERS.

In the table below is a summary of chromosome counts reported for species generally included in Haloragaceae or belonging to genera which have at one time or another been included in that family. The counts given for *Haloragis* and *Gonocarpus* appear to be the only ones reported, while those for the other genera are only a selection made from the more readily available literature. However, in these genera, an attempt has been made to obtain a representative sample of species and numbers.

Species	n	2n	Reference
GONOCARPUS (*'Haloragis'*)			
G. halconensis (Merr.) Orch.		56("58"p.143)	Borgmann, 1964
G. micranthus Thunb.	6		Chuang et al., 1962
" "		12	Larsen, 1966
HALORAGIS			
H. erecta		14	Forde, 1964
MYRIOPHYLLUM			
M. alterniflorum L.	7		Scheerer, 1939
" "		14	Joergensen et al., 1958
" "		14	Larsen, 1965
" "		14	Gadella & Kliphuis,1968
" " var. *americanum* Pugol		14	Love & Love, 1958
M. alternifolium DC.		14	Pogon, 1966
M. exalbescens Fern.		14	Love, 1954
" "		42	Packer, 1964
M. spicatum L.		28	Love, 1954
" "		28	Taylor & Mulligan,1968

Species	n	2n	Reference
M. spicatum ssp. *exalbescens* (Fern.) Hulten		42	Love & Ritchie, 1966
M. verticillatum L.		28	Pogon, 1966
<u>*GUNNERA*</u>			
G. albocarpa (Kirk) Ckn.		34	Beuzenberg & Hair, 1963
G. arenaria Raoul		34	Beuzenberg & Hair, 1963
G. chilensis Lam	ca.12		Winge, 1917
G. densiflora Hook. f.		34	Beuzenberg & Hair, 1963
G. dentata Kirk		34	Beuzenberg & Hair, 1963
G. flavida Col.		34	Beuzenberg & Hair, 1963
G. hamiltonii Kirk		34	Beuzenberg & Hair, 1963
G. insignis (Oersted) DC.	17	34	Virkki, 1962
G. macrophylla Bl.	12		Samuels, 1912
" "		24	Borgmann, 1964
G. mixta T. Kirk		34	Beuzenberg & Hair, 1963
G. monoica Raoul		34	Beuzenberg & Hair, 1963
G. prorepens Hook. f.		34	Beuzenberg & Hair, 1963
G. strigosa Col.		34	Beuzenberg & Hair, 1963
<u>*TRAPA*</u>			
T. conocarpa ssp. *laevigata* Nath		48	Trela-Sawicka, 1965
T. media (Gluck) Vassil		48	Trela-Sawicka, 1965
T. muzzanensis (Jaggi) Szafer, Kulcz & Pawl		48	Trela-Sawicka, 1965
T. natans L.		40	Trela-Sawicka, 1965
" var. *subcoronata* (Nath.) Gluck		48	Trela-Sawicka, 1965

Species	n	2n	Reference
HIPPURIS			
H. tetraphylla L		32	Zhukova, 1966
H. vulgaris L., s.l.		48	Zhukova, 1966
H. vulgaris L.	16		Winge, 1917
"		30	Harada, 1952
"		32	Joergensen et al.,1958
"		32	Sokolovskaja, 1960
"		32	Gadella & Kliphuis,1963
"		32	Gadella & Kliphuis,1966
"		32	Love & Ritchie, 1966
CALLITRICHE			
C. antarctica Engelm.ex.Hegelm.	20		Moore, 1960
"		40	Beuzenberg & Hair, 1963
C. aucklandica R. Mason		40	Beuzenberg & Hair, 1963
C. elegans V. Petr.		20	Sokolovskaja, 1960
C. japonica Engelm. ex Hegelm.		10	Shimoyama, 1958
C. muelleri Sond.		10	Beuzenberg & Hair, 1963
C. obtusangula Le Gall. ex Hegelm.		10	Savidge, 1956
C. petriei R.Mason ssp.*petriei*		20,30	Beuzenberg & Hair, 1963
" ssp.*chathamensis* R. Mason		20	Beuzenberg & Hair, 1963
C. platycarpa Kutz.		20	Savidge, 1956
C. stagnalis Scop.		10	Savidge, 1956
"		10,15	Beuzenberg & Hair, 1963
C. sp.		40	Beuzenberg & Hair, 1963

Species	n	2n	Reference
C. verna L.	8		Winge, 1917
"		20	Joergensen et al., 1958
"	10	20	Shimoyama, 1958
COROKIA			
C. buddleoides A. Cunn.	9		Hair & Beuzenberg, 1959
" var. *linearis* Cheesem.	9		Hair & Beuzenberg, 1959
C. cheesemannii Carse	9		Hair & Beuzenberg, 1959
C. cotoneaster Raoul	9	18	Hair & Beuzenberg, 1959
C. macrocarpa T. Kirk	9		Hair & Beuzenberg, 1959
GRISELINIA			
G. littoralis Raoul	18	36	Hair & Beuzenberg, 1959
G. lucida Forst. f.	18		Hair & Beuzenberg, 1959

Because of the paucity of chromosome counts for *Gonocarpus* and *Haloragis* and the apparent lack of any information for *Laurembergia*, *Glischrocaryon*, *Haloragodendron*, *Meziella* and *Proserpinaca*, it is difficult to draw meaningful conclusions about relationships.

The *Myriophyllum* species show a polyploid series up to the hexaploid state, with a base number of x = 7. *Gonocarpus halconensis* could be fitted into this series, with its sporophyte number of 56 representing the octoploid state, but *G. micranthus* (n = 6, 2n = 12) seems to have a base number of x = 6 (3?)

Gunnera (with the exception of *G. chilensis* and *G. macrophylla* - gam. no. = 12,spor. no. = 24, x = 6) is reported to have a constant somatic number of 34 (and therefore x = 17). This difference in basic chromosome number adds weight to the separation of *Gunnera* from Haloragaceae. Similarly, the affiliation of *Trapa* (spor. no. = 40, 48; x = 4?) and *Hippuris* (spor. no. = (30)32(48); x = 8?) with Haloragaceae is not supported by the chromosomal evidence. *Callitriche* shows a well defined polyploid series up to the octoploid state, based on x = 5, and is thus distinct from all the other genera so far considered.

Griselinia and *Corokia*, two basically New Zealand genera of uncertain affinity (often placed in Cornaceae) show a basic number of x = 9, with *Corokia* attaining the diploid state and *Griselinia* the tetraploid.

Very little lead as to affinity can be expected from a comparison of the counts listed above with those of putatively related families for two main reasons. Firstly, only comparisons between closely related families could reasonably be expected to yield agreement in a character as variable as the chromosome number. As so many of the genera above are usually considered "of doubtful affinity" it is unlikely that they have any extant close relatives. Secondly, the variability of base numbers even between the genera *Gonocarpus* and *Myriophyllum* (x=(6-)7), which are probably fairly closely related, makes wider comparison seem of doubtful validity. However, for the sake of completeness, the basic numbers of families which have been considered related to Haloragaceae are listed below. The numbers are taken from Darlington & Wylie (1955) and Ornduff (1967, 1968), which, while not containing all or even the latest known numbers, are probably reasonably representative.

The numbers are: Onagraceae (x = 5,7,8,9,11,17), Lythraceae (x = 5,6,8,11,15,25), Cornaceae (x = 8,9,10,11), Araliaceae (x = 11,12), Apiaceae (x = 6,7,8,9,10,11), Combretaceae (x = 11,12,13), Rhizophoraceae (x = 18), Celastraceae (x = 8,14,23,40), Aquifoliaceae (x = 9,10), Datiscaceae (x = 11), Theligonaceae (x = 11) and Ceratophyllaceae (x = 8?). A relationship between *Gonocarpus* - *Myriophyllum* and any of the families Cornaceae, Araliaceae, Combretaceae, Rhizophoraceae, Aquifoliaceae, Datiscaceae, Theligonaceae and Ceratophyllaceae is not supported by the numbers cited. Onagraceae, Lythraceae, Apiaceae and perhaps Celastraceae agree with the *Gonocarpus* - *Myriophyllum* group, at least in part, but as discussed earlier, this agreement is inconclusive.

X. PHYTOCHEMISTRY.

Comparative information in this field is very fragmentary as far as Haloragaceae are concerned. The available facts are best summarized under the headings polyphenols, saponins, cyanogenic compounds and alkaloids.

Polyphenols.

Cambie et al. (1961) found leucoanthocyanins in *Haloragis erecta, H. cartilaginea, H. depressa, H. procumbens, Myriophyllum votschii* and *M. pedunculatum*. These compounds were absent in *Haloragis incana, Myriophyllum robustum, M. propinquum, M. elatinoides*, and six species of *Gunnera*. These results were confirmed in part by Bate-Smith (1962) who found no leucoanthocyanins in *Gunnera manicata* or *Myriophyllum proserpinacoides* but found leucocyanidin in "*Haloragis alata*" (= *H. erecta*). In the same paper, the presence of the flavonol quercetin in all three species, and kaemferol in *Haloragis* and perhaps *Gunnera*, but not *Myriophyllum*, was also reported. Of other identifiable phenolic compounds, *Gunnera* contained ellagic acid, caffeic acid, p-coumaric acid and perhaps a trace of ferulic acid, *Haloragis* contained ellagic acid, caffeic acid and perhaps p-coumaric acid, while *Myriophyllum* only contained ellagic acid.

Saponins.

Cambie et al. (1961), reported a positive saponin test for *Haloragis procumbens* and doubtfully positive tests for *Haloragis erecta, Gunnera strigosa* and *Gunnera arenaria*. However, three other species of *Haloragis*, four species of *Gunnera* and five species of *Myriophyllum* returned a negative test. Saponins were also absent in four species of

Gunnera and three species of *Myriophyllum* in Chile, tested by Ricardi et al. (1958).

Cyanogenic compounds.

The Poison Plants Committee (1929) reported that six specimens of an unidentified species of *Haloragis* had been found to be cyanogenic. Mirande (1913) found *Haloragis erecta* ('*H. alata*') to be cyanogenic and Hegnauer (1958) found 1.8 mg HCN/kg freshweight of *Myriophyllum brasiliense*. However Webb (1949) found no trace of HCN in *Gonocarpus tetragynus* ('Haloragis tetragyna') and *Myriophyllum propinquum*. Aplin (1968) reported that *Glischrocaryon aureum* and *G. roei* ('*Loudonia aurea* and *L. roei*') gave positive reactions for HCN

Alkaloids.

Webb (1949) found traces of alkaloid in the roots of *Gonocarpus tetragynus*, but none in the leaves, and none in *Myriophyllum propinquum*. Webb (1952) detected no alkaloids in *Haloragis heterophylla*, and Cambie et al. (1961) reported alkaloids absent from their five species of *Haloragis*, six species of *Gunnera* and five species of *Myriophyllum*.

The data outlined above are too sparse to make a detailed comparison with other families worthwhile. Hegnauer (1966) considered that on the chemical evidence, *Hippuris* was not closely related to Haloragaceae, but could well fit into the Tubiflorae. The position for the Haloragaceae was considered to be in the Myrtales. Callitrichaceae are so imperfectly known that Hegnauer refrained from assigning them to any position on the chemical evidence.

Bate-Smith (1962) divided the families for which polyphenolic content data were available into four groups, ab, a_ob, ab_o and a_ob_o depending on whether leucoanthocyanins were present or absent (a or a_o) and whether trihydroxy constituents were present or absent (b or b_o). Because the conversions $a \rightarrow a_o$ and $b \rightarrow b_o$ were considered virtually irreversible, the group ab would be the most primitive and the group a_ob_o the most derived in this respect. Of the families listed earlier as putative relatives of the Haloragaceae, the group ab contains Celastraceae, Rhizophoraceae and Haloragaceae, the group a_ob contains Lythraceae, Combretaceae, Onagraceae and Cornaceae, the group ab_o none, and the group a_ob_o contains Callitrichaceae, Aquifoliaceae, Datiscaceae, Hippuridaceae, Araliaceae and Apiaceae. Thus on the evidence from polyphenolic constituents, this last group of families (a_ob_o) is least likely to be closely related to Haloragaceae (ab). It is perhaps worth mentioning that *Gunnera* considered separately from Haloragaceae, falls into the group a_ob, while the rest of the family (so far as known) falls fairly consistently into ab.

XI. REVIEW OF FOSSIL RECORDS

This aspect of Haloragaceae has been ably summarized by Praglowski (1970), and will not be reiterated in detail here. Most of the fossil records are of pollen samples, and thus, because of the similarity in pollen morphology of most genera of Haloragaceae, cannot be accurately referred to individual species or (sometimes) even to genera.

Fossil pollen assigned to *Myriophyllum* spp. is known from Oligocene and Miocene deposits in New Zealand, from the Miocene of Madras and from the Middle Eocene of Colorado and Utah. Numerous records of fossil *Myriophyllum* pollen,seeds and fruits are known from the inter- and post-glacial deposits of Britain and Europe.

Pollen similar to that of *Haloragis* has been found in the Oligocene of New Zealand, and the Pliocene of Western Australia, whereas pollen similar to that of *Gonocarpus* has been found in the Eocene of Burma.

Fossil fruits of *Proserpinaca* are known from late Tertiary and Miocene deposits of Europe and Siberia. *Proserpinaca* is now confined to Central America. With this exception, the fossil evidence shows a distribution pattern for the genera of Haloragaceae which is more or less unchanged from the late Tertiary to the present.

Praglowski (1970) suggested that some members of the widespread Tertiary and late Cretaceous sporomorph Stemma Normapolles have similarities with the pollen of Haloragaceae, particularly *Haloragis*. On this basis he proposed that during the Tertiary Haloragaceae (or their immediate progenitors) were much more widespread than at present, and occurred "throughout Euro-Asia and the palaeo-subantarctic areas".

In view of the close similarity that Praglowski himself found between the pollen of *Haloragis*, *Gonocarpus*, *Proserpinaca*, *Laurembergia* and *Myriophyllum*, and the similarity between the pollen of Haloragaceae and such typically European families as Ulmaceae and Betulaceae (Praglowski, 1970; Erdtman, 1966), it seems premature to suggest that the Normapolles fossils of Eurasia are more likely to be proto-*Haloragis* than they are likely to be proto-*Myriophyllum* or even proto-*Ulmus*. Until a more complete series of fossils between Normapolles and *Haloragis* can be demonstrated, it seems better to postulate a basically Southern Hemisphere origin for Haloragaceae, at least as far back as the Oligocene. The presence of the aquatic genera *Myriophyllum* and *Proserpinaca* in the Northern Hemisphere in the Tertiary can probably be explained by either long-distance dispersal, or movement through the tropics via their aquatic (and therefore relatively uniform) environment.

XII. TAXONOMY

(Note: The use of new names and new combinations in this thesis does not constitute valid publication.)

HALORAGACEAE R. Brown in Flinders, Voy. Terra Aust. 2, App.3(1814)549 ['Halorageae'] [Type genus: *Haloragis* Forst. & Forst. f.] Gray, British Pl. 2(1821)555; Reichenbach, Consp. Reg. Veg. (1828)169; DC., Prod. 3(1828)65-72; Dumort., Anal. fam. (1829)39 ['Haloragideae']; Lindley, Nat. Syst. (1830)57; Bartling, Ord. Nat. Pl. (1830)314; Don, Gen. Hist. Dichlam. pl. 2(1832)701; Reichenbach, Fl. Germ. (1832)632; Wight & Arn., Prod. (1834)337; Spach, Veg. Phan. 4(1835)442; Meisner, Pl. Vasc. Gen. (1838)122 [subord. Onagracearum]; Endl., Gen. pl. (1840)1195; Endl., Enchir. (1841)639; Walp., Rep. 2(1843)98('89')-100; Nees in Lehm., Pl. Preiss. 1(1844)158-159; Walp., Rep. 5(1846)671-672; Lindley, Veg. Kingd. (1846)722 ['Haloragaceae']; Nees in Lehm., Fl. Preiss. 2(1848)224-226; A. Gray, Bot. U.S. Expl. Exped. 1(1854)624-634 [subord. Onagracearum]; Hook. f., Fl. Tas. 1(1856)119-124; Sonder, Linnaea 28(1856)229-234; Benth., Fl. Aust. 2(1864)470; Benth. & Hook., Gen. Pl. (1865)673-677; Le Maout & Decaisne, Gen. syst. (1873)414-416; Clarke in Hook. f., Fl. Brit. Ind. 2(1878)430-434; F.v.M., Census 1(1882)49-50; Bailey, Syn. Qld. Pl. (1883)156-158; F.v.M., Key Syst. Vict. Pl. 2(1885)22, 1(1887-8) 259; F.v.M., Sec. Census 1(1889)85-86; Featon, Art Alb. N.Zeal. Fl. 1(1889)147-153; Tate, Fl. S.Aust. (1890)100-102, 233-234; Moore, Hdbk. Fl. N.S.Wales (1893) 184-187; Kirk, Stud. Fl. N.Zeal. (1899)147-156; Petersen, Pflfam. III.7(1893)226-237 ['Halorrhagidaceae']; Bailey, Qld. Fl. 2(1900)552-558; Rodway, Tasm. Fl. (1903)48-50; Diels & Pritzel, Bot. Jb. 35(1904)444-449; Schindler, Bot. Jb. 34, Beibl. 77(1904)1-77;

Schindler, Pflrch. 23(1905)1-133 ['Halorrhagaceae']; Cheeseman, Man. N.Zeal. Fl. (1906)147-159; Dixon, Pl. N.S.Wales (1906)129-131; Merrill, Philipp. J. Sci. 1, Suppl. (1906)216; Britten, J. Bot. 45(1907)135-137; Cheeseman, Trans. N.Zeal. Inst. 42(1909)201-203; Bailey, Cat. Qld. Pl. (1913)174-175; Guillaumin, Bull. Soc. Bot. France 61(1914)8-12; Maiden & Betche, Census N.S.Wales Pl. (1916)158-159; Ewart & Davies, Fl. N.Terr. (1917)214-215; Cheeseman, Man. N.Zeal. Fl. 2 ed. (1925)619-630 ['Haloragidaceae']; Black, Fl. S.Aust. (1926)428-432; Mansfeld, Bot. Jb. 61(1927)26-27; Domin, Bibl. Bot. 89(1929)1034-1036; Ewart, Fl. Vict. (1931)878-887; Gardner, Enum. (1931)99-100; van Steenis, Bull. Jard. Bot. Buitenz. III.13(1934)217-218; Merrill & Perry, J. Arn. Arb. 23(1942) 407; Black, Fl. S.Aust. 2 ed. (1952)640-647; Curtis, Stud. Fl. Tasm. 1(1956)186-191; Hutchinson, Fam. Fl. Pl. 2 ed. 1(1959)448-449; Gardner, Wildfls W.Aust. (1959)119-120; Bullock, Taxon 8(1959)175; Allan, Fl. N.Zeal. 1(1961)241-253; Evans in Beadle, Evans & Carolin, Vasc. Pl. Syd. Distr. (1963)174-176 ['Haloragiaceae']; Blackall & Grieve, W.Aust. Wildfls. 3(1965)463-474; Ohwi, Fl. Jap. (1965)659-661.

Hygrobiae L.C.M. Richard, Dem. Bot. (1808)34; Cambess. in St.Hil., Fl. Bras. 2(1830)250-252 ['Hygrobieae']; Spach, Veg. Phan. 4(1835)442-443 [trib. Haloragarum].

Cercodianae Jussieu, Dict. ~~Sie.~~ Sci. Nat. 5(1817)441-442.

Annual or perennial aquatic or terrestrial herbs or small shrubs, glabrous or scabrous with simple uniseriate hairs. Stems creeping, procumbent, ascending or erect, often rooting at the lower nodes. Leaves decussate, spiral or whorled, exstipulate, sessile or petiolate, simple, blades entire, toothed or deeply dissected, midrib usually ± channelled above, prominent below.

Inflorescence an indeterminate or determinate spike of dichasia (or monochasia, or single flowers) borne in the axils of leaf-like primary bracts. Lateral inflorescences similar to, but usually simpler than the main one, are borne in the axils of the upper leaves. Where the inflorescence consists of many-flowered dichasia, the flowers are subtended by membranous, persistent or deciduous, secondary, tertiary and higher order bracts.

Flowers actinomorphic, choripetalous, epigynous, protandrous, anemophilous or entomophilous, cream, green or reddish, bisexual or unisexual-monoecious. Sepals (2-3-)4 (absent in female flowers of *Myriophyllum*), linear, deltoid, ovate or cordate, lacking ribs, or with a prominent midrib, ± median basal callus. Petals same in number as sepals (absent in *Proserpinaca* and female flowers of *Myriophyllum* and *Laurembergia*), imbricate, hooded or navicular, ± unguiculate, ± keeled, deciduous with stamens. Stamens equal to or twice the number of sepals, filaments short, slender; anthers 4-locular, dehiscing by slits, oblong (reniform in *Proserpinaca*), the connective sometimes produced to form an apiculum, the antisepalous anthers sometimes ± longer than antipetalous ones. Pollen grains paraisopolar to isopolar, radially symmetrical, pertectate, 4-5 (-6)-colpate or 4-5-porate, crassimarginate or tenuimarginate, frequently aspidote, polar axis 16-35μ, equatorial diameter 20-40μ, suboblate, oblate-spheroidal or rarely spheroidal or oblate, peritreme to goniotreme. Microspore cytokinesis is simultaneous and the grains are shed at the 3-celled stage.

Styles same in number as sepals (rarely, half as many), clavate, ± bulbous based, convergent at tips until anthers shed, stigmas ± capitate, fimbriate. Ovary syncarpous, smooth or longitudinally ribbed opposite sepals and petals, ± (2-3-)4-celled, septa solid, of up to 7 cells in thickness, or insubstantial, or practically absent (present only at base and apex of ovary). Ovules 1-2 per locule (if 2, then 1 aborts at an early stage), pendulous, anatropous, bitegmic, and crassinucellar, with porogamous fertilization. Embryo sac development of Polygonum type; endosperm *ab initio* Cellular or Nuclear; embryogeny conforms to the Myriophyllum-variation of the Caryophyllad type.

Fruit an indehiscent 1-4-seeded nut (splitting into four 1-seeded nutlets in *Myriophyllum*), usually ± ovoid, but variously ornamented with wings, ribs and tubercles. Pericarp ± membranous or endocarp (and septa, if present) woody, exocarp membranous or swollen and spongy. Sepals persistent, erect or reflexed, enclosing styles or styles reflexed between them.

A family of eight genera and about 100 species, distributed mainly in the Southern Hemisphere, particularly in Australia; *Myriophyllum* is cosmopolitan and *Proserpinaca* is confined to the northern Hemisphere. The species are found in most types of habitat, although rare in tropical rainforest, and absent in marine environments.

Notes.

1. Numerous different spellings of the name for this family have been proposed since Brown's recognition of the family in 1814. The spelling Haloragaceae is conserved under the International Code of Botanical Nomenclature (see Bullock, 1959).

2. In his paper of 1904 Schindler used many of the new names and new combinations later published in his monograph (1905). As he cited many of these names as "ined." in the earlier paper it is considered that he did not accept them as being validly published in this paper, and they therefore date from 1905.

KEY TO THE GENERA OF HALORAGACEAE

1. All flowers with petals.
   2. Leaves entire or toothed, rarely deeply dissected (if dissected, then lacking tooth in the sinus between the segments.
      3. Petals hooded; anthers non-apiculate; inflorescence indeterminate.
         4. Fruits (2-3-)4- locular, septa solid; flowers in (1-)3-7-flowered dichasia in the axils of alternate primary bracts. A. *Haloragis*
         4. Fruits 1-locular, septa absent; flowers solitary (rarely 1-3) in axils of alternate or opposite primary bracts. E. *Gonocarpus*
      3. Petals navicular; anthers usually apiculate; inflorescence determinate.
         5. Leaves serrate; inflorescence narrow, spike-like. B. *Haloragodendron*
         5. Leaves entire; inflorescence broad, pseudo-umbelliform. C. *Glischrocaryon*
   2. Leaves trifid, with small tooth in the sinus between the lobes. D. *Meziella*
1. At least female flowers lacking petals.
   6. Fruit indehiscent.
      7. Flowers unisexual; petals absent in female flowers only; fruit 1-locular. F. *Laurembergia*
      7. Flowers bisexual; petals absent (rarely, rudimentary); fruit 3-locular. G. *Proserpinaca*
   6. Fruit splitting at maturity into 4 nutlets. H. *Myriophyllum*

A. HALORAGIS Forst. et Forst. f., Char. Gen. (1776)61, t.31 [Type ~~species~~: *Haloragis prostrata* Forst. et Forst. f.]; L'Herit., Stirp. Nov.(1788)82; Dryand. in Aiton, Hort. Kew 2(1789)37; Brown, App. Flinders Voy. 2(1814)550 p.p.; DC., Prod. 3(1828)66; Wight & Arn., Prod. (1834)338 p.p.; Lindl., Nat. Syst. 2 ed. (1836)37 p.p.; Walp., Rep. 2(1843)99 p.p.; Walp., Rep. 5(1846)672; Hook. f., Fl. N.Zeal. 1(1852)62 p.p.; Gray, Bot. U.S. Expl. Exped. 1(1854)624 p.p.; Hook. f., Fl. Tas. 1(1856)119 p.p. 2(1859)162 p.p.; Benth., Fl. Aust. 2(1864)473 p.p.; Benth. & Hook. Gen. Pl. 1(1965)674, 675 p.p.; LeMaout & DeCaisne, Gen. Syst. Bot. (1873)414 p.p.; Eichler, Bluethendiag. (1875)463-464 p.p.; Hook., f., Fl. Brit. India 2(1878)430 p.p.; Baill., Nat. Hist. Pl. 6(1880)500 p.p.; F.v.M., Census 1(1882)49 p.p.; Bailey, Syn. Qld. Fl. (1883)156 p.p.; F.v.M., Key Syst. Vict. Pl. 2(1885)22, 1(1887-8)261 p.p.; F.v.M., Sec. Census 1(1889)85 p.p.; Featon, Art Alb. N.Zeal. Fl. (1889)147 p.p.; Tate, Fl. S.Aust. (1890)101 p.p.; Petersen, Pflfam. 3(1893)227-233 p.p. ['Halorrhagis']; Moore, Fl. N.S.Wales (1893)185; Bailey, Qld. Fl. 2(1900)552 p.p.; Rodway, Tas. Fl. (1903)48 p.p.; Diels & Pritzel, Bot. Jb. 35(1904)445, 446 p.p.; Schindler, Pflrch. 23(1905)19 p.p.; Dixon, Pl. N.S.Wales (1906)129, 130 p.p.; Merrill, Philip. J. Sci. 1 Suppl. (1906)216 p.p.; Britten, J. Bot. 45(1907)135-137 p.p.; Cheeseman, Trans. N.Zeal. Inst. 42(1909)201-203 p.p.; Bailey, Cat. Qld. Pl. (1913)174 p.p.; Maid. & Betche, Cens. N.S.Wales Pl. (1916)158 p.p.; Ewart & Davies, Fl. N. Terr. (1917)214 p.p.; Went, Nova Guinea 14(1924)105-106 p.p.; Cheeseman, Fl. N. Zeal. 2 ed. (1925)620 p.p.; Black, Fl. S.Aust. (1926)429 p.p.; Mansfeld, Bot. Jb. 61(1927)26 p.p.; Domin, Bibl. Bot. 89(1929)1034 p.p.; Ewart, Fl. Vict. (1931)879 p.p.; Gardner, Enum. (1931)99 p.p.;

van Steenis, Bull. Jard. Bot. Buitenz. III, 13(1934)217-218 p.p.; Black, Fl. S. Aust. 2 ed. (1952)641 p.p.; Curtis, Stud. Fl. Tasm. 1(1956)187 p.p.; Gardner, Wildfl. W. Aust. (1959)120 p.p.; Evans in Beadle, Evans & Carolin, Hdbk. Pl. Syd. Dist. (1963)174 p.p.; Ohwi, Fl. Japan (1965)660 p.p.; Blackall & Grieve, W. Aust. Wildfl. 3(1965)463, 464 p.p.; Praglowski, Grana 10(1970)159-239 p.p.

Cercodia Banks ex Murray, Comm. Goett. (1780)3-8 [Type species: *C.erecta* Banks ex Murray]; Lam., Encycl. Meth. 1(1785)682 et Tabl. Enc. 1(1797)t.319 ['Cercodea']; DC., Prod. 3(1828)67; Lindl., Nat. Syst. 2.ed. (1836)37; Cunningham, Ann. Nat. Hist. 3(1839)29;

Meionectes R. Br., App. Flinders Voy. 2(1814)550 [Type species: *M.brownii* Hook. f.]; Hook. f. in Hook., Icones Pl. 4(1841)t.306; Lindl., Nat. Syst. 2 ed. (1836)37 ['Mejonectes']; Endl., Gen. Pl. Suppl. 2(1842)93; Walp., Rep. 2(1843)98, 5(1846)671 ['Meionectis']; Nees in Lehm., Pl. Preiss. 2(1848)224 [on p.225,'Mejonectes']; Hook., f., Fl. Tasm. 1(1856)123; Benth., Fl. Aust. 2(1864)486; Benth & Hook., Gen. Pl.1(1865)675; LeMaout & DeCaisne, Gen. Syst. (1873)414; Eichler, Bluethendiag. (1875)463,464; F.v.M., Census 1(1882)50; F.v.M., Trans. roy. Soc. Vict. 24(1888)137 pro syn. *Haloragis*, ['Meinoctes' sphalm]; Petersen, Pflfam. 3(1893)233; Dixon, Pl. N.S.Wales (1906)130.

Annual or perennial herbs or subshrubs 10-80(-150) cm tall, rootstock a simple taproot or a deep horizontal stolon, stems prostrate, ascending or erect, smooth or 4-5 ribbed, herbaceous or woody towards base, sometimes rooting in lower part, glabrous, scabrous or pilose with various types of simple hairs.

Leaves alternate or opposite, terete, linear, lanceolate or ovate, simple to pinnatifid, margin entire or (usually) serrate, midrib sunken above, prominent (rarely obscure) below, petiolate or sessile, exstipulate, glabrous, scabrous or pilose with hairs as for stems.

Inflorescence an indeterminate spike of (1-)3-7-flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences usually borne in the axils of the upper leaves. Primary bracts leaflike, grading into upper leaves at base of inflorescence, becoming ± rapidly reduced in size and serrations towards apex. Secondary, tertiary etc. bracts brown, linear, membranous, much smaller than primary bracts.

Flowers 2-3-or 4-merous on short pedicels. Sepals 2, 3 or 4, usually smooth, deltoid, glabrous, scabrous or pilose. Petals same in number as sepals, hooded, ± unguiculate, keeled, glabrous or pilose or scabrous on keel. Stamens twice the number of sepals, filaments short; anthers 4 locular, non-apiculate, oblong, antisepalous anthers slightly longer than antipetalous ones. Styles same in number as sepals, clavate, stigmas capitate. Ovary ovoid to hemispherical, smooth, or ribbed opposite petals and/or sepals, glabrous, scabrous or pilose, with 2, 3 or 4 locules,each with 1(-2) pendulous ovules (if 2, then 1 aborts at an early stage).

Fruits extremely variable in shape, smooth or ribbed opposite sepals and/or alternating with them, or winged between sepals, and/or with massive protuberant processes opposite sepals, or covering entire fruit, smooth or tuberculate between ribs or wings; sepals persistent, usually deltoid, erect or reflexed, ± smooth; 2, 3 or 4 locules, septa and endocarp solid, ± woody, exocarp membranous or spongy; 1-4 seeds (potentially 1 per locule, but fruit forms normally whether all seeds develop or not).

Distribution.

Haloragis is confined almost entirely to Australia, where it grows in all but the tropical and subtropical areas in the extreme north. The only extra-Australian species are the type *H. prostrata* which is endemic to New Caledonia and nearby islands, *H. erecta* in New Zealand, Chatham and the Kermadec Islands, and *H. masatierrana* and *H. masafuerana* which are found in the Juan Fernandez islands.

Ecology.

The species of this genus occupy a wide range of habitats, ranging from obligate aquatics (*H. brownii*) to desert ephemerals (*H. gossei*). They are found on deep sand (*H. acutangula*) or heavy clays (*H. heterophylla*), on shallow soils over limestone (*H. acutangula*). on the sea shore (*H. prostrata*) or only inland (*H. uncatipila*), in tussocks within swamps (*H. myriocarpa*), confined to river banks (*H. exalata*) or semi-arid savannah woodland (*H. odontocarpa*). Many species favour disturbed habitats, spreading by means of a deep stoloniferous rootstock, and have become serious weeds in pastures in some areas (*H. heterophylla*, *H. glauca*). The only major habitat types which *Haloragis* avoids within its range are salty areas (although 1 collection of *H. erecta* is claimed to have come from "salt marshes" (Scott CHR87914), and several species are coastal), rain forest and subtropical areas, and alpine localities where snow habitually persists on the ground during winter. Flowering and fruiting times may be irregular (in ephemeral species e.g. *H.gossei*) but are usually during the drier summer period of about October to March. Pollination is probably mainly anemophilous, but in at least one species, (*H. acutangula*), can be entomophilous. Most species are potentially perennial, dying back to the rootstock and lower branches after fruiting, and shooting again during the following winter/spring.

Notes.

1. The Forsters spelt the name of this genus "Haloragis' and this original spelling was observed until 1893 when Petersen changed the spelling of the genus and family to 'Halorrhagis' and 'Halorrhagidaceae' respectively, presumably to bring them into line with classical usage. Petersen was followed by Schindler in the spelling of the genus, but Schindler called the family 'Halorrhagaceae',and coined the names for the subfamily 'Halorrhagoideae', tribe 'Halorrhageae', and subgenera 'Euhalorrhagis' and 'Pseudohalorrhagis'. Schindler's spellings have been followed since 1905 by most authors. However, under the International Code of Botanical Nomenclature a name may not be changed because it fails to comply with classical usage, in which case the original spelling must be followed, and Petersen's and Schindler's names are to be considered as orthographic variants. [The name Haloragaceae for the family is conserved. International Code of Botanical Nomenclature ed. 1966, p.216.]

2. *Cercodia* was first reduced to synonymy under *Haloragis* by L'Heritier (1788) and he was followed by most subsequent authors, although deCandolle (1828), Lindley (1836) and Cunningham maintained *Cercodia* as a distinct genus.

3. *Meionectes* was described by Robert Brown to include species differing from *Haloragis* in their number of floral parts (bimerous flowers instead of tetramerous). The genus was subsequently typified by J.D. Hooker's *M. brownii*. Baillon (1877) was the first author to reduce *Meionectes* to synonymy under *Haloragis*, pointing out the existence

of intermediate (trimerous) species. Although this reduction in status was not immediately accepted by all authors, it was adopted by Schindler (1904, 1905) and is now generally agreed to be correct.

4. *Gonocarpus* was considered synonymous with *Haloragis* by Brown (1814), and he was followed by most authors (with the notable exception of deCandolle). In the present study *Gonocarpus* is reinstated as a distinct genus on the basis of differences in the inflorescencee and in fruit and seed morphology and development.

Key to the species of *Haloragis*.

(1) Vegetative leaves opposite, at least in the lower parts, (linear-) lanceolate to ovate, never pinnatifid or terete.

(2) Ovary 4-locular, styles 4.

(3) Fruit becoming 3-locular by abortion, leaves coriaceous.
8. *H. eichleri*

(3) Fruit 4-locular, leaves thin.

(4) Leaves sessile

(5) Leaves lanceolate to oblong, (4.0-) 6.0-10.0 cm long, 1.3-2.5 cm wide
1. *H. exalata* subsp. *exalata*

(5) Leaves not as above.

(6) Leaves spathulate, ± entire, 1.5-3.0 cm long, 0.5-0.8 cm wide; plant prostrate, glabrous. [New Caledonia]
6. *H. prostrata*

(6) Leaves linear-lanceolate, entire or finely serrate, 2.5-4.0 cm long, 0.2-0.5 cm wide, plant erect, scabrous. [Australia]
2. *H. stricta*

(4) Leaves petiolate; petioles at least 0.2 cm long.

(7) Lamina ovate to orbicular.

(8) Fruits ovoid, with 4 deltoid wings or ribbed between sepals, glabrous or scabrous.

(9) Sepals 0.8-1.2 mm long, petals (1.6-) 2.0-2.2 mm long, 0.6-0.7 mm wide (keel to margin). [New Zealand, Chatham and Kermadec Is.]
3. *H. erecta*

(9) Sepals 0.6–0.8 mm long, petals (1.8–) 2.2–2.3 mm long, 0.5–0.6 mm wide (keel to margin). [Juan Fernandez Is.]

4. *H. masafuerana*

(8) Fruits ovoid, without wings or ribs between sepals, glabrous. [Juan Fernandez Is.]

5. *H. masatierrana*

(7) Lamina spathulate or narrow-lanceolate.

(10) Lamina narrow-lanceolate, finely serrate with 30–40 teeth, 5.5–6.0 cm long, 0.6–0.8 cm wide, densely velvety tomentose.

1. *H. exalata* subsp. *velutina*

(10) Lamina spathulate, entire, 1.5–3.0 cm long, 0.5–0.8 cm wide, glabrous. 6. *H. prostrata*

(2) Ovary 2-locular, styles 2 7. *H. serra*

(1) Vegetative leaves all alternate, rarely opposite in lower parts and then leaves pinnatifid, trifid, multifid or terete.

(11) Leaves distinctly petiolate (petiole at least 0.5 cm long).

(12) Flowers tetramerous, fruits ± 4-winged or wingless.

9. *H. odontocarpa*

(12) Flowers trimerous, fruits 3-winged.

(13) Fruiting sepals lacking lateral veins, wings membranous without semitransparent "windows".

10. *H. gossei*

(13) Fruiting sepals with midrib and 2 lateral veins, wings woody with 2–4 semitransparent "windows"

11. *H. trigonocarpa*

(11) Leaves sessile or very shortly petiolate (petiole less than 0.5 cm long).

(14) Ovary and fruit 4-locular.

(15) Leaves narrow-lanceolate to narrow-ovate (never terete, multifid or pinnatifid), serrate at least in upper part.

(16) Plants scabrous.

(17) Hairs curved, 1-2-celled, 0.1-0.3(-0.4) mm long.

(18) Plants lacking stoloniferous rootstock.

(19) Flowering sepals deltoid, fruiting sepals deltoid, about as broad as long,(1.0-1.2 X 0.8-1.0 mm)

12. *H. acutangula*

(19) Flowering sepals cordate, fruiting sepals unknown.

16. *H. foliosa*

(18) Plants with stoloniferous rootstock.

(20) Flowering sepals cordate, fruiting sepals unknown.

16. *H. foliosa*

(20) Flowering sepals linear-lanceolate, fruiting sepals linear, 1½-2 times as long as broad, (1.0-1.5 X 0.4-0.5(-1.0) mm).

15. *H. glauca*

(17) Hairs hooked at tip, 2-4-celled, 0.1-0.5 mm long.

(21) Fruit ovoid, pyriform or globular, exocarp not swollen or spongy, sepals erect in fruit.

13. *H. aspera*

(21) Fruit globular, exocarp swollen, spongy, sepals erect or reflexed in fruit. 14. *H. uncatipila*

(16) Plants glabrous or with papillose hairs.

(22) Plants glabrous; fruits of various shapes.

(23) Fruiting sepals deltoid, about as long as broad [1.0-1.2 X 0.8-1.0 mm]; leaves green.

12. *H. acutangula*

(23) Fruiting sepals linear, longer than broad [1.0-1.5 X 0.4-0.5 mm]; leaves glaucous.

15. *H. glauca*

(22) Plants with unicellular, transparent papillose hairs 0.1-0.2 mm long; fruit depressed globular; exocarp swollen, spongy. 17. *H. platycarpa*

(15) Leaves terete, multifid or pinnatifid, margins not serrate.

(24) Leaves multifid or trifid, scabrous with hairs hooked at the tip, or rarely glabrous. 20. *H. heterophylla*

(24) Leaves terete, glabrous or very sparsely scabrous with short, thick, curved 1-2 celled hairs, margins sometimes very weakly tubercularly toothed.

21. *H. myriocarpa*

(14) Ovary and fruit (1-)2-3 celled.

(25) Leaves linear to narrow-lanceolate.

(26) Plants scabrous.

(27) Leaves serrate with (2-)6-8 linear-deltoid teeth 1-3 mm long; fruit 1.8-2.0 mm long, 1.5-1.9 mm wide, 2-3-locular.
18. *H. aculeolata*

(27) Leaves entire or very weakly serrate with 1-4 teeth; fruit 1.3-1.5 mm long, 0.9-1.0(-1.4) mm wide, 1-3-locular.
22. *H. digyna*

(26) Plants glabrous

(28) Leaves 4.0-6.0(-7.5)cm long, 0.2-0.4(-0.7) cm wide, strongly serrate with 2-4 (-8) teeth in upper part; fruit 2-locular. 19. *H. scoparia*

(28) Leaves (1.0-)1.5-2.0(-2.3) cm long, (1.0-)1.5-2.0 mm wide, entire or weakly serrate with 1-4 teeth; fruit 1-3-locular.
22. *H. digyna*

(25) Leaves pinnatifid, multifid or pinnatipartite.

(29) Fruit and ovary 3-locular. 23. *H. tenuifolia*

(29) Fruit and ovary 2-locular. 24. *H. brownii*

1. *Haloragis exalata* F.v.Mueller, Trans. ~~roy.~~ Soc. Vict. 24(1888)133, 134 [Typus: "Mount Dromedary (Reeder), on the Burnett River (Hely)." Lectotypus (Orchard): Anon s.n., Mt. Dromedary, NSW37303 (fl.)! Syntypus: C. Hely s.n., Burnett River, Queensland, MEL1003524 (fl.,fr.)!]; F.v.M., Sec. Census 1(1889)85; Moore, Hdbk. Fl. N.S.Wales (1893)186; Schindler, Bot. Jb. 34 Beibl. 77(1904)42; Schindler, Pflrch. 23(1905)50; Dixon, Pl. N.S.Wales (1906)129; Maid. & Betche, Census N.S.Wales Pl. (1916)158; Skottsberg, Nat. Hist. Juan Fern. & Easter Is. 2(1922)153; Ewart, Fl. Vict. (1931)883; Evans in Beadle, Evans & Carolin, Hdbk. Vasc. Pl. Syd. Dist. (1963)175; Forde, N.Zeal. J. Bot. 2(1964)426, 448-450.

Figs: Schindler, Pflrch. 23(1905) fig.15A,B; Forde, N.Zeal. J. Bot. 2(1964) fig. 16f.

Haloragis alata auct. non Jacquin (1781): Benth., Fl. Aust. 2(1864)479; F.v.M., Census 1(1882)49; Bailey, Qld. Fl. 2(1900)554; Bailey, Comp. Cat. Qld. Pl. (1913)174.

Subshrub 1-1½ m tall, stems erect, prominently 4-angled, glabrous or finely scabrous, green to reddish-purple. Leaves opposite, becoming alternate just below inflorescence, lanceolate to narrow-lanceolate, (4-)5.5-10 cm long, 0.6-2.5 cm wide, serrate or biserrate, sessile or shortly petiolate, midrib channelled above, prominent below, glabrous, finely scabrous or with a velvety tomentum.

Inflorescence an indeterminate spike of 3-7(-15)-flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences are borne in the axils of the upper (alternate) leaves. Within each dichasium, all flowers develop to anthesis except that those of the ultimate branches may abort at an earlier stage. Primary bracts leaf-like, serrate, lanceolate, midrib ± distinct, (2-)5-7 mm long, 0.5-1.5 (-3.0) mm wide; secondary bracts membranous, brown, linear-lanceolate, entire (0.2-) 0.4-0.5 mm long, 0.1-0.2 mm wide, deciduous; tertiary and higher order bracts minute, membranous, deciduous.

Flowers 4-merous. Sepals 4, ovate-deltoid, smooth, 0.6-0.8 mm long, 0.5 mm wide, glabrous or tomentose. Petals 4, yellow-green to reddish, hooded, (2.0-)2.4-3.3 mm long, 0.6-0.7 mm wide (keel to margin), glabrous or tomentose. Stamens 8, filaments 0.3-0.5 mm long; anthers yellow, non-apiculate, 1.6-2.0(-2.8) mm long, 0.2-0.3 mm wide. Styles 4, hooked at tips; stigmata fimbriate, pink-purplish. Ovary green, globular to ovoid, on a pedicel 0.7-1.5 mm long, 4-angled opposite the petals, otherwise smooth, 0.5-0.6 mm long, 0.5-0.6 mm wide, glabrous, scabrous or velvety tomentose, ovules pendulous, 2 per locule but 1 aborts at an early stage.

Only 1-3(-7) flowers per compound dichasium develop into fruits. Fruit ovoid to pyriform, 2.0-2.5 mm long, 1.7-2.2 mm wide, 4-ribbed opposite the petals, with ± 4 grooves opposite the sepals, smooth or somewhat wrinkled or irregularly transversely corrugated between the ribs, 4-celled with a woody endocarp and septa, and hollow columella. Sepals persistent, erect, deltoid, 0.5-1.0 mm long, 0.5-1.0 mm wide, with a faint median rib. Seeds 1 to 4.

i. subsp. *exalata*

Subshrub 1-1½ m tall, stems glabrous or very finely scabrous, particularly on the ribs. Leaves opposite, becoming alternate in the inflorescence, sessile or very shortly petiolate, (and then the leaf tapering abruptly into the petiole), lanceolate, (4.0-)6.0-10.0 cm long, 1.3-2.5 cm wide, broadest just below the middle, serrate or biserrate, midrib channelled above, prominent below, lateral veins faint and diverging at 20°-30° to the midrib, lamina dark green above, paler below, glabrous or very finely scabrous.

Inflorescence and flowers as for the species. Flowers glabrous or scabrous, 3-7(-15) per compound dichasium, of which all except those of the ultimate branches are functional. Fruits as for the species, ovoid, 2.0-2.5 mm long, 1.8-2.2 mm wide; sepals persistent, deltoid, 0.8-1.0 mm long, 0.8-1.0 mm wide, enclosing the persistent styles.

α. var. *exalata*

Stems and leaves finely scabrous. Flowers glabrous except for the ovary which is scabrous. Inflorescence as for the species, with 3-7 flowers per dichasium, of which only 1-2(-3) develop into fruits. Primary bracts leaf-like, lanceolate, 5-7 mm long, 1.5-3.0 mm wide, serrate, finely scabrous, midrib distinct; secondary bracts membranous, linear-lanceolate, 0.5 mm long, 0.1 mm wide, entire, glabrous. Fruit as for the subspecies. (Fig. 21)

Distribution. (Map 1)

This plant is known only from the lower reaches of the Glenelg River and Curdies Creek in south-western Victoria, and from three widely scattered localities in eastern New South Wales. Location of type locality (Mt. Dromedary) unknown. (?Qld. or Tas.).

Ecology.

Very little is known, or recorded, except that the species as a whole appears to favour the banks or vicinity of fairly large rivers.

Common names.

"Wingless raspwort" (Beauglehole 457)

Specimens examined.

Victoria: Beauglehole 457, 25.iii.1945, -.x.1946, above Swan Lake Falls, ± 20 m. W. of Portland, BEAUGLEHOLE (st.), MEL (fr.); Beauglehole 5879, 15.iii.1954, S. of Dartmoor, Lower Glenelg River, AD, MEL (fr.); Beauglehole 17012, -.x.1946, Moleside Creek, Lower Glenelg River, BEAUGLEHOLE (st.); Beauglehole 17031, 5.iii.1950, Swan Lake Falls, ± 20 m. W. of Portland, BEAUGLEHOLE (fl.,fr.); Beauglehole & Finck 20012 (&21122?), 5.ix.1966, W. side of Port Campbell Creek, BEAUGLEHOLE (st.); Eckert s.n., 1891, Lower Glenelg River, MEL1003738 (fl.); Gardiner s.n., -.i.1900, Curdies River, MEL1003529 (fr.); Orchard 2011, 2014, 13.ii.1969, Moleside Creek, AD (fl.,fr.); Orchard 2016, 13.ii.1969, junction of Moleside Creek and Glenelg River, AD (fr.); Walter s.n., -.i.1900, Curdies River, NSW99248 (fr.); Williamson s.n., 1894, Entrance of the Curdies River, MEL38933, 1003528, 1003540 (fl.,fr.); Williamson s.n., -.xi.1900, Curdie River, NSW99249 (fl.,fr.).

New South Wales: Anon. s.n., banks of Nepean River, MEL1003525 (fl.); Anon. s.n., Mt. Dromedary, NSW37303 (fl.) - lectotype of *Haloragis exalata*; Baeuerlen 131, -.i.1889, Mount Dromadary [sic], MEL (fl.,fr.); Betche 5, -.xii.1892, near Clifton, NSW (fr.); Reader s.n., Tilba Tilba, MEL1003523 (fl.); Woolls s.n., Nepean, MEL1003534 (st.); Woolls s.n., Nepean, MEL1003539 (fl.); Woolls s.n., Nepean River, NSW37302 (fl.,fr.).

Notes.

1. The choice of a lectotype was necessary because Mueller mentioned two specimens when proposing the new name for the Australian plants formerly referred to the New Zealand species *H. alata (H. erecta)*. One of the specimens mentioned by Mueller, (Hely, Burnett River) can be fairly safely identified as MEL1003524, but the other (Reeder, Mt. Dromedary) is obscure. There is no specimen collected by Reeder in the MEL holdings and the only collection from Mt. Dromedary ['Dromadary'] is ascribed to Baeuerlen and was collected after the species had been described. In the National Herbarium of New South Wales there is a collection annotated "Mt. Dromedary" but lacking a collector's name, number and date. This collection, (NSW37303), has had the original epithet "*alata*, Jacq"

crossed out, and "*exalata,* FvM" in a hand matching Mueller's substituted. As this specimen matches Mueller's scanty description more closely than Hely's specimen, and was probably seen and annotated by Mueller, it is chosen as lectotype, and fixes the application of the name *H. exalata* to the subspecies and varietas described above. The syntype (Hely, Burnett River, MEL1003524) differs somewhat from the lectotype, and falls into subspecies *velutina.*

2. A clinal variation exists in the degree of scabridity of the leaves and stems of var. *exalata.* In south-western Victoria var. *exalata* can scarcely be distinguished visually from var. *laevis,* because of the extremely short trichomes. However, the leaves and stems are distinctly scabrous to the touch. In New South Wales, especially in the Clifton specimen, and to a lesser extent in the Nepean specimens, the trichomes are easily visible to the naked eye. This may be caused by introgression with subsp. *velutina;* the hairs in these northern specimens approach those of subsp. *velutina* in size, but not in density or texture.

β. var. *laevis* (Schindl.) Orchard, comb. et. stat. nov.

Haloragis laevis Schindler, Pflrch. 23(1905)51 [Typus: "Australien (Bauer [del 673], Caley, D'Urville). - Herb. Berlin, Wien". Lectotypus (Orchard): Ferd. Bauer, del 673, Nova Holland., W (fl.)! Isolectotypus: Ferd. Bauer, del 673, Nova Holland., NSW99247 ex W (fl.)! Syntypi: Caley s.n., Nova Hollandia, W (Hrb. Maillo, Dupl. Banks) (fl.,fr.)!, D'Urville n. 1825, NSW99246 ex B (st.)!]

Stems and leaves as for var. *exalata,* but glabrous. Inflorescence as for the species, with up to 15 flowers in each compound dichasium. Of these 7-10 develop to anthesis and up to 7 finally form fruits. Primary bracts leaflike, lanceolate, 2.0-2.5 mm long, 0.5-0.7 mm wide, serrate, glabrous,midrib distinct; secondary bracts brown, membranous, linear-lanceolate,0.4 mm long, 0.1-0.2 mm wide, glabrous, deciduous. Flowers completely glabrous. Mature fruits not seen. (Fig.21)

Distribution. (Map 1)

The only collections with localities indicated are those of Woolls from Paramatta and the Nepean River (near Sydney), New South Wales. D'Urville's collection was probably from the vicinity of Port Jackson (Sydney) (cf. Maiden, 1910, pp 143-144), while Caley's and Bauer's collections were probably from east-central New South Wales (cf. Currey, 1966).

Ecology.

Nothing has been recorded.

Specimens examined:

New South Wales: Bauer 673, Nova Holland., W, NSW99247 (fl.) - lectotype & isolectotype of *H. laevis;* Caley s.n., Nova Hollandia, W (fl., young fr.) - syntype of *H. laevis;* D'Urville 1825, s. loc. NSW99246 (st.) - syntype of *H. laevis;* Woolls s.n., Nepean River, MEL1003526 (fl., young fr.); Woolls s.n., Paramatta, Nepean (2 labels), MEL1003538 (fl., young fr.).

Notes.

1. The choice of a lectotype was necessary because Schindler cited three collections in his description of *H. laevis*. The D'Urville collection in NSW is only a small fragment of the former collection in B (destroyed) and lacks flowers and fruits. The Bauer collection was preferred for the lectotype ahead of the Caley collection, as the former has a duplicate in NSW.

ii. ssp. *velutina* Orchard, ssp. nov.

Valde similari ssp. *exalatae* sed in caulibus foliis et floribus velutino - tomentosis differt. Folia angusto-lanceolata 5.5-6.0 cm longa 0.6-0.8 cm lata serrata dentibus deltatis 30-40, petiolus 0.5-1.0 cm longus. Bracteae primariae foliiformes lanceolatae 4.0-5.0 mm longae 0.6-1.0 mm latae integrae velutino-tomentosae; bracteae secundae membranaceae lineari-lanceolatae 0.2-0.3 mm longae 0.1-0.15 mm latae integrae velutino-tomentosae deciduae. Fructus obpyriformis 2.0 mm longus 1.7 mm latus leviter 4-costatus, rugosus.

Holotypus: J.L. Boorman s.n., -.i.1907, Dalmorton near Grafton N.S.W., NSW99251 (fl.)! Isotypus: J.L. Boorman s.n., -.i.1907, Dalmorton N.S.W., MEL1003575 ex NSW (fl., young fr.)!]

Syn.(?) *Haloragis burianum* Schindler, Fedde Rep. 9(1911)123 [Typus: "Neu-Sud-Wales, Kempsey (J.L. Boorman, Jan. 1907). Specimen aus dem National Herbarium of N.S.W. unter dem Namen *H. laevis* Schindler. - Herb. Berlin." Holotypus: n.v. (destroyed). Isotypi (?): J.L. Boorman s.n., -.i.1907, George's Creek, via Kempsey N.S.W., NSW99252 (fl.)!; J.L. Boorman s.n., -.i.1907, Kempsey N.S.W., G(herb. Pitard-Briau) ex NSW (fl., young fr.)! - see Note 1.]

Stems erect, red, slightly 4-angled, covered with a fine dense velvety tomentum less than 0.01 mm long. Leaves opposite, on petiole 0.5-1.0 cm long, narrow-lanceolate, 5.5-6.0 cm long, 0.6-0.8 cm wide, widest in middle, tapering gradually towards both ends, serrate with 30-40 small teeth mainly in the upper part, or almost entire, covered on both faces by a dense velvety tomentum; midrib channelled above,

± prominent below, lateral veins very indistinct.

Inflorescence as for ssp. *exalata*. Flowers in compound dichasia of 3-7, all flowers except those of the ultimate branches functional. Primary bracts leaf-like, lanceolate, 4.0-5.0 mm long, 0.6-1.0 mm wide, entire, velvety-tomentose, midrib ± distinct; secondary bracts, brown, membranous, linear-lanceolate, 0.2-0.3 mm long, 0.1-0.15 mm wide, entire, velvety-tomentose, deciduous; tertiary bracts minute.

Flowers velvety-tomentose on ovary, sepals and petals, reddish, otherwise as for ssp. *exalata*. 1-3 flowers per dichasium form fruits. Fruits pyriform 2.0 mm long, 1.7 mm wide, faintly 4-ribbed opposite the petals, slightly wrinkled, sepals deltoid, 0.5 mm long, 0.5 mm wide, persistent, styles reflexed between sepal lobes. (Fig. 21; Plate 13)

Distribution. (Map 1)

Confined to the eastern side of the Great Dividing Range, in north-eastern New South Wales and south-eastern Queensland. Where this sub-species overlaps in latitudinal range with var. *exalata* in north-eastern New South Wales, the two populations are separated by the Divid-ing Range.

Ecology.

Apparently confined to watercourses. Collectors' notes include "Swamp near Hamilton" (Bailey BRI080044) and "A fairly common plant growing amongst loose stones, along the course of the Macleay and Little Rivers" (Boorman NSW99252).

Specimens examined.

Queensland: Bailey s.n., Brisbane River, swamp near Hamilton, BRI080044 (fr.); Hely s.n., Burnett River, MEL1003524 (fl.,fr.) - syntype of *H. exalata;* White s.n., Bunya Mts., BRI080043 (st.).

<u>New South Wales</u>: Beckler s.n., Clarence River, MEL1003535 (fl.); Beckler s.n., Clarence River, MEL1003537 (st.); Beckler s.n., Richmond River, MEL1003527 (fr.); Boorman s.n., -.i.1907, Dalmorton, MEL1003575, NSW99251, (fl.,fr.) - isotype, holotype of *H. exalata* ssp. *velutina;* Boorman s.n., -.i.1907, George's Creek via Kempsey, NSW 99252 (fl.) - ? isotype of *H. burianum* (see Note 1.); Boorman s.n., -.i.1907, Kempsey, G (herb. Pitard-Briau) (fl.,fr.) - ? isotype of *H. burianum* (see Note 1); Crawford 564, -.iv.1885, Moona, Walcha, MEL (fl.,fr.); Davis 129, 26.i.1941, Macleay River, NSW (fl.); Leichardt s.n., Mr. Busden's New England, MEL1003533 (fr.).

<u>Notes</u>.

1. Schindler's description of *H. burianum* matches *H. exalata* ssp. *velutina* in all respects, except that Schindler described his plant as glabrous. The holotype of *H. burianum* formerly in B (ex NSW) has been destroyed (burnt in 1943), but a specimen in NSW and another in G, match the holotype citation and would normally be considered to be isotypes. However, these specimens, J.L. Boorman s.n., -.i.1907, Georges Creek, via Kempsey N.S.W.,NSW99252 (fl.) and J.L. Boorman s.n., -.i.1907, Kempsey N.S.W., G (herb. Pitard-Briau) ex NSW (fl., young fr.), have the velvety tomentum usual in *H. exalata* ssp. *velutina,* although agreeing with the description of *H. burianum* in all other respects. If it is considered that Schindler was mistaken in describing his plant as glabrous, then the specimens in NSW and G can be considered isotypes of *H. burianum* and that species is then synonymous with *H. exalata* ssp. *velutina*. If however the Boorman collection was mixed, and Schindler correctly described his plant as glabrous, then the only known collection, the holotype formerly in B, has been destroyed. In these circumstances the name cannot be typified until more material is collected from which a neotype could be selected; but even then, *H. burianum,* differing only in the lack of indumentum from *H. exalata* ssp. *velutina,* scarcely warrants specific status, and is probably best

considered as a minor variant of the latter, perhaps as a variety of that subspecies.

2. *H. exalata* was cited by Bentham (1864) and Mueller (1882) as *H. alata*. This was the name then applied (incorrectly) to the New Zealand species *H. erecta*. Mueller (1888) recognized that the Australian plants differ from the New Zealand ones in characters of the fruit, leaves and primary bracts. He coined the name *H. exalata* for the former group. In this he has been followed by all subsequent workers, with the exception of Bailey, who followed Bentham.

3. *H. exalata* agrees well with *H. erecta* in general habit and in some leaf, flower, fruit and indumentum characteristics, suggesting that these two species are fairly closely related. Among the Australian species, *H. exalata* (especially subsp. *velutina*) is probably most closely allied to *H. stricta*.

2. *Haloragis stricta* R. Br. ex Bentham, Fl. Aust. 2(1864)482 [Typus: "Queensland. Broad Sound, R. Brown (Herb. R. Br.)" Holotypus: R.Brown s.n., Broad Sound, MEL39298 ex K (fl.,fr.)! Isotypus: R.Brown s.n., 1802-5, Iter Australiense, LE (st.)!]; F.v.M., Census 1(1882)50, Sec. Census 1(1889)86; Bailey, Qld. Fl. 2(1900)555; Schindler, Bot. Jb. 34. Beibl. 77(1904)29; Schindler, Pflrch. 23(1905)60; Bailey, Comp. Cat. Qld. Pl. (1913) 174.

Figs: Schindler, Pflrch. 23(1905) fig. 17C.

Perennial herb 25-50 cm tall, taproot ± well developed, stems erect, ± herbaceous, sparsely branched and then only at base, 4-ribbed, moderately densely scabrous with rigid, spreading, 2-3 celled, semi-tránsparent hairs 0.1-0.2(-0.3) mm long.

Leaves opposite, sessile, linear-lanceolate, 2.5-4.0 cm long, 0.2-0.4(-0.5) cm wide) tapering gradually to base and apex, entire or finely serrate with up to 12 deltoid teeth 1 mm long, margin revolute, midrib channelled above, prominent below, lateral veins obscure, scabrous with hairs as for stems.

Inflorescence an indeterminate spike of 1-3-flowered dichasia in the axils of primary bracts. No lateral inflorescences. Primary bracts linear, 2.5-5.5 mm long, 0.4-0.9 mm wide, fleshy, entire, midribbed, scabrous; secondary and tertiary bracts, 0.5-0.7 mm long, 0.1-0.15 mm wide, brown, membranous, scabrous.

Flowers 4-merous, on pedicels 0.2-0.3 mm long. Sepals 4, lanceolate smooth, 0.6-0.9 mm long, 0.4-0.6 mm wide, lacking midrib, scabrous. Petals 4, brown, hooded, tips erect, keeled, shortly unguiculate, 2.4-2.7 mm long, 0.4-0.6 mm wide (keel to margin), scabrous on keel. Stamens 8, filaments 0.2-0.3 mm long; anthers yellow to red, oblong, 2.1-2.2 mm long, 0.3-0.4 mm wide, 4-celled, non-apiculate. Styles 4, clavate, 0.4 mm long, stigmas capitate. Ovary ovoid to hemispherical, 0.4 mm long, 0.4-0.5 mm wide, not ribbed, scabrous, 4-locular, with 1 pendulous ovule per locule.

Fruits 1-3 per axil, ovoid to globular, 2.5-2.7 mm long, 2.5 mm wide, verrucose or ± smooth, scabrous; sepals linear, 1.0 mm long, 0.5 mm wide, persistent, erect; fruit 4-locular, pericarp and septa ± woody, 1-4 seeds.

Distribution. (Map 1)

Collection localities are scattered over a wide area of south-eastern Queensland and north-eastern New South Wales.

Ecology.

The specimen of O'Shanesy 1250 is recorded from "wet clay soils". Flowering period is unknown, but fruiting is documented in November and March.

Specimens examined.

New South Wales: Leichhardt s.n., 19.iii.1844, west side of the gwydir(?), MEL39029 (fr.).

Queensland: Anon. 60, Rockhampton, MEL39026 (fr.); Brown s.n., 1802-5. Broad Sound, LE, MEL (fl.,fr.) - types of *H. stricta*; O'Shanesy 1250, 1.xi.1870, Gracemere, MEL (fr.); Wood 65, 137, Springsure, MEL (fl.,fr.).

Notes.

1. The locality on Leichhardt's collection is almost illegible, but appears to be "gwydir". He is known to have collected at this place.

2. *H. stricta* is most closely allied to *H. exalata* subsp. *velutina* but differs in its indumentum and sessile, smaller leaves.

3. *Haloragis erecta* (Banks ex Murr.) Eichler, Bluethendiag. (1875) fig. 191A [*Haloragis erecta* LeMaout & DeCaisne (1873), nom. inval.] Schindler, Bot. Jb. 34, Beibl. 77(1904)3, 42; Schindler, Pflrch. 23(1905)49, 50; Cheeseman, Trans. N.Zeal. Inst. 42(1909)202, 203; Cockayne, Rep. Bot. Surv. Stewart Is. (1909)57; Skottsberg, Nat. Hist. Juan Fern. & Easter Is. 1(1922)264, 2(1922)153; Cheeseman, Man. N.Zeal. Fl. 2 ed. (1925)620; Allan, Trans. Roy. Soc. N.Zeal. 69(1939)273; Allan, Fl. N.Zeal. 1(1961)242; Cambie et al., N.Zeal. J. Sci. 4(1961)616; Forde, N.Zeal. J. Bot. 2(1964)425-453; Hair, N.Zeal. J. Bot. 4(1966)584.

Cercodia erecta Banks ex Murray, Comm. Goett. (1780)3-8, t.3 [Typus: l.c., t.3!]; DC., Prod. 3(1828)67; A.Cunn., Ann. Nat. Hist. 3(1839)29.

Tetragonia ivaefolia L.f., Suppl. (1781)257, nom. illeg.

Haloragis ivaefolia (L.f.) Salisbury, Prod. (1796)276.

Haloragis alata Jacquin, Misc. Austr. 2(1781-2)332(n.v.) et Icon. Pl. Rar. (1783)t.69, 1(1781)7,nom. illeg.; Forst., Prod. (1786)30; Jacq., Pl. Rar. Schoenb. 1(1798)7; Hook. f., Fl. N.Zeal. 1(1852)62; Gray, Bot. U.S. Expl. Exped. 1(1854)625; Benth., Fl. Aust. 2(1864)479, 480, 483; Baill., Nat. Hist. Pl. 6(1880) fig. 457-461; F.v.M., Census 1(1882)49; Bailey, Syn. Qld. Fl. (1883)157; Featon, Art Alb. N.Zeal. Fl. (1889)149; Petersen, Pflfam. III.7(1893)230,233; Cheeseman, Trans. N.Zeal. Inst. 29(1897)391; Kirk, Stud. Fl. N.Zeal. (1899)148; Bailey, Qld. Fl. 2(1900)554, 555; Cheeseman, Man. N.Zeal. Fl. (1906)148; Britten, J. Bot. 45(1907)136; Bailey, Comp. Cat. Qld. Pl. (1913)174; Bate-Smith, J. Linn. Soc. (Bot.) 58(1962)148.

Haloragis tetragonia L'Herit., Stirp. Nov.(1788)82, nom. illeg.

Haloragis cercodia Dryander in Aiton, Hort. Kew. 2(1789)37, nom. illeg.; Sprengel, Syst. Veg. 2(1825)260.

Cercodia alternifolia A. Cunn., Ann. Nat. Hist. 3(1839)29 [Typus: "New Zealand (Northern Island). Among fern, on the shores of the Bay of Islands. - 1833, R. Cunningham". Holotypus: R. Cunningham No. 527, 1834, New Zealand, K (fr.)!]

Haloragis alternifolia (A. Cunn.) Walp., Rep. 2(1842)99.

Haloragis cartilaginea Cheeseman, Trans. N.Zeal. Inst. 29(1897) 390-391 [Typus: "Hab. Cliffs near North Cape; not uncommon". Holotypus: "Cheeseman, Jan. 1896, Cliffs near North Cape, A" (fide Allan, 1961) n.v.]; Schindler, Pflrch. 23(1905)51; Cheeseman, Man. N.Zeal. Fl. 2 ed. (1925)621; Skottsberg, Nat. Hist. J. Fern. & Easter Is. 2(1953)152; Cambie et al., N.Zeal. J. Sci. 4(1961)616; Allan, Fl. N.Zeal. 1(1961)243; Forde, N.Zeal. J. Bot. 2(1964)426, 427, 446-448.

Haloragis alata var. *cartilaginea* (Cheeseman) Cheeseman, Man. N.Zeal. Fl. (1906)148.

Haloragis colensoi Skottsberg, Nat. Hist. Juan Fern. & Easter Is. 1(1922)152, 153, 156, n.v.; emend. Skottsberg, in Allan, Trans. roy. Soc. N.Zeal. 69(1939)273 [Typus: "Hab. Novae Zealandiae ins. bor. (Colensoi in herb. Kew); in collibus Puketoi dictis, commun. H.H. Allan". Holotypus: Colenso 938, sine loc., K (fr.)!]; Allan, Trans. roy. Soc. N.Zeal. 69(1939)273; Allan, Fl. N.Zeal. 1(1961)243; Kapil, Bull. Bot. Surv. India 4(1962)61-63; Forde, N.Zeal. J. Bot. 2(1964)426, 427, 445-446.

Figs: Murray, Comm. Goett. (1780)t.3; Jacq., Icon. Pl. Rar. (1783)t.69; Eichler, Bluethendiag. (1875) fig. 191A; Baill., Nat. Hist. Pl. 6(1880) fig. 457-461; Petersen, Pflfam. III.7(1893) fig. 102A; Schindler, Pflrch. 23(1905)fig.14; Forde, N.Zeal. J. Bot. 2(1964)fig. 1-15.

Perennial herb or shrub 25-85 cm tall, stems erect, procumbent or ascending, freely branching, green to red-brown, 4-ribbed, woody at base, rooting in lower parts, glabrous, or scabrous with minute, 2-celled, ± transparent hairs, with swollen basal cell, 0.05-0.1 mm long.

Leaves opposite, petiolate on petiole (0.2-)-0.8-1.0(-3.0) cm long, broad lanceolate, ovate or orbicular, 1.5-8.5 cm long, (0.5-)1.0-3.5 cm wide, serrate with up to 45 blunt teeth 0.5-4.0 mm long, midrib sunken above, prominent below, lateral veins ± obscure, departing at 20^{o}-35^{o}, glabrous, or scabrous as for stems.

Inflorescence an indeterminate spike of 3-7 flowered dichasia in the axils of the alternate or subopposite primary bracts. Lateral inflorescences in the axils of the upper leaves. Primary bracts leaflike, lanceolate to ovate, 0.5-2.5 cm long, 0.2-1.2 cm wide, green, midribbed, ± serrate, petiolate, glabrous or scabrous; secondary bracts brown, membranous, linear, 0.5-1.2 mm long, 0.1-0.2 mm wide; tertiary bracts brown, membranous, linear, 0.3-0.6 mm long, 0.05-0.1 mm wide.

Flowers 4-merous, on pedicels 0.5-0.6 mm long. Sepals 4, deltoid, 0.8-1.2 mm long, 0.6-0.9 mm wide, ± thickened on either side at base, otherwise smooth, glabrous or scabrous. Petals 4, hooded, keeled, unguiculate, tip rounded or erect, (1.6-)2.0-2.2 mm long, 0.6-0.7 mm wide (keel to margin), glabrous or scabrous on keel. Stamens 8, filaments 0.4 mm long; anthers yellow or red, oblong, (1.2-)1.4-1.7 mm long, 0.3-0.5 mm wide, 4-locular, nonapiculate, antipetalous anthers 0.2 mm shorter than antisepalous ones. Styles 4, clavate, 0.4 mm long, stigmas capitate. Ovary ovoid 0.9-1.0 mm long, 0.7-1.2 mm wide, 4-winged opposite petals, 4-ribbed opposite sepals, glabrous or scabrous, 4-locular, 1 ovule per locule.

Fruits 1-3(-5) per axil, on pedicels 0.8-1.0 mm long, obturbinate or pyriform to ovoid 1.8-3.0 mm long, 1.5-2.5(-4.0) mm wide (including wings), rugose smooth or 4-ribbed opposite sepals, 4-ribbed or 4-deltoid-winged between sepals, glabrous or scabrous; sepals persistent, erect, narrow deltoid, 0.9-1.7 mm long, 0.5-0.7 mm wide, not ribbed, glabrous or scabrous; fruit 4-locular, septa and pericarp woody, 1-4 seeds.

Two subspecies can be distinguished as follows:

1. Leaves broad lanceolate to ovate, thin, upper surface dark green, lower surface light green, serrate with 20-30(-45) teeth, (1.5-) 2.5-4.5(-8.5)cm long, (0.5-)1.0-3.5 cm wide, on petiole (0.5-) 0.8-1.7(-3.0) cm long ... i. subsp. *erecta*
1. Leaves orbicular to broad ovate, thick, both surfaces grey green, upper surface drying shiny, cartilaginous, lower surface dull, serrate with 10-15 teeth, 1.5-2.2 cm long, 1.0-1.5 cm wide, on petiole 0.2-0.4 cm long ... ii. subsp. *cartilaginea*

i. subsp. *erecta*

Perennial (rarely annual) herb or subshrub 30-85 cm tall, stems erect or procumbent, green to red-brown, glabrous or scabrous.

Leaves on petioles (0.5-)0.8-1.7(-3.0) cm long, broad lanceolate to ovate, (1.5-)2.5-4.5(-8.5) cm long, (0.5-)1.0-3.5 cm wide, thin, dark green above, light green below, lateral veins well defined, serrate with 20-30(-45) blunt deltoid teeth 1.0-2.0(-4.0) mm long, glabrous or scabrous.

Inflorescence as for species; lateral inflorescences borne in the axils of the upper 6-8 leaves. Primary bracts ovate to lanceolate, 1.0-2.5 cm long (including petiole) 0.5-1.2 cm wide, serrate, petiolate, rapidly reduced in size, number of teeth and length of petiole towards apex, glabrous or scabrous; secondary bracts 0.5-0.8 mm long, 0.1-0.2 mm wide; tertiary bracts 0.3-0.4 mm long, 0.05-0.1 mm wide. Flowers as for species.

Fruit ovoid to pyriform, 2.0-2.3(-3.0) mm long, 1.5-2.5(-4.0) mm wide (including wings), 4-ribbed opposite sepals, deltoid-winged (or rarely ribbed) between sepals, ± rugose or smooth between ribs/wings, sepals 0.9-1.2 mm long, 0.5-0.7 mm wide.

Distribution. (Map 4)

H. erecta subsp. *erecta* is widespread in both North and South Islands of New Zealand, and on Chatham and the Kermadec Islands.

Ecology.

This taxon is most common in disturbed habitats, usually in open situations, but also in dense undergrowth. There is apparently no soil preference. Collectors' notes include "on limestone outcrop" (Allan CHR194908); "open country - lowland" (Carrodus 194); "grassy coastal vegetation" (Fryer & Wardle CHR185622); "hillside overlooking sea" (Hay CHR73718); "under scrub" (Macmillan 65/30); "embankment at lake edge" (Mason CHR65412); "half prostrate in open bush" (Moore CHR36041); "clay bank above beach" (Moore CHR87908); "river bed, plants prostrate, straggling over sand bars" (Rawson CHR97186A); "salt marshes" (Scott CHR87914); "in neglected cultivated land" (Simpson CHR29511); "shingle banks" Sorenson CHR194909). Flowering occurs from November until

February, and fruiting from (November?) December until April (-August).

Common name.

"Toa-toa" - Maori name (Carrodus 194).

Specimens examined.

Chatham Island: Entomology Div. Exped. s.n., 25.ii.1967, Makara River, CHR176552A (fl.,fr.).

Kermadec Islands: Sykes 497/K, 27.xii.1966, South Meyer Island, CHR (fl.,fr.).

North Island: Allan s.n., 6.i.1925, Mamuku west of Lake Rotorua, CHR11324 (fl.,fr.); Ashwin 20D, Pukeora near Waipawa, CHR (fl.,fr.); Carrodus 194, -.vi.1951, Wellington, AD (fr. - terat.); Davey s.n., 18.ii.1940, Tukituki River near Waipawa, CHR175300 (fr.); Druce s.n., -.xii.1962, TeReinga, CHR131882A & B (fl.,fr.); Druce s.n., -.v.1966, 5 miles W.S.W. of Waipukurau, CHR159347 (st.); Druce s.n., -.v.1966, San Hill, Pukeora, CHR159351 (fr.); Hamilton s.n., 13.i.1956, Little Barrier Island, CHR87432 (fr.); Hay s.n., 8.xii.1949, Pukerua Bay, CHR73718 (fl.); Hynes s.n., -.xi.1952, Auckland, U31912B (fl.,fr.); Latta s.n., Puketoi Hills, CHR175298 (st.); Mason 4208, 12.i.1946, swamp south of Manutaki CHR (fl.,fr.); Moore s.n., 29.viii.1942, Johnson's Hill, Karori, Wellington, CHR36041 (fr.); Moore s.n., 3.ix.1955, Pukeora Sanitorium near Waipawa CHR87766 (st.); Zotor s.n., 8.ii.1929, Princess St., Palmerston N., CHR1165 (fl.,fr.).

South Island: Allan s.n., 19.xii.1940, Port Hills, Christchurch, CHR146880 (fl.); Allan s.n., 29.i.1941, Limestone Range near Waikari, CHR194908 (fr.); Allan s.n., 16.iii.1941, Point Elizabeth near Greymouth, CHR87095 (fr.); Fryer & Wardle s.n., 23.vii.1968, Okarito Bluff, CHR185622 (st.); Kirk 314, Nelson, AD, CGE (fl.); Lindsay s.n., 30.xii.1861, Leith Bush, Dunedin, CGE (fl.,fr.); McMillan 65/30, 8.ii.1965, S. side of Lynn Ck., Mt. Peel, CHR (fr.); Mason s.n., 27.iv.1949, Waihola, CHR65412 (fr.); Mason & McQueen 2679, 27.xii.1953, Clarence Valley, CHR (fl.,fr.); Moore s.n., 5.iii.1953, Lower Acheron Valley, CHR194910 (fr.); Moore s.n., 28.xii.1955, Ngaio Bay, Nelson, CHR87908 (fl.); Raoul s.n., 1843, Banks Peninsula, LE ex P (fl.,fr.); Rawson s.n., 9.ii.1955, Selwyn River, Canterbury, CHR97186A (fl.,fr.); Scott s.n., 11.i.1955, Wharariki, CHR87914 (fl.,fr.); Simpson s.n., -.ii.1940, Anita Bay, Milford Sound, CHR29511 (fr.); Sorensen s.n., 1.ii.1948, near mouth of Waiau River, Tewaewae, CHR194909 (fl.,fr.); Thomson s.n., -.i.1879, near Dunedin, BRI079974 (fl.,fr.).

New Zealand s. loc. spec.: Bailey s.n., New Zealand, BRI079975 (fl.); Colenso 938, K (fl.) - holotype of *H. colensoi*; Cunningham 527, 1834 New Zealand, K (fr.) - holotype of *H. alternifolia*; D'Urville s.n., 1829, Nouv-Zelande, G (Herb.DC) (fr.); Forster 1.130, Nova Zeelandia, GOET (fr.); Solander, s.loc., G (Herb. Deless.) (fl.,fr.) - ?type of *Cercodia erecta*.

ii. subsp. *cartilaginea* (Cheeseman) Orchard, comb. et stat. nov.

Haloragis cartilaginea Cheeseman, Trans. N.Zeal. Inst. 29(1897) 390-391. [Typus: "Hab. Cliffs near the North Cape; not uncommon". Holotypus: n.v.] Schindler, Pflrch. 23(1905)51; Skottsb., Nat. Hist. J. Fern. & Easter Is. 2(1953)152; Cambie et al., N.Zeal. J. Sci. 4(1961) 616; Forde, N.Zeal. J. Bot. 2(1964)426, 427, 446-448, fig. 14, 15.

Haloragis alata var. *cartilaginea* (Cheeseman) Cheeseman, Man. N.Zeal. Fl. (1906) 148.

Perennial shrub 25-30 cm tall, stems ascending or procumbent, dark red, otherwise as for species, scabrous.

Leaves on petioles 0.2-0.4 cm long, orbicular to broad ovate, 1.5-2.2 cm long, 1.0-1.5 cm wide, glabrous, thick, grey-green on both surfaces, upper surface drying shiny and cartilaginous, lower surface dull, lateral veins obscured, margin ± thickened, shortly and bluntly serrate with 10-15 deltoid teeth 0.5-1.0 mm long.

Inflorescence as for species; lateral inflorescences few. Primary bracts ovate, 0.5-1.0 cm long, 0.2-0.6 cm wide, serrate, petiolate, becoming lanceolate, ± entire, sessile in upper part; secondary bracts 0.8-1.2 mm long, 0.15-0.2 mm wide; tertiary bracts 0.4-0.6 mm long, 0.1 mm wide. Flowers as for species.

Fruit obturbinate to ovoid, 1.8-2.0 mm long, 1.8-2.0(-2.5) mm wide (including wings), not ribbed opposite sepals, thickly 4-deltoid-winged between sepals, rugose between wings, scabrous, sepals (1.0-) 1.5-1.7 mm long, 0.6-0.7 mm wide.

Distribution. (Map 4)

This subspecies is confined to the North Cape Peninsula, at the northern extremity of North Island, New Zealand.

Ecology.

The only collectors' notes seen were "under Pohutukawa" (Baylis CHR18171) and "rocky slope to sea" (Moore & Mitchie CHR83657). Flowering is recorded in December and January, and fruiting in January and April. Forde (1964) reported that this taxon "is known only from a small strip of coast near North Cape, where it is found in dwarf scrub on dry coastal bluffs." Through crossings with *H. erecta* from other parts of the country, she was able to demonstrate a partial reproductive barrier between '*H. cartilaginea*' and *H. erecta*.

Specimens examined.

North Island: Baylis s.n., 11.xii.1934, North Cape, CHR18171 (fl.) - pollen sent to Palyn. Lab. Stockholm; Finlayson s.n., -.vi.1944, North Cape, CHR185368 (st.); Kelly s.n., -.iv.1967, Kerr Pt., CHR178170 (fr.); Moore & Mitchie s.n., 1.i.1954, Kerr Point, North Cape Peninsula, CHR83657 (fl.,fr.).

Notes.

1. The name *Haloragis erecta* was first used by LeMaout & DeCaisne (1873) in plate LXXXIX accompanied by a habit drawing. However this publication was invalid as there was no reference to a previously published name, or any analysis of the plant to which the name was applied. The first valid publication of the combination *Haloragis erecta* was that of Eichler (1875).

2. The names *Tetragonia ivaefolia, Haloragis ivaefolia, Haloragis alata, Haloragis tetragonia* and *Haloragis cercodia* are all illegitimate as they included the type of the name *Cercodia erecta* ['*Cerodia erecta*'

in the case of *Tetragonia ivaefolia*]. As the epithet "*erecta*" had not previously been used in *Haloragis*, it had priority and should have been taken up.

3. The study by Forde (1964) on the *H. erecta* complex in New Zealand helps considerably in understanding the nature of the variation that can be observed in this and in other polymorphic species of *Haloragis*. Her concepts of the species limits and relationships are substantially maintained in this study.

4. *H. erecta* very closely resembles the Juan Fernandez species *H. masafuerana* and *H. masatierrana* and can be distinguished from them only on a combination of characters. *H. erecta* is also closely related to the Australian species *H. exalata*.

4. *Haloragis masafuerana* Skottsberg, Nat. Hist. Juan. Fern. & Easter Is. 2(1922)156, fig. 20 [Typus: "Masafuera: Germain oct. 1854 (Herb. Santiago!); Q. de las Vacas, on the walls of the outer section (fr. 10/2 17, no. 441 - f. tuberculata); stony beach near Varadero (fr. 22/2 17, no. 1216); Q. de la Loberia, near the shore (fr. 17/2 17. no. 485 - f. alulata)." Lectotypus (Orchard): Carl o. Inga Skottsberg 1216, 22.ii.1917, Juan Fernandez: Masafuera, shore near entrance to Quebr. de Varadero, S, n.v.; Isolectotypi: l.c., HBG, UPS (fl.,fr.)! Syntypi: Carl o. Inga Skottsberg 441, 10.ii.1917, Juan Fernandez: Masafuera, Quebrada de las Vacas, S (fr.)!; Carl o. Inga Skottsberg 485, 17.ii.1917, Juan Fernandez: Masafuera, Loberia, S (fr.)!]; Allan, Trans. roy. Soc. N.Zeal. 69(1939)273; Allan, Fl. N.Zeal. 1(1961)243; Forde, N.Zeal. J. Bot. 2(1964)426, 450, 452.

Figs: Skottsberg, Nat. Hist. Juan Fern. & Easter Is. 2(1922) figs. 18, 20; Forde, N.Zeal. J. Bot. 2(1964) fig. 16(g-o), 17.

Perennial herb 25-40 cm tall, stems erect, freely branched, red-brown, 4-ribbed, or almost smooth, glabrous, or scabrous with short, spreading 2-3-celled hairs with swollen bases, tapering rapidly to very sharp points, 0.1-0.2(-0.3) mm long, opaque.

Leaves opposite, petiolate, petiole 0.5-1.8 cm long, lamina broad lanceolate to ovate 1.5-4.6 cm long, 0.8-1.5(-2.5) cm wide; bright green above, dull light green below, midrib sunken above, prominent below, lateral veins depart at 35^{o}-45^{o}, serrate with 15-25 deltoid teeth 0.1-0.2 mm long, glabrous, or scabrous on margins, ± upper and lower surfaces with hairs as for stems.

Inflorescence an indeterminate spike of 1-3(-5) flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences few, in the axils of the upper leaves. Primary bracts lanceolate to narrow ovate, 1.0-3.0(-4.0) cm long, 0.3-1.0 cm wide, leaflike, green fleshy, petiolate, serrate, glabrous or scabrous; secondary bracts 0.6-1.0 mm long, 0.1-0.2mm wide, brown, membranous, linear; tertiary bracts as for secondary bracts, 0.5-0.7 mm long, 0.1 mm wide.

Flowers 4-merous, on pedicels 0.4-0.7 mm long. Sepals 4, deltoid to ovate, 0.6-0.8 mm long, 0.6 mm wide, green, not ribbed, glabrous or scabrous. Petals 4, (1.8-)2.2-2.3 mm long, 0.5-0.6 mm wide (keel to margin), yellow-green, hooded, tip erect, keeled, unguiculate, glabrous, or scabrous on keel. Stamens 8, filaments 0.3-0.4 mm long; anthers yellow, oblong, (1.1-)1.4-1.6 mm long, 0.3-0.4 mm wide, 4-celled, nonapiculate, antipetalous anthers ca 0.2 mm shorter than antisepalous ones. Styles 4, clavate, 0.4 mm long, stigmas capitate. Ovary globose to ovoid, 1.2-1.3 mm long, 1.1-1.3 mm wide, strongly 4-ribbed opposite petals, weakly 4-ribbed opposite sepals, 4-locular with 1 ovule per locule.

Fruits 1-3 per axil on pedicels (0.7-)1.0-3.0 mm long, globose to ovoid or pyriform, verrucose, tuberculose or smooth, weakly 8 ribbed, or ribs between sepals converted to small deltoid or oblong membranous wings; sepals persistent, erect, deltoid, 0.8-1.0 mm long, 0.6-1.2 mm wide, fruit 4-locular, septa and pericarp woody, 1-4 seeds.

Two varieties of this species can be distinguished as follows:

1. Glabrous plant; fruit usually lacking wings, 3.0-4.0 mm long, 2.8-3.3 mm wide ... α. var. *masafuerana*
1. Scabrous plant; fruit usually winged, 1.8-2.0 mm long, 2.0-3.0 mm wide. ... β. var. *asperrima*

α. var. *masafuerana*

Glabrous plant, 25-30 cm tall. Leaves ovate to narrow ovate, 1.5-3.5 cm long, 0.8-1.5 cm wide, bright green above, dull green below, on a petiole 0.5-1.0 cm long.

Dichasia 1-3 flowered; primary bracts lanceolate, 1.0-1.4(-2.0)cm long, 0.4-0.5 cm wide, secondary bracts 0.6 mm long, 0.2 mm wide. Flowers 4-merous on pedicels 0.5-0.7 mm long, mature flowers not seen; sepals 4, deltoid to ovate, not ribbed; petals hooded, keeled, glabrous; stamens 8, anthers 4-celled, oblong, nonapiculate; styles 4, clavate, ovary ovoid, 8-ribbed.

Fruits 1-3 per axil, on pedicels 3 mm long, ovoid to globose, 3.0-4.0 mm long, 2.8-3.3 mm wide, verrucose or tuberculose, very weakly 8-ribbed or rarely weakly and irregularly winged between sepals; sepals 0.9-1.0 mm long, 1.0-1.2 mm wide.

Distribution. (Map 3)

Confined to the island of Masafuera.

Ecology.

The collection Skottsberg 1260 was collected on the shore. Fruits and a few flowers are present in February.

<u>Specimens examined.</u>

<u>Masafuera</u>: C. & I. Skottsberg 441, 10.ii.1917, Quebrada de las Vacas, S (fr.) - syntype of *H. masafuerana;* C. & I. Skottsberg 485, 17.ii.1917, Loberia, S (fr.) - syntype of *H. masafuerana;* C. & I. Skottsberg 1216, 22.ii.1917, Quebr. de Varadero, HBG, UPS (fl.,fr.) - isolectotypes of *H. masafuerana.*

β. var. *asperrima* (Skottsberg) Orchard, comb. et stat. nov.

Haloragis asperrima Skottsberg, Nat. Hist. Juan Fern. & Easter Is. 2(1922)153-154, fig. 18 [Typus: "Masafuera: Skottsberg 1908, ster. - Q. de las Casas, quite common (fl.,fr.) 11/2 17, no. 457 - f. fructibus alatis); Q. de las Vacas (fl. - fr. 10/2 17, no. 442 - f. non alata); Q. del Blindado, in the forest c. 440m; Q. del Varadero; on the precipice above Buque Varado, c. 1200m." Lectotypus (Orchard): Carl o. Inga Skottsberg 457, 11.ii.1917, Juan Fernandez: Masafuera, Quebrado de las Casas, S (fr.)! Isolectotypi: HBG ! K ! UPS ! Syntypus: Carl o. Inga Skottsberg 442, 10.ii.1917, Juan Fernandez: Masafuera, Quebrada de las Vacas, S (fr.)!]; Allan, Trans. roy. Soc. N.Zeal. 69(1939)273; Kapil, Bull. Bot. Surv. India 4(1962)61; Forde, N.Zeal. J. Bot. 2(1964)426, 448, 450, 452,

<u>Figs</u>: Skottsberg, Nat. Hist. J. Fern. & Easter Is. 2(1922) fig. 18; Forde, N.Zeal. J. Bot. 2(1964) fig, 16(g-o), 17.

Scabrous plant up to 38 cm tall, leaves broad lanceolate to narrow ovate, 2.0-4.6 cm long, 0.8-1.7(-2.5) cm wide, dark green above, light green below, on a petiole 0.7-1.8 cm long.

Dichasia 1-3(-5) flowered; primary bracts lanceolate to narrow-ovate, 1.0-3.0(-4.0) cm long, 0.3-1.0 cm wide; secondary bracts (0.6-)0.8-1.0 mm long, 0.1-0.2 mm wide; tertiary bracts 0.5-0.7 mm long, 0.1 mm wide. Flowers 4-merous, on pedicels 0.4-0.6 mm long; sepals, petals etc. as for species.

Fruits 1-3 per axil, on pedicels 0.7-1.0 mm long, ovoid to pyriform, 1.8-2.0 mm long, 2.0-3.0 mm wide (including wings), 4-ribbed opposite sepals, 4-ribbed or winged between sepals, wings membranous, deltoid or oblong, near base of fruit, scabrous; sepals 0.8 mm long, 0.6-0.8 mm wide.

Distribution. (Map 3)

Confined to the island of Masafuera.

Ecology.

Collectors' notes include "in the forest c. 440m." (Skottsberg - Q. del Blindado); "on the precipice above Buque Varado, c. 1200m." (Skottsberg); "dry outer slopes" (Skottsberg 457). Flowers and fruits are both plentiful on collections made in February.

Specimens examined.

Masafuera: C. & I. Skottsberg 442, 10.ii.1917, Quebrada de las Vacas, S (fr.) - syntype of *H. asperrima;* C. & I. Skottsberg 457, 11.ii.1917, Quebrada de las Casas, HBG, K, S, UPS (fl.,fr.) - lecto- and isolectotypes of *H. asperrima.*

Cultivated in New Zealand: Ashwin s.n., grown from seed sent by Professor Skottsberg from Masafuera, CHR (st.).

Notes.

1. The choice of lectotype for the name *H. masafuerana* was necessary as Skottsberg cited 4 different collections with his description. Skottsberg's number 1216 was chosen because Skottsberg described the flowers of the species and this was the only collection cited by him with flowers.

2. Similarly, the name *H. asperrima* required lectotypification, and Skottsberg's number 457 was chosen because duplicates exist in at least 3 other herbaria.

3. On the basis of present collections, var. *asperrima* and var. *masafuerana* can be easily distinguished from each other and from *H. masatierrana*. However, when further collections have been made, it may be found necessary to include all three taxa in a single species.

4. The affinities of *H. masafuerana* are with *H. masatierrana*. These two species, as suggested by Forde (1964), are closely related to the New Zealand species *H. erecta*, and can be separated from it only on a combination of characters, rather than on any particular difference.

5. *Haloragis masatierrana* Skottsberg, Nat. Hist. J. Fern. & Easter Is. 2(1922)155, fig. 19 [Typus: "Not rare on the dry rocky ridges, also on open, stony ground in the forest belt. Rabanal (Johow); El Pangal, on the western slope; C. Centinela (Johow); V. Colonial, C. Central (also Johow), 570m (fl.-fr. 18/1 17, no. 304), Q. del Monte Maderugo, roadside in the macal, 240m, and rocky wall, 390m; C. Salispuedes, frequent, 350-650m (fl. 20/12 16, no. 172); Portezuelo de Villagra, not rare on both sides (fl. 3/12 16, no. 34 also observed by Johow); ridge between Vaqueria and Q. Juanango, 300m; Q. Juanango, outer part. South side of the island, Q. Villagra, rare in the forest c. 500m; east side of B. Chupones, barren slopes." Lectotypus (Orchard): Carl o. Inga Skottsberg 34, 3.xii.1916, Juan Fernandez: Masatierra, Portezuelo de Villagra, a 'ruggarna tia'; 590m., S (fl.,fr.)! Isolectotypus: Carlo. Inga Skottsberg 34, 3.xii.1916, Juan Fernandez: Masatierra, Portezuelo de Villagra, 540m., UPS (fl.,fr.); Syntypi: Carl o. Inga Skottsberg 304, 18.i.1917, Juan Fernandez: Masatierra, Vahe Colonial, Cordon Central; 570m, HBG, UPS (fl.,fr.)]; Allan, Trans. roy. Soc. N.Zeal. 69(1939)273; Allan, Fl. N.Zeal. 1(1961)243; Forde, N.Zeal. J. Bot. 2(1964)426, 450, 452.

Figs: Skottsberg, Nat. Hist. J. Fern. & Easter Is. 2(1922) fig. 19; Forde, N.Zeal. J. Bot. 2(1964) fig. 16(a-e), 18.

Perennial shrub 30 cm tall, stems erect, freely branched, woody near base, red-brown, 4-ribbed, glabrous.

Leaves opposite, petiolate, on petiole (0.4-)0.6-1.0(-1.2) cm long; ovate, (1.0-)1.5-2.7 cm long, (0.5-)0.7-1.5 (-1.7) cm wide, lamina dark green above, light green below, serrate with (12-)15-25 teeth

0.5-1.0 mm long, midrib sunken above, prominent below, lateral veins ± obscure, departing at 20°-30° to midrib, glabrous.

Inflorescence an indeterminate spike of 1-3(-7) flowered dichasia in the axils of primary bracts. Lateral inflorescences absent or borne in the axils of the upper 4-8 leaves. Primary bracts lanceolate to ovate, (0.3-)0.5-0.9 cm long, 0.1-0.4 cm wide, leaflike, green, fleshy, serrate, shortly petiolate, midribbed, glabrous; secondary bracts linear, 0.5-0.7 mm long, 0.1-0.3 mm wide, membranous, red-brown, deciduous at an early stage; tertiary bracts as for secondary bracts, 0.3-0.5 mm long, 0.1 mm wide, deciduous.

Flowers 4-merous on pedicels 0.5-1.0 mm long. Sepals 4, ovate, 0.9-1.1 mm long, 0.8-0.9 mm wide, red, midribbed. Petals 4, 2.5-2.8 mm long, 0.8 mm wide (keel to margin), red to yellow, hooded, tip erect, ± non-unguiculate, keeled, glabrous. Stamens 8, filaments 0.2-0.3 mm long; anthers 1.9-2.3 mm long, 0.3-0.4 mm wide, yellow, oblong, 4-celled, nonapiculate, antipetalous anthers ca 0.1 mm shorter than antisepalous ones. Styles 4, clavate, 0.4-0.5 mm long, stigmas capitate. Ovary obovoid, 1.0-1.2 mm long, 0.8-0.9 mm wide, 8-ribbed, glabrous, 4-locular with 1 ovule per locule.

Fruits 1-3 per axil, on pedicels 1.0-1.7 mm long, ovoid, (2.4-)2.5-3.0 mm long, (1.8-)2.0-2.4 mm wide, smooth, not winged or ribbed, glabrous; sepals persistent, erect, oblong to ovate, 1.2-1.3 mm long, 0.9-1.0 mm wide, not ribbed, glabrous; fruit 4-locular, septa and pericarp ± woody, 1-4 seeds.

Distribution. (Map 3)

This species is confined to Masatierra, in the Juan Fernandez group of islands.

Ecology.

According to Skottsberg (1922), *H. masatierrana* is fairly common on dry, rocky ridges and on open stony ground in the forest belt. Flowering occurs in December-January, and fruiting from January onwards.

Specimens examined.

Masatierra: Cuming 1347, Juan Fernandez, CGE (2 sheets) (fl.,fr.); C. & I. Skottsberg 34, 3.xii.1916, Portezuelo de Villagra, S, UPS (fl., fr.) - lecto & isolectotypes of *H. masatierrana;* C. & I. Skottsberg 304, 18.i.1917, Vahe Colonial, HBG, UPS (fl.,fr.) - syntype of *H. masatierrana.*

Cultivated: Ashwin s.n., 9.i.1958, cultivated at Lower Hutt, New Zealand, from seed sent by Skottsberg, CHR (fl.,fr.).

Notes.

1. The choice of a lectotype was necessary as Skottsberg listed a number of specimens with his description, without particular mention of any one of them. The specimen chosen was favoured because it was the only specimen seen from Herb. S, where Skottsberg's main collection is housed.

2. Because of the few specimens available, it is difficult to determine the true status of this species. It is certainly very closely allied to *H. masafuerana,* and with the collection of further material, the two species may have to be amalgamated. See also *H. masafuerana* note 4.

6. *Haloragis prostrata* Forst. & Forst. f., Char. Gen. Pl. (1776)62 [Typus: "Botanices insula" (in Prod. q.v.). Lectotypus (Orchard): In Botanices ins. ad Novam Caledoniam leg. Forster, Dr. & Forster, GOET (fl.,fr.)! Syntypus: Forster s.n., Hab. in Botanices insula, LE ex herb. Fischer (fl.,fr.)! Syntypi (?): Anon. s.n., Bot. Isle, N.Caledonia, LE (fr.)!; J.R. Forster s.n., Nova Caledonia, S (fr.)!; Anon. 67, Botanices Insula prope Novam Caledoniam, W137655 ex Reichenbach fil. (fl.,fr.)!; Forster s.n., Nova Caled., W ex herb Jacq. (fl.,fr.)!]; Forster, Fl. Ins. Aust. Prod. (1786)30, L'Herit., Stirp. Nov. (1788)82; Sprengel (ed.), Syst. veg. 2(1825)261; DC., Prod. 3(1828)67; Schindler, Pflrch. 23(1910)48; Guillaumin, Ann. Mus. Col. Marseilles, II, 9(1911)141; Guillaumin, Fl. Nouv. Cal. (1948)249.

Fig: Forst. & Forst. f., Char. Gen. Pl. (1776) pl.31.

Prostrate glabrous herb (?), stems reddish, ± 4-angled, 15-20(-35) cm long, leaves opposite, spathulate, 1.5-2.0(-3.0) cm long, 0.5-0.6(-0.8) cm wide, entire or crenulate, apiculate, ± sessile or shortly (1-2 mm) petiolate, midrib sunken above, prominent below, lateral veins indistinct,

Inflorescence an indeterminate spike of 3-flowered dichasia in the axils of primary bracts. All flowers capable of developing to fruit. Primary bracts opposite in lower parts becoming alternate and reduced in upper parts, green, fleshy, spathulate-oblanceolate, 0.7-1.0(-1.5) cm long, 0.2-0.4 cm wide, entire, apiculate, midrib apparent; secondary bracts membranous, linear-lanceolate, 1.0 mm long, 0.2 mm wide, lacking midrib, tertiary bracts membranous, linear-lanceolate, 0.5-0.7 mm long, 0.1-0.2 mm wide.

Flowers green, 4-merous, on pedicel 0.7-1.0 mm long, peduncle minute. Sepals 4, deltoid, 0.8-1.0 mm long, 0.5-0.7 mm wide, lacking midrib. Petals 4, green to yellowish, hooded, keeled, shortly unguiculate, tip not hooked, 1.5-1.8 mm long, 0.6-0.7 mm wide (keel to margin). Stamens 8, filaments 0.2 mm long; anthers yellow, 4-locular, oblong, 0.9-1.0 mm long, 0.3 mm wide, non-apiculate, equisized. Styles 4, clavate, 0.5 mm long, stigmas fimbriate, red to yellow. Ovary orbicular, 1.2-1.5 mm diameter, not ribbed, 4-locular, with 1 pendulous ovule per locule.

Up to 2 fruits per dichasium mature. Fruit globular, 2.3-3.0 mm long, 2.6-4.0 mm wide, very slightly 4-angled between the sepals, exocarp spongy, endocarp woody; sepals persistent, deltoid, 0.9 mm long, 0.8 mm wide, midribbed, spreading; 1 seed potentially able to develop in each locule.

Distribution. (Map 3)

This species is found only in the New Caledonia-New Hebrides group of islands, where it has been collected only rarely.

Ecology.

H. prostrata apparently only grows on sandy beaches. As the type species of the genus, this habitat preference, combined with its large rounded fruits, inspired the name *Haloragis* (literally: "sea-berry"). Collectors' notes include "sables maritim" (Lemee 2283) and "prostrate plant..., on beach" (McKee 7889). Flowering and fruiting occurs in December-January, but is not well documented.

Specimens examined.

New Caledonia and dependencies: Anon. s.n., Bot. Isle, N.Caledonia, LE (fr.) - ?isotype of *H. prostrata;* Anon. 67, Botanices Insula prope Novam Caledoniam, W (fl.,fr.) - ?syntype of *H. prostrata;* Forster s.n., 1779, in Botanices insula, LE (fl.,fr.) - syntype of *H. prostrata;*

Forster & Forster s.n., in Botanices ins. ad Novam Caledoniam, GOET (fl.,fr.) - lectotype of *H. prostrata;* Forster s.n., Nova Caled., W (fl.,fr.) - ?syntype of *H. prostrata;* McKee 7889, 1.i.1961, Tanghene, New Caledonia, CANB (fl.,fr.); Vieillard 2974, 1861-67, Torio [?] Nouvelle Caledonie, LE (fr.).

New Hebrides: Lemee 2283, 1928, Isle St. Marie [? = Gawa],BRI (fl.).

Notes.

1. All the specimens examined are uniform morphologically, with the exception of Lemee 2283 which is much more robust than the others (leaves 3.0 cm long, 0.8 cm wide, stems 35 cm long). However, although the flowers in this specimen are only young buds, there seems little doubt that it belongs to *H. prostrata.*

2. As it is impossible to determine which of the various specimens of the Forsters' herbarium belongs to the original set, I have designated the specimen at GOET as the lectotype and all others syntypes.

3. The relationships of this species are obscure, but probably lay with the *H. erecta-H. exalata* group.

4. Hiepko (1969) lists a specimen ("7758. (Spr.) Nova Caledonia") in Herb. Willdenow (B) which probably represents syntype material of this species. I have not been able to examine it. If the specimens cited as "syntypi (?)" above should be shown not to be true type material, then they are at least good matches with the lectotype.

7. *Haloragis serra* Brongniart in Duperrey, Voy. Coq. Bot. (1829-1834) t. 69 [Typus: loc. cit. t.69 !]; A. Gray, Bot. U.S. Expl. Exped. 1(1854)625; Benth., Fl. Aust. 2(1864)479, 482, 483; F.v.M., Census 1(1882)49; F.v.M., Trans. roy. Soc. Vict. 24(1888)134; F.v.M., Sec. Census 1(1889)85; Moore, Hdbk. Fl. N.S.Wales (1893)186; Petersen, Pflfam. III.7(1893)232; Schindler, Bot. Jb. 34, Beibl. 77(1904)24, 30; Schindler, Pflrch. 23(1905)52, 53; Maiden & Betche, Census N.S.Wales Pl. (1916)158.

Erect perennial herb or small shrub 40-60(-90) cm tall, rootstock stoloniferous, stems branching freely, strongly 4-ribbed, green to red-brown, woody, scabrous (particularly on ribs) with curved 2-3-celled translucent hairs (basal cell ± swollen) 0.1-0.2 mm long.

Leaves opposite, sessile, lanceolate to narrow lanceolate, (2.5-)3.0-5.0(-6.0)cm long, 0.6-1.0 cm wide, apex acute, serrate with 10-30 teeth 0.1-0.2 mm long, midrib channelled above, prominent below, lateral veins obscure, glabrous, or scabrous on margins and midrib with hairs as for stems.

Inflorescence an indeterminate spike of 1-3 flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper 4-6(-8) leaves. Primary bracts leaflike, green, fleshy, linear-lanceolate, 0.5-1.0(-1.5) cm long, 0.1-0.3 cm wide, serrate or entire, scabrous; secondary bracts brown, membranous, linear, 0.4-0.5 mm long, 0.1-0.2 mm wide, prominent midrib; tertiary bracts brown, membranous, linear, 0.2-0.3 mm long, 0.1 mm wide.

Flowers tetramerous, on pedicel 0.8-1.0 mm long. Sepals 4, ovate-deltoid, 0.7-0.8 mm long, 0.6-0.7 mm wide, green, not ribbed, glabrous. Petals 4, yellow to green, hooded, tips erect, keeled, unguiculate, (2.4-)2.8-2.9 mm long, 0.6-0.9 mm wide, scabrous on keel or glabrous. Stamens 8, filaments 0.2 mm long; anthers yellow, oblong, (1.8-)2.1-2.3 mm long, 0.4 mm wide, 4-celled, nonapiculate. Styles 2, clavate, 0.5 mm long, stigmas capitate. Ovary oblong, 0.9-1.0 mm long, 0.5-0.7 mm wide, tapering to base, furrowed between styles, protuberant opposite styles, somewhat flattened in plane of styles, 2-locular with 1 pendulous ovule per locule.

Fruits 1-3 per axil, on pedicels 0.8-1.0 mm long, oblong-ovoid, 2.0-3.3 mm long, 1.3-1.7 mm wide, slightly contracted in upper half, weakly 4-ribbed between sepals, ± rugose in lower half, compressed in plane of styles, glabrous; sepals persistent, erect, deltoid, 0.7-0.9 mm long, 0.6-0.7 mm wide, not ribbed; 2-locular, pericarp and septum sub-woody, seeds 1 or 2.

Distribution. (Map 1)

H. serra is known only from eastern New South Wales, where it has been collected mainly on the lower western slopes of the Great Dividing Range between 300-600 m (1,000-2,000 feet) altitude, although a few collections are known from the adjacent plains.

Ecology.

This species is found over a wide range of soils and vegetation types. Collectors' notes include "a small plant ... which progresses by means of underground stolons; 3 ft.; clay banks of creeks: (Althofer 5); "found on the fringe of forest-lands in sandy soil, on the tops of ridges in rich alluvial deposits" (Boorman -.xii.1904); "on limestone hills

2000'" (Constable NSW31196); "amongst limestone rocks on cliff face" (Constable NSW35324); and "on rocky outcrops at top of bluff" (Rodd 499). Flowering occurs from November until January(-March) and fruiting from December until May.

Specimens examined.

New South Wales: Althofer 5, 13.iii.1949, Dripstone, BRI (fl.,fr.); Anon. s.n., 1.iii.1843, west of Mr. Otley's station, MEL (st.); Anon. s.n., Gundagai, MEL39295, NSW99081 (fl.,fr.); Anon 33, rocky banks of Riv. Severn, MEL (fr.); Anon. 315, R. Severn-Clifton, MEL (fl.,fr.); Betche s.n., -.i.1883, Liverpool plains, NSW99258 (fl.,fr.); Blakely s.n., -.i.1900, Jenolan Caves, MEL39289, NSW99256 ('19'), SYD (fl.fr.); Boorman s.n., -.xii.1904, Gungal, AD96905140, BRI080095, MEL39297, NSW99082, SYD (fl.,fr.); Boorman s.n., -.xi.1906, Molong, AD96920061 (fl.); Burgess s.n., 7.viii.1963, Wingen, CBG016747 (st.); Carter s.n., 1886, Moonan Brook, Scone, MEL1003670 (fl.,fr.); Constable s.n., 22.iii.1955, Abercrombie Caves, NSW31196 (fr.); Constable s.n., 23.i.1956, Bungonia Lookout, nr. Caves, NSW35324 U091001B (fr.); Gauba s.n., 7.v.1950, Burrinjuck, AD96911100 (fr.); Goddard s.n., -.i.-, Jenolan Caves, SYD (fl.); Leichhardt s.n., Roolah Station, Liverpool Range, MEL39286, 39287 (fl.,fr.); Maiden & Boorman s.n., -.vi.1906, Tamworth, AD96920060 (st.); Moore s.n., the Castlereagh, MEL39294 (fl.,fr.); Moore s.n., Castlereagh River, MEL1003532 (fl.); Stuart s.n., River Severn, New England, MEL39291 (fr.); Stuart 315, New England, MEL (fl.,fr.); Rodd 499, 23.vii.1967, Abercrombie Caves, NSW99253 (st.); Rupp s.n., -.ii.1907, Warialda, NSW99257 (fl.,fr.); Rupp s.n., -.iii.1913, Barraba, MEL39282 (fr.); Rupp s.n., -.iv.1916, Barraba, NSW99254 (fr.); Vickery s.n., -.v.1959, Gulgamree near Mudgee, NSW99255 (fr.).

Notes.

1. The collection Althofer 5 is completely glabrous, but agrees with the species in all other respects.

2. This species is quite closely related to *H. exalata*, differing mainly in its narrower leaves and 2-(not4-)locular ovary.

8. *Haloragis eichleri* Orchard, sp. nov.

Herba perennis vel suffrutex 25-50 cm altus, caules arcuati ascentes laeves in partibus inferioribus radicantibus, pilis mollibus pellucidis simplicibus patentibus 3-5-cellularis 0.1-0.2(-0.4) mm longis. Folia opposita, alterna prope inflorescentiam, crassa coriacea sessilia vel subsessilia in petiolis usque ad 3 mm longos, ovata vel anguste ovata, (1.5-)3.5-5.5 cm longa (0.5-)1.0-1.5(-2.0) cm lata, serrata dentibus 10-15 obtusis prominentibus 2-3 mm longis, lamina supra atroviridem infra viridem pallidam. Flores 4-meri, sepala et petala et styli 4, stamina 8, loculi 4 uniovulati, ovulis pendulis. Fructus ovoidei, 2.0-2.5 mm longi 1.5-2.0 mm lati (sepala exclusa), 4-angulati obtusi inter sepala 4-sulcati, sepala opposita, subtiliter ± transverse rugosi; 3-4 loculi (1 loculus saepe abortivus), pericarpium et septa sublignosa, semina 1-4.

Typus: Hj. Eichler 20806, 31.xii.1970, South Australia. South East. Coastal sand dunes south of Evans Cave ca 3 km south of Robe, AD97105074 (fl.,fr.)! Holotypus: AD(97105074). Isotypi: Still to be distributed.

Perennial herb or subshrub 25-50 cm tall, growing as independent, isolated rounded bushes, stems arcuate ascending, red to green, smooth, rooting (mainly in internodes) in lower part, branching mainly from base, prostrate parts of stems woody, erect parts herbaceous, pilose with soft, simple, pellucid, 3-5-celled, spreading hairs 0.1-0.2(-0.4) mm long.

Leaves opposite in lower parts, becoming alternate near inflor- escence, dark green above, light green below, thick, leathery, sessile, or subsessile on petiole up to 3 mm long, ovate to narrow ovate, (1.5-)3.5-5.5 cm long, (0.5-)1.0-1.5(-2.0) cm wide, tapering equally to either end, serrate with 10-15 blunt, prominent teeth 2-3 mm long, midrib channelled above, prominent below, lateral veins indistinct, sparsely pilose on both surfaces with hairs as for stems.

Inflorescence an indeterminate spike of 1-7 flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences are borne in the axils of the upper 4-6 leaves. Primary bracts leaflike, lanceolate, (0.6-)1.0-1.5 cm long, 0.2-0.4 cm wide, thick, green, entire or 2-6 serrulate, prominent midrib, pilose on margins; secondary bracts brown, membranous, linear, 1.0-2.0 mm long, 0.3-0.4 mm wide, midrib present, pilose on margins or glabrous; tertiary bracts brown, membranous, linear, 0.8-1.0 mm long, 0.2-0.3 mm wide, lacking midrib, pilose on margins or glabrous; quaternary bracts as for tertiary, 0.6-0.7 mm long, 0.2 mm wide.

Flowers 4-merous, those of final dichasial branches often rudimentary. Sepals 4, green, deltoid, 0.8-0.9 mm long, 0.6-0.7 mm wide, not ribbed, pilose. Petals 4, red to green, hooded, tip horizontal, shortly unguiculate, keeled, 1.8-2.3 mm long, 0.7-0.8 mm wide (keel to margin) pilose on keel. Stamens 8, filaments 0.1-0.2 mm long; anthers yellow to red, oblong, 1.5-1.8 mm long, 0.3-0.4 mm wide, 4-celled, non-apiculate, antisepalous anthers ca 0.3 mm longer than antipetalous ones. Styles 4, yellow, clavate, 0.4-0.5 mm long, stigmas capitate, red or yellow. Ovary ovoid to globose, 0.6-0.7 mm long, 0.6-0.8 mm wide, 4-angled opposite petals, pilose, 4-locular with 1 pendulous ovule per locule.

Fruit ovoid, 2.0-2.5 mm long, 1.5-2.0 mm wide, finely ± transversely rugose, bluntly 4-angled opposite petals, 4-furrowed opposite sepals, sessile or on pedicel 0.5 mm long, pilose with hairs as for stems; sepals persistent, erect, deltoid, 0.6-1.1 mm long, 0.7-0.8 mm wide, not ribbed, sometimes with weakly developed median basal callus; 3-4 locules (basically 4, but 1 often aborts), pericarp and septa ± woody, 1-4-seeded. (Fig. 22; Plate 14)

Distribution. (Map 1)

This species is confined to South Australia, being most common in the South East part of the State, from about Kingston south and east to the Victorian border. It is also known from southern Kangaroo Island and from Port Lincoln on southern Eyre Peninsula.

Ecology.

H. eichleri has been recorded only from sand dune habitats, usually from disturbed communities. Collectors' notes include "sandhills and limestone near sea" (Cleland AD968020568); "recently burnt" (Eichler 18553); "coastal sanddunes" (Eichler 20806); "coastal sanddunes...in cleared firebreak through tall mallee" (Orchard 3226, 3227). Flowering occurs from November until January and fruiting from (November-) December until March.

Specimens examined.

South Australia: Alcock 85, 25.xii.1963, roadside north of The Gap, AD (fr.); Anon. s.n., Port Lincoln, AD96906022 (fl.,fr.); Browne 82, Port Lincoln, MEL (fl.,fr.); Cashmore s.n., -.xi.1934, Cape Gantheaume K.I., AD96810045 (fl.); Cleland s.n., 18.xi.1924, Rocky River K.I., AD96803289 (fl.); Cleland s.n., 6.iii.1929, Rocky River K.I., AD968020568 (fr.); Cleland s.n., 4.xii.1934, road to Cape du Couedic K.I., AD968020566 (fr.); Eichler 18553, 3.i.1966, Mt.Stockade, Hundred of Newland K.I., AD (fl.,fr.); Eichler 20806, 31.xii.1970, south of Evans Cave ca 3 km south of Robe, AD (fl.,fr.) - type of *H. eichleri*; Hunt 1661, 24.xi.1963, between The Gap and Western Flat, AD (fl.,fr.) - pollen sent to Palyn. Lab. Stockholm sub nom. *H. heterophylla*; Ising s.n., 24.i.1937, Wynarka, AD966031977 (fl.,fr.); Lothian 5138, 22.xi.1970, Gum Lagoon National Park, AD (fl.); Orchard 3226, 23.i.1971, ca 3 km south-east of Robe, AD (fl., fr.); Orchard 3227, 23.i.1971, l.c., AD (sterile seedling); Tate s.n., 11.xi.1882, Beachport, AD96810010 (fl.).

Notes.

1. *H. eichleri,* the only species of *Haloragis* wholly endemic to South Australia, is named in honour of Dr. Hj. Eichler, Keeper of the State Herbarium of South Australia (AD) since its inception in 1955, and author of the Supplement to Black's Flora of South Australia (1965), in recognition of his efforts to promote taxonomic botany in this State.

2. *H. eichleri* approaches closely in habit, leaf, hair and fruit characteristics, *H. odontocarpa* f. *rugosa,* from which it differs principally in having ± opposite leaves which are much thicker and more shortly petiolate. Some affinity of *H. eichleri* with *H. acutangula* f. *acutangula* is indicated by their similarity in general appearance, habitat preference and distribution. Here again the most obvious difference lies in the leaves, which in *H. acutangula* are never opposite or petiolate, or as coriaceous as those of *H. eichleri.* The fruits of *H. eichleri,* where 1 locule commonly fails to develop, are unique in the genus.

9. *Haloragis odontocarpa* F.v.Mueller, Fragm. 1(1859)108 [Typus: "In collibus arenosis prope Kulkyne. J. Dallachy." Holotypus: Dallachy s.n., Kulkyne, MEL39198 (fl.,fr.);! Isotypus (?): Anon. s.n., Kulkyne, MEL39200 (fl.,fr.)!]; Benth., Fl. Aust. 2(1864)479; F.v.M., Fragm. 10(1876)54; Tate, Trans. roy. Soc. S.Aust. 3(1880)64; F.v.M., Census 1(1882)49; F.v.M., Key Syst. Vict. Pl., 2(1885)22, 1(1887-8)261; F.v.M., Trans. roy. Soc. Vict. 24(1888)134; F.v.M., Sec. Census 1(1889)85; Tate, Trans. roy. Soc. S.Aust. 12(1889)95; Tate; Fl. S.Aust. (1890)101; Moore, Hdbk. Fl. N.S.Wales (1893)185; Tate in Spencer, Rep. Horn Exped. 3(1896)157; Schindler, Bot. Jb. 34, Beibl. 77(1904)30, 35; Schindler, Pflrch. 23(1905)57; Dixon, Pl. N.S.Wales (1906)130; Black, Trans. roy. Soc. S.Aust. 39(1915)823, 824; Maiden & Betche, Census N.S.Wales Pl. (1916)158; Black, Fl. S.Aust. (1926)431, 2 ed. (1952)644; Ewart, Fl. Vict. (1931)883; Chippendale, Trans. roy. Soc. S.Aust. 82(1959)333.

Haloragis coronopifolia Schindler, Pflrch. 23(1905)56, fig. 17C. [Typus: "Australien: Girilambone (Betche). - Herb. Berlin." Holotypus: n.v. - probably destroyed. Isotypus (?): E. Betche s.n., -.x.1886, Girilambone MEL38937 (fl.)! - see note 3.] Maiden & Betche, Census N.S. Wales Pl. (1916) 158.

Figs: Black, Fl. S.Aust. 2 ed. (1952)fig. 878; Schindler, Pflrch. 23(1905) fig. 17C.

Annual herb (10-)30-45(-100) cm tall, strongly developed taproot, stems erect or ascending, branching from base, herbaceous, rooting in lower parts, green to reddish, smooth, glabrous, or pilose with soft sub-arachnoid, simple, transparent, (4-)6-8 celled hairs. (0.2-)0.4-1.0 mm long, concentrated on younger parts.

Leaves alternate (± opposite at extreme base), petiolate (petiole (0.5-)0.7-1.5(-2.0) cm long), ovate, 4.5-6.0(-8.0) cm long (0.7-)1.0-1.5(-2.5) cm wide, tapering gradually to apex, abruptly to petiole, serrate with 10-15(-30) prominent blunt teeth 0.2-0.4 mm long, midrib sunken above, prominent below, lateral veins indistinct, departing at ca 30° to midrib, pilose on both surfaces with hairs as for stems.

Inflorescence an indeterminate spike of 3-7(-15) flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper leaves. Primary bracts leaflike, green, linear, 3.0-6.5 mm long, 0.8-2.0 mm wide, entire or serrate with 4-5 teeth, midrib absent, pilose; secondary bracts brown, membranous, linear, 0.6-0.7 mm long, 0.1-0.2 mm wide, pilose on margins; tertiary bracts brown, membranous linear, 0.5-0.7 mm long, 0.1 mm wide, pilose on margins.

Flowers 4-merous, on pedicels 0.2-0.5 mm long. Sepals 4, deltoid, 0.6-1.0 mm long, 0.5-0.7 mm wide, not ribbed. Petals 4, yellow-green, hooded, tip erect, shortly unguiculate, 2.0-2.6 mm long, 0.5-0.8 mm wide, glabrous, or pilose on keel. Stamens 8, filaments 0.2-0.3 mm long; anthers yellow, oblong, 1.8-2.2 mm long, 0.3-0.4 mm wide, non-apiculate, 4-locular. Styles 4, reddish, clavate, 0.3-0.4 mm long, stigmas capitate. Ovary ovoid 0.4-0.5 mm long, 0.4-0.5 mm wide, ± 4-angled opposite petals, densely pilose

Fruits extremely variable, 1-3(-5) per axil, on pedicel (0.7-) 1.0-2.0 mm long, ovoid, globose, pyriform or rectangular, rugose, 4-angled, -ribbed or-winged opposite petals, wings (if present) spongy, oblong or constricted in centre, or "tooth-like" appendages borne opposite sepals;

sepals persistent, erect, deltoid, (0.8-)1.0-1.5 mm long, (0.5-)0.8-1.5 mm wide, weakly midribbed, glabrous or pilose on outer face; 4 locules, endocarp and septa ± woody, exocarp membranous or ± spongy, 1-4 seeds.

Distribution. (Map 2)

H. odontocarpa is widespread in the semi-arid areas of eastern, central and western Australia, extending in a broad band from Charleville in southern Queensland through central New South Wales and north-western Victoria to south-eastern South Australia. The species is also well collected in the Everard-George Gill Ranges area on the South Australia-Northern Territory border, and throughout south-central Western Australia.

Ecology.

The distribution pattern of this species matches well the 8-10(-14) inches winter rainfall isohyet. It grows in a variety of soils in open savannah woodland, the dominant tree species usually being mulga (*Acacia aneura*). In Queensland and New South Wales, it is considered to be good stock fodder, but has the effect of turning sheep's urine red, at the same time preventing fly "strike". Representative collectors' notes include "common on limestone outcrop in restricted area" (Chippendale NT2858); "in red gravelly loam with mulga" (George 8708); "in railway enclosure amongst grasses (*Amphipogon* and *Aristida* spp) on brown sandy soil" (Hubbard & Winders 6125); "occasional in sandy red earth with *Acacia aneura* and *Eragrostis eriopoda*" (Lazarides 6149); "well watered red-brown clay (*E. populnea, Acacia aneura* etc.)" (Moore 4789); "grows profusely on the rough ringbarked mulga country. The sheep eat it readily and apparently thrive on it. It has the effect of discolouring their urine a saffron colour, with the remarkable effect that the sheep depastured on it are kept absolutely free from fly, when sheep in the adjoining paddocks where this plant does not grow are badly struck" (Penzer BRI080074). Flowering and fruiting seems to occur at all times of the year.

Common names.

"Spinach" (Barlow BRI080079), "Mulga Spinach" (Latham 1, White 11867); "Mulga Cabbage" (White 11867), "Nettle" (Barlow BRI080083), "Mulga Nettle" (Martin BRI070875).

Specimens examined.

In common with several other *Haloragis* species, *H. odontocarpa* shows considerable variation in fruit shape, independent of variation in other characters. However, as approximately 50% of collections of this species lack fruits, they are listed separately below to establish the complete distribution pattern. Fruiting specimens are listed under their respective formae.

Victoria: Beauglehole 1422, -.x.1948, Hattah National Park, BEAUGLEHOLE (st.); Beauglehole 16036, 20.ix.1966, Sunny Cliffs, S. of Mildura, BEAUGLEHOLE (fl.); Beauglehole 17034, 3.x.1960, Hattah Lakes National Park, BEAUGLEHOLE (fl.); Beauglehole & Finck 29506, 11.xi.1968, Wyperfeld National Park, BEAUGLEHOLE (fl.).

New South Wales: Beadle s.n., near Griffith, SYD (fl.); Beadle s.n., 1942, Co. Dowling, SYD (fl.); Betche s.n., -.x.1886, Girilambone, MEL38937 (fl.) - isotype (?) of *H. coronopifolia*; Blakely & Shiress s.n., near Griffith, NSW99308 (fl.); Boorman s.n., -.x.1912, Waverley Downs-Hungerford AD96905130, BRI080082 (fl.); Constable s.n., 16.x.1947, The Meadows, U72277A (fl.); Constable s.n., 30.vii.1955, 10m. N.E. Goolgowi, NSW37863 (fl.); McHatten s.n., -.viii.1913, Bourke, SYD (fl.); Moore 4027, 20.ix.1966, "Tundulga" about 25 miles S.E. of Louth, CANB (fl.); Moore 4184, 23.ix.1966, l.c. CANB (fl.); Moore 4613, 18.x.1966, 42 miles west of West Wyalong, CANB (fl.); Moore 5521, 29.viii.1968, "Tundulga" about 25 miles southeast of Louth, CANB (fl.); Phillips s.n., 13.ix.1966, Round Hill Mallee Fowl Reserve, CBG023418 (fl.).

Queensland: Everist 2921, 25.iii.1947, Boatman Station, CANB (fl.); Gurney 450, 30.vii.1930, "Mount Morris" near Charleville, BRI (fl.); Martensz s.n., 8.viii.1967, Gilruth Plains Stn, Cunnamulla, CANB1751 (fl.); Martin s.n., 8.viii.1967, "Arabella" about 20 miles S.E. of Charleville, BRI070875 (fl.); Roe 337, 22.vii.1941, Top Cane Paddock, Gilruth Plain, CANB (fl.); White 11867, 26.iii.1941, Wallal, BRI (fl.).

Northern Territory: Beauglehole 22827, -.vii.1967, S.E. side of Mt.Conner, BEAUGLEHOLE (fl.); Beauglehole 23001, 3.vii.1967, W. of Farrer Spring, George Gill Range, BEAUGLEHOLE (fl.); Beauglehole 26908, 15.vii.1968, Kathleen Spring, George Gill Range, BEAUGLEHOLE (fl.); Chippendale s.n., 13.viii.1957, Bagot's Creek, George Gill Range, AD95918319, CANB55780, MEL39194, NSW99313, NT3605, PERTH (fl.).

Western Australia: Burbidge 273, -.viii.1938, Glenorn Station, Malcolm, PERTH (fl.); Gardner s.n., 30.viii.1945, near Pindar, PERTH (fl.); Gardner 2410, 25.vii.1931, 30m. S. of Wiluna, PERTH (fl.); George 5422, 25.vii.1963, 22 miles W. of Browne Ra., PERTH (fl.); McMillan s.n., -.ix.1958, Hamersley Range, PERTH (fl.); Speck 1171, 7.viii.1958, 2 miles south of Yandil, AD, BRI, CANB, PERTH (fl.); Wilson 7425, 28.viii.1968, Von Treuer Tableland, PERTH (fl.); Young s.n., 14.vii.1875, between Youldah and Ouldabinna, MEL39195 (fl.).

South Australia: Cleland s.n., 1.ix.1954, Everard Park, eastern end of Everard Ranges, AD (fl.); Forde 492, 4.ix.1956, 40 miles E.S.E. of Emu, CANB (fl.); Reid s.n., 24.vi.1967, Officer Creek Block - S. of Ernabella, ADW (fl.); Spooner 77, -.ix.1968, Everard Ranges, AD (fl.).

Key to the formae of *H. odontocarpa* based on fruit shape.

1. Fruit 4-angled or ribbed longitudinally between sepals, not winged.
    2. Fruit with tooth-like appendages 1-1.5 mm long projecting opposite sepals ... α. f. *odontocarpa*
    2. Fruit lacking appendages of all sorts, ± smooth or irregularly rugose ... β. f. *rugosa*
1. Fruit 4-winged longitudinally between sepals.
    3. Wings entire, oblong ... γ. f. *pterocarpa*
    3. Wings constricted in centre ... δ. f. *octoforma*

α. forma *odontocarpa*

Fruits 1-3 per axil on pedicels 0.5-0.7 mm long, ovoid or rectangular, 2.0-2.5 mm long, 1.0-1.5 mm wide (excluding teeth), 4-angled between sepals, ± smooth except for long tooth-like appendages 1.0-1.5 mm long, projecting opposite sepals at base of fruit or at base and apex (i.e. 1 or 2 per side), pilose; sepals persistent, erect, deltoid, 1.0 mm long, 0.5-1.0 mm wide, faintly midribbed, pilose; fruit 4-locular, septa and endocarp woody, exocarp ± spongy in parts.

<u>Distribution</u>. (Map 2)

This forma is known only from New South Wales.

<u>Specimens examined</u>.

<u>New South Wales</u>: Anon. s.n., Kulkyne, MEL39200 (fl.,fr.) - (?) isotype of *H. odontocarpa*; Dallachy s.n., Kulkyne, MEL39198 (fl.,fr.) - holotype of *H. odontocarpa*; Martensz 176, 23.v.1969, 2½ miles east from the Euabolong turnoff along road between Lake Cargelligo-Mt. Hope, CANB (fr.).

β. forma *rugosa* Orchard, f. nov.

Fructus ovoideus vel globosus vel pyriformis, 2.5-3.0 mm longus (1.4-)1.6-2.0(-3.0) mm latus, 4-angulatus vel costatus inter sepala vel laevis, irregulariter rugosus basin versus praesertim. Typus: Hj. Eichler 13772, 19.iv.1957, South Australia. Murray Mallee. Ca 3.5 km south of Monash, ca 22 km south-west of Renmark, (fr.)! Holotypus: AD95814059. Isotypi: Still to be distributed.

Fruits 1-3(-5) per axil, on pedicel 2.0 mm long, ovoid, globose or pyriform, 2.5-3.0 mm long, (1.4-)1.6-2.0(-3.0) mm wide, 4-angled or ribbed between sepals, or smooth, irregularly rugose particularly in lower part, pilose or glabrous; sepals persistent, erect, deltoid, 1.0-1.4 mm long, 0.8-1.2 mm wide, weakly midribbed, ± 2 lateral veins, pilose or glabrous; 4 locules, septa and endocarp ± woody, exocarp membranous, 1-4 seeds.

<u>Distribution</u>. (Map 2)

This is one of the most widespread forms, and is found throughout the distributional area of the species, with the exception of Victoria.

However, as it has been collected just across the River Murray in New South Wales (Vickery NSW2025) it must almost certainly occur in north-western Victoria as well.

Specimens examined.

New South Wales. Constable s.n., 16.x.1947, The Meadows, NSW4568 (fl.,fr.); Moore 4789, 15.xii.1966, "Tundulga" about 25 miles south-east of Louth, CANB (fl.,fr.); Mueller s.n., 1896, Riverina, MEL39201 (fr.); Peacock, s.n., -.x.1900, Girilambone, NSW99098 (fl.,fr.); Rick & Common 0327, 24.xi.1949, 70 miles W. of Cobar, CANB (fl.,fr.); Vickery s.n., 19.viii.1946, between Euston and Mildura, NSW2025 (fl.,fr.).

Queensland: Allen 196, 2.x.1941, Gilruth Plains, Cunnamulla, CANB (fl.,fr.); Barlow s.n., -.vi.1919, Charleville, BRI (fr.); Ebersohn E240, 24.viii.1962, 40 miles N.W. of Charleville, BRI (fl.,fr.); Everist 2881, 22.iii.1947, Coniston, S.W. of Boatman Station, BRI, CANB (fl.,fr.); Everist 5912, 11.xi.1957, Gowrie Station about 12 miles N.E. of Charleville, BRI (fl.,fr.); Everist & White 29,25.v.1936, between Bollon and Shamrock Wells, BRI (fl.,fr.); Holland 204, 2.v.1953, Bollon-Cunnamulla road west of Nebine, CANB (fl.,fr.); Hubbard & Winders 6125, 2.i.1931, Charleville, BRI (fr.); Latham 1, 29.iv.1936, Cunnamulla, BRI (fr.); Penzer, s.n., 6.xi.1933, Rosewood Station near Charleville, BRI080074 (fl.,fr.); Phillips s.n., 22.ix.1963, 37 miles from Charleville on road to Quilpie, CBG015868 (fl.,fr.); Simpson 3, 20.iv.1959, 45 miles S.W. of Cunnamulla, BRI (fl.,fr.); White 11865, 3.iv.1941, Shamrock Wells, NSW (fl.,fr.).

Northern Territory: Beauglehole 23520, 9.vii.1967, Bagot Creek, George Gill Range, BEAUGLEHOLE (fl.,fr.); Chippendale s.n., 11.ix.1956, 14 m. N.E. of Angas Downs H.S., MEL39192, NSW99314, NT2858 (fl.,fr.); Latz 311, 11.xii.1968, Kings Canyon, AD (fl.,fr.); Lazarides 6149, 7.x.1956, 7 miles W.N.W. of Ayers Rock, AD, BRI, CANB, MEL,NT, (fl.,fr.).

Western Australia: Clarke 166, -.vii.1916, E. Laverton, PERTH (fr.); George 4007, 25.viii.1962, 33 miles S.E. of Winduldarra Rockhole, Warburton road, AD, PERTH (fl.,fr.); George 5590, 28.vii.1963, ± 22 miles S. of Wongawol H.S., PERTH (fl.,fr.); George 8708, 13.vii.1967, 134 miles N.E. of Cosmo Newberry on Warburton road, AD, PERTH (fl.,fr.); Wilson 7231, 26.ix.1968, 32 km N. of Menzies, AD (fl.,fr.); Wilson 7288, 26.viii.1968, Lake Carey, PERTH (fl.,fr.).

South Australia: Cleland s.n., -.i.1921, Berri, AD966032608 (fl.,fr.); Eichler 13722, 19.iv.1957, ca 3.5 km south of Monash, AD (fr.) - type of *H. odontocarpa* f. *rugosa*; Reid s.n., 30.ix.1955, between Mt. Woodroffe & Mt. Harriet, ADW19218 (fl.,fr.).

γ. forma *pterocarpa* Orchard, f. nov.

Fructus ovoideus, 3.0-4.5 mm longus, 3.0-5.0 mm latus (alae inclusae), 4-alatus inter sepala; alae haud constrictae, oblongae, 0.5-1.5 mm latae, venis lateralibus; fructus inter alas laevis vel rugosus.

Typus: A.E. Orchard 1859, 16.xii.1968, South Australia. Murray Lands. Ca 3 km south-east of Waikerie, (fl.,fr.)! Holotypus: AD96851140, Isotypus: Still to be distributed.

Fruits 1-3(-5) per axil, on pedicels 1.0 mm long, ovoid, fruit 3.0-4.5 mm long, 3.0-5.0 mm wide (including wings), 4-winged between sepals, smooth or rugose between the wings; wings unconstricted, oblong, laterally veined, 0.5-1.5 mm wide; glabrous or pilose; sepals persistent, erect, deltoid, 1.3-1.5 mm long, 1.0-1.5 mm wide, midribbed, ± 2 lateral veins, glabrous or pilose; 4 locules, septa and endocarp ± woody, exocarp spongy, particularly the wings, 1-4 seeds. (Fig. 21)

Distribution. (Map 2)

This forma is found through the range of the species.

Specimens examined.

Victoria: Beauglehole & Finck 29476, 11.xi.1968, Wyperfeld National Park, BEAUGLEHOLE (fl.,fr.).

New South Wales: Boorman s.n., -.xi.1903, Byrock, NSW99309, ('12') (fl.,fr.); Maiden s.n., -.xii.1908, Coolabah, MEL39205 (fl.,fr.); Martensz 177, 23.v.1969, 2½ miles east from the Euabolong turnoff along road between Lake Cargellico-Mt. Hope, CANB (fl.,fr.); Moore s.n., 6.x.1886, Giriligambone, MEL1003671 (fl.,fr.); Straatmans s.n., -.x.1958, Lake Cargelligo, CANB61346 (fl.,fr.); Tucker s.n., 1879, Lachlan River, MEL39196 (fl.,fr.).

Queensland: Allen A72, 6.xi.1941, St.George-Bollon rd. CANB (fl.,fr.); Barlow s.n., -.x.1916, Bollon, BRI080083 (fl.,fr.); Clemens s.n., 15.xi.1945, Charleville, BRI080081 (fr.); Everist 5912, 11.xi.1957, Gowrie Station about 12 miles N.E. of Charleville, CANB (fl.,fr.).

Northern Territory: Chippendale s.n., 11.ix.1956, 14 m N.E. of Angas Downs H.S., CANB40180 (fl.,fr.); Lazarides 6149, 7.x.1956, 7 miles WNW of Ayers Rock, PERTH (fl.,fr.).

Western Australia: Baird s.n., -.viii.1961, Morowa area, UWA488 (fl., fr.); Bennett s.n., 7.vii.1941, Lake Violet Station, PERTH (fl.,fr.); Burbidge 6070, 9.v.1958, 56 miles S. of Mundiwindi on Meekatharra Rd, CANB, PERTH (fl.,fr.); George 4077, 26.viii.1962, Miss Gibson Hill, PERTH (fl.,fr.); George 8709, 13.vii.1967, 134 miles N.E. of Cosmo Newberry on Warburton road, PERTH (fl.,fr.); Young s.n., 10-15.x.1875, near Ularing, MEL1003558 (fr.).

South Australia: Cleland s.n., -.i.1921, Berri, AD96803063 (fl.,fr.); Cleland 46, 2.xii.1913, Alawoona, AD (fl.,fr.); Eardley s.n., 20.xi.1946, Waikerie, ADW6190 (fr.); Eichler 13722 bis, 19.iv.1957, ca 3.5 km south of Monash, AD (fr.); Gross s.n., -.vi.1936, Morgan-Renmark, ADW3322 (fl., fr.); Henderson s.n., 14.vi.1969, ca 50 km north of Barmera, AD96927239 (fl.,fr.); Orchard 1859, 16.xii.1968, ca 3 km south-east of Waikerie, AD (fl.,fr.) - type of *H. odontocarpa* f. *pterocarpa*; Orchard 1859A, 16.xii.1968, l.c. AD (fl.,fr.).

δ. forma *octoforma* Orchard, f. nov.

Fructus ovoideus, 2.5-4.0 mm longus, 2.0-3.0 mm latus (alae inclusae), 4-alatus inter sepala; alae in centris constrictae; fructus inter alas rugosus, costatus. Typus: D.J.E. Whibley 1229, 18.ix.1963, South Australia. Far North West. Everard Range. Hill north of Everard Park Homestead. Everard Park Homestead is ca 275 km west-north-west of Oodnadatta. (fr.)! Holotypus: AD96640180.

Fruits 1-3 per axil on pedicel 0.7-1.0 mm long, octoform in outline, 2.5-4.0 mm long, 2.0-3.0 mm wide, body of fruit ovoid, rugose, 4-ribbed opposite sepals, 4-winged between sepals, the wings constricted in centre, pilose or glabrous; sepals persistent, erect, deltoid, 0.8-1.5 mm long, 0.7-1.5 mm wide, midribbed, ± 2 lateral veins, pilose on outer face; 4 locules, septa and endocarp ± woody, exocarp ± spongy particularly wings, 1-4 seeds.

Distribution. (Map 2)

This forma, although much less common than f. *rugosa* and f. *pterocarpa*, occupies much the same area. It is known throughout the range of the species, with the exception of Victoria and south-eastern South Australia.

Specimens examined:

New South Wales: Constable 4568A, 17.x.1963, Mulwarrina Creek, Mulwarrina Creek, Mulgowen Station, 35 miles south of Bourke, NSW (fl.,fr.); Wells & Gill s.n., -.xi.1968, 'Wakoo' between Bourke and Cobar, CANB188156 (fr.).

Queensland: Francis s.n., 25.ii.1934, Wallal, 12 miles S. of Charleville, BRI080080 (fr.); White 11865, 3.iv.1941, Shamrock Wells, BRI (fr.).

Northern Territory: Cleland s.n., 7.vi.1955, between Middleton Ponds and Liddles, AD966042093 (fr.); Horn Exped. s.n., 1894, McDonald Ranges, NSW99311 (fl.,fr.).

Western Australia: Lindgren 73, 14.ix.1966, 13 miles N.W. of Thundelarra Station, PERTH (fr.); Royce 4422, 23.ix.1953, Comet Vale, N. of Kalgoorlie, PERTH (fr.).

South Australia: Batt s.n., 1891, Nullarbor Plains, MEL38936 (fl.,fr.); Whibley 1229, 18.ix.1963, north of Everard Park Homestead, AD (fr.) - holotype of *H. odontocarpa* f. *octoforma*.

Notes:

1. Although the formae recognized above have very different shaped fruits, and might at first sight seem to warrant a status above formae, the variation in fruits (as in *H. acutangula)* is independant of other characters, and of distribution. Different formae apparently grow together in a single population, as evidenced by e.g. Martensz 176 (f. *odontocarpa*) and Martensz 177 (f. *pterocarpa)* growing side by side (collector's note); Eichler 13722 (f. *rugosa*) and Eichler 13722 bis (f. *pterocarpa*); and a number of collections, where "duplicates" in different herbaria belong to different formae (e.g. Chippendale s.n., Angus Downs; Lazarides 6149). The collection Lazarides 6149 in CANB, although consisting of f. *rugosa*, has fruits of f. *rugosa*, f. *pterocarpa* and f. *octoforma* in an attached packet.

2. The epithets *rugosa* (wrinkled), *pterocarpa* (winged fruit) and

octoforma (figure-of-eight shape) all refer to the fruits.

3. The status of the name *Haloragis coronopifolia* Schindler is uncertain. The type specimen in B is probably destroyed, and the only known possible isotype (MEL38937) has flowers but lacks fruits. From Schindler's description and figure it seems likely that *H. coronopifolia* is synonymous with *H. odontocarpa* f. *rugosa*.

4. Although only 4 fruit forms are formally recognized, others worthy of description may become apparent when more fruiting material has been collected. Even as circumscribed above, f. *rugosa* shows considerable variation.

10. *Haloragis gossei* F.v.Mueller, Fragm. 8(1874)161 [Typus: "In Australia fere centrali montem Olgae versus; Gosse". Holotypus: Gosse s.n., 1873, Mount Olga, MEL1003542 (fr.)!]; Tate, Trans. roy. Soc. S.Aust. 3(1880)64; Kempe, Trans. roy. Soc. S.Aust. 3(1880)133; F.v.M., Fragm. 11(1881)134; F.v.M., Census 1(1882)49; Winnecke, Trans. roy. Soc. S.Aust. 8(1886)12; F.v.M., Trans. roy. Soc. S.Aust. 9(1887)214; F.v.M., Trans. roy. Soc. Vict. 24(1888)136; Tate, Trans. roy. Soc. S.Aust. 12(1889)95; F.v.M., Sec. Census 1(1889)85; Tate, Fl. S.Aust. (1890)101,234; F.v.M. & Tate, Trans. roy. Soc. S.Aust. 13(1890)101, 16(1896)352; Tate in Spencer, Rep. Horn Exped. 3(1896)157; Moore, J. Bot. 35(1897)167; Moore, J. Linn. Soc. (Bot.) 34(1899)190; Bailey, Qld. Fl. 2(1900)553; Diels & Pritzel, Bot. Jb., 35(1904)445; Schindler, Bot. Jb. 34, Beibl. 77(1904)5,6,29,30, 31,35, Pflrch. 23(1905)58; Britten, J. Bot. 45(1907)136; Bailey, Comp. Cat. Qld. Pl. (1913)174; Ewart & Davies, Fl. N. Terr. (1917)214; Black, Fl. S.Aust. (1926)431; Domin, Bibl. Bot. 89(1929)1035; Gardner, Enum. (1931)99; Black, Trans. roy. Soc. S.Aust. 59(1935)260; Black, Fl. S.Aust. 2 ed. (1952)644; Chippendale,Trans. roy. Soc. S.Aust. 82(1959)333; Eichler, Suppl. Black's Fl. S.Aust. (1965)245; Blackall & Grieve, W.Aust. Wildfls. 3(1965)468.

Figs: Black, Trans. roy. Soc. S.Aust. 59(1935) pl. 5, fig. 2; Black, Fl. S.Aust. 2 ed. (1952) fig. 878; Blackall & Grieve, W.Aust. Wildfls. 3(1965)468.

Herbaceous annual 20-40 cm tall, stems erect, glabrous, branching mainly from base of plant, almost lacking longitudinal ridges. Leaves bright green, soft, ± slightly succulent, lowest 2-3 pairs subopposite, otherwise alternate, linear-lanceolate to oblanceolate, 2.0-5.0 cm long, 0.5-1.2 cm wide, 6-8 toothed, tapering gradually at base into a short, winged petiole 0.5-1.0 cm long, midrib smooth on upper surface, ± prominent below, glabrous.

Inflorescence an indeterminate spike of 7-15 flowered dichasia borne in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper leaves. Only 1-7 of the flowers in each dichasium are functional, the rest are rudimentary. Primary bracts leaflike in lower parts of inflorescence, reduced and almost absent in upper parts; secondary bracts hyaline, membranous, deltoid, 0.1-0.9 mm long, caducous; tertiary and higher order bracts similar to secondary ones but minute.

Flowers trimerous, borne on pedicels 0.8-1.5 mm long, glabrous. Sepals 3, ovate, 0.8-1.0 mm long, 0.9 mm wide, not ribbed. Petals 3, usually yellow-green occasionally red or brown, hooded, 2.5-3.0 mm long, 0.7-1.0 mm wide. Stamens 6, filaments 0.2 mm long; anthers yellow to red, oblong, 2.5 mm long, 0.4 mm wide, 4-locular, non-apiculate. Styles 3, clavate, 0.5 mm long, stigmas capitate. Ovary obpyramidal, 1.0-1.5 mm long, 0.8-1.0 mm wide, 3-winged opposite petals, wings decurrent in pedicel, 3-locular with 1 ovule per locule.

Fruit green to brown, on pedicel 2 mm long, ovate or obcordate in outline, 6.5-8.0 mm long, 5.5-8.0 mm wide, body of fruit ± ovoid, 3-winged, irregularly rugose or ribbed between wings. Wings soft, membranous, slightly spongy at base, somewhat pointed at top, rounded or tapering at base, produced below body of fruit and decurrent in the pedicel, veins distinct, not or only slightly prominent, anastomosing, forming 3-5 opaque large islets in each wing, finely dichotomously branched towards margins. Sepals persistent, erect, rhomboidal to obovate with 3 distinct longitudinal veins, 1.8-2.0 mm long, 2.1-2.4 mm wide, overtopped by wing apices, completely enclosing styles and stigmas. Endocarp semi-woody, exocarp membranous, 3-locular, septa moderately thick, woody, one seed per locule.

Cotyledons linear to linear-lanceolate, entire, 1.5-2.0 cm long, 1.0-1.5 mm wide [Orchard 789]. (Fig. 21)

Distribution. (Map 1)

H. gossei is widespread throughout central Australia, being particularly abundant in the southern half of the Northern Territory and in central and western Western Australia. A few records exist for South Australia and Queensland, in most cases close to the Northern Territory border.

Ecology.

The distribution of this species fairly closely matches the area between the 7 and 10 inch (ca. 19-25 cm) rainfall isohyets, growing in ± deep red sand in the wetter parts of its range, confined to clay pans and other wetter areas in the drier parts, often in association with spinifex (*Triodia* spp.) and mulga (*Acacia aneura*). Collectors' notes include "on sandy loam flat below ironstone ridge" (Burbidge 6037), "common in deep red sand" (Chippendale - many collections), "in stony soil with mulga" (George 2850), "in red sand, with *Casuarina decaisneana*, spinifex and scattered shrubs" (George 8901), "common in coarse clayey sand with *Acacia aneura* and *Triodia basedowii*" (Lazarides 5988), "growing on lowest part of swale" (Must 317), "common near and in

Triodia tussocks in deep red sand" (Nelson 339), "rare on calcareous soil flat with *Triodia* sp." (Perry 3342). Flowering and fruiting is irregular, but flowers usually (May-)July to November(-March) and fruits from (July-)August to June(-July).

Specimens examined.

Western Australia: Aplin 2284, 17.viii.1963, 24 miles N.E. of Menzies on road to Leonora, PERTH (fl.) - pollen sent to Palyn. Lab. Stockholm, voucher for alkaloid survey; Beauglehole ACB11542, 16.viii.1965, 9 m E. of Wittenoom, BEAUGLEHOLE (fl.,fr.); Burbidge 1052, 9.vi.1941, near Talga River Gap, PERTH (fl.,fr.); Burbidge 5921, 28.iv.1958, upper reaches of Turner R., Woodstock Stn., S. of Port Hedland, CANB (fr.); Burbidge 6037, 8.v.1958, Roy Hill-Mundiwindi, AD, CANB, PERTH (fl.,fr.); Carey s.n., 1878, Fortescue River, MEL1003547 (fl.); Carey s.n., 1885, near Exmouth Gulph, MEL1003548 (fr.); Carolin 6052, 2.viii.1967, Blackstone Range, SYD (fl.,fr. - terat.); Carolin 6260, 11.viii.1967, near the southern end of Walter James Range, SYD (fl.,fr. - terat.); Chadwick 1381, 30.viii.1964, Cape Range near Exmouth, PERTH (fl.,fr.); Clarke 74, -.vii.1916, east of Laverton, PERTH (fl.); Cleland s.n., Port Hedland, PERTH (fr.); Forrest s.n., 1878, Nickol River, MEL1003543, 1003544, 1003545 (fl.,fr.); Forrest s.n., 1878, Cane River et Ashburton River, MEL1003546 (fl.,fr.); Gardner 3251, 30.viii.1932, Barrabiddy Creek, Minilya River, PERTH (fl.); Gardner 12164, -.xi.1958, Perenjori, PERTH (fl.); George 1144, 28.viii.1960, 10 mls S. of Onslow, PERTH (fl.,fr.); George 2850, 24.viii.1961, 4 mls. E of Cosmo Newberry, PERTH (fl.); George 8221 (b), 2.x.1966, ± 120 miles W. of Giles Met. Station, PERTH (fr.); George 8901, 24.vii.1967, S. of Sir Frederick Range, AD, PERTH (fl.); George 8979, 27.vii.1967, Dovers Hills - 128°40'E 23° 08'S, PERTH (fl.); George 9103, 30.vii.1967, 15 miles NW of Kidson Well (± 125° 10'E, 22° 25'S), AD, PERTH (fl.,fr.); Giles s.n., between the Rawlinson Range & Alfred-Maries Range, MEL1003556,1003557 (fl.); Halford s.n., -.iv.1925, nr. Kalgoorlie, PERTH (fr.); Helms s.n., 17.viii.1891, nr. Barrow Range, MEL1003760 (fl.- terat.); Helms s.n., 28.viii.1891, near Mt. Squires, Barrow Range, AD96810028, MEL1003678, NSW98946 (fl.); Ride s.n., -.viii.1958, Hammersley Range, PERTH (fl.); Robinson s.n., 7.ix.1959, South Barlee Range, PERTH (fl.); Speck 633, 5.ix.1957, 13 miles N.W. of Belele, AD, BRI, CANB (fl.); Symon 2193, 31.vii.1962, 78 m. S. of Giles, ADW (fl.); Symon 2232, 1.viii.1962, W. end of Hopkins Lake, ADW (fl.); Symon 2287, 1.viii.1962, 25 m. S. of Sir Frederick Range (± 128° 40'E, 24° 10'S), AD, ADW (fl.,fr.); Symon 2454, 1.viii.1962, creekline, base of the E. end of the Schwerin Mural Crescent (± 128° 50'E, 24° 50'S) AD, ADW, PERTH (fl.); Tietkins s.n., 1889, north side of Lake Macdonald, AD96810030, MEL1003715 (fl.,fr. - terat.); Wilson 7260, 26.viii.1968, near Murrin Murrin, ca. 65 km WSW of Laverton, PERTH (fl.).

Northern Territory: Beauglehole ACB20237, 8.x.1966, Mt. Ebenezer turnoff on Alice Springs road, AD, BEAUGLEHOLE (fl.,fr.); Beauglehole 20348, 9.x.1966, Kings Canyon, BEAUGLEHOLE (fr.); Beauglehole ACB23517, 9.vii.1967, Bagot Creek, George Gill Range, AD, BEAUGLEHOLE (fl.,fr.); Beauglehole ACB23871, 16.vii.1967, Glen of Palms, Fincke River, BEAUGLEHOLE (fl.); Beauglehole ACB24075, 19.vii.1967, Annabelle Gorge, BEAUGLEHOLE (fr.); Beauglehole ACB24332, 29.vii.1967, Corroboree Rock, E. of Alice Springs, AD, BEAUGLEHOLE (fl.,fr.); Beauglehole ACB24671, 7.viii.1967, Small Range, 103 m. S. of Alice Springs, AD, BEAUGLEHOLE (fl.,fr.); Beauglehole ACB26070, 8.vii.1968, Kings Canyon, BEAUGLEHOLE (fl.); Beauglehole ACB26312, 9.vii.1968, Carmichael's Crag, George Gill Range, BEAUGLEHOLE (fl.,fr.); Carolin 5182, 13.viii.1966, Hugh River near Stuart's Well, NSW, SYD (fl.,fr.); Chippendale s.n., 30.viii.1955, 36 m. N.E. of Angas Downs H.S., AD95952007, CANB70129, NT1575, NSW98944 (fl.); Chippendale s.n., 22.ix.1955, No. 2 Desert Bore, Hamilton Downs, CANB70130, NT1694 (fl.); Chippendale s.n., 12.iv.1956, l.c., BRI080006, NSW98948, NT 2016 (fr.); Chippendale s.n., 23.viii.1956, near Ulumbaura Spring, Haasts Bluff, AD96915150, NT2570 (fl.); Chippendale s.n., 14.ix.1956, 24.7 m S.W. Angas Downs H.S., NT2923, PERTH (fl.); Chippendale s.n., 20.ix.1956, 38½ m S.W. Tobermorey H.S., BRI080005,NT2970 (fl.); Chippendale s.n., 12.viii.1959, 12 m. N.W. Harper Springs H.S., AD96811126, NT6463 (fl.); Chippendale s.n., 9.ix.1959, 18 m. S. of Lilla Creek H.S., AD96639055, NT6611 (fl.); Chippendale s.n., 9.xi.1960, 10.3 m W. Xmas Bore, AD97008234 (fr.); Cleland s.n., 23.viii.1932, north of Rumbalara, AD966042132 (fl.); Cleland s.n., between Middleton Ponds and Liddles, AD966042131 (fl.,fr.); Cleland s.n., 17.viii.1956, Haasts Bluff Reserve, AD966042134 (fl.); Cleland s.n., 28.viii.1956, Gosse Range, AD966042127 (fl.); Cleland s.n., 25.viii.1957, Mt.Wedge Station, AD966042077 (fl.); Crocker s.n., 1939, ca. 260 km east of Bundooma, AD95833116 (fr.); Crocker s.n., 18.vi.1939, ca. 335 km east-south-east of Alice Springs, AD96810061 (fl.,fr.); Forde 92, 10.v.1956, A.I.B. Desert Grazing Block, NT (fl.,fr.); Gardner 11674, 16.iii.1953, 55 miles S.W. from Alice Springs, NT, PERTH (fl.,fr.); Giles s.n., near Alice Springs, MEL1003553 (fr.); Giles s.n., -.v.1875, between Alice Springs & Charlotte Waters, MEL1003555 (fl.); Gosse s.n., 1873, Mount Olga, MEL1003542 (fr.) -holotype of *H. gossei*; Henry s.n., 1889, Georgina River, MEL1003560 (fl.); Ising 2376, 24.viii.1931, Horse Shoe Bend, AD (fl.,fr.); Latz 322, 11.xii.1968, Kings Canyon, AD (fr.); Latz 958, 4.xi.1970, ca 28 m S.S.W. Docker River Settlement, AD (fl.,fr.); Lazarides 5988, 15.ix.1957, Desert Grazing Block, 27 miles N.E. of Narwietooma Station AD, BRI, CANB, MEL, NT, NSW, PERTH (fl.,fr.); Mahood s.n., 29.iii.1962, 40 m. N.W. of The Granites, NT8740 (fl.); Must 317, 8.viii.1968, 17 m N.W. of Andado H.S., AD, NT (fl.); Must 344, 19.i.1968, 23 m. S. Alice Springs, AD (fl.); Nelson 339, 21.vi.1962, 1.2 m. E. of Connors Well, CANB, NT (fl.,fr.); Nelson 1738, 20.viii.1968, 1½ m. N. of Conners Well, AD (fl.); Nelson 1768, 15.x.1968, 62 m. N. of Alice Springs, AD (fr.); Orchard 789, 13.vii.1968, Andado Station, ca 24 km north of homestead, AD (fl.); Perry 3342, 7.iii.1953, 21 miles NNE of Alice Springs township, CANB (2 sheets), NT (fl.,fr.); Pryor s.n., 31.viii.1966, Fincke Gorge, NSW98941 (fl.); Schneider s.n., -.vii.1968, Tempe Downs, AD97033088 (fr.); Symon 4387, 2.xi.1966, Amerada Petroleum Corp. No. 1 Hale River (136° 43' 35" E, 25° 15' 50" S), AD, ADW, CANB, (fl.,fr.); Tate s.n., 23.v.1894, Chambers Pillar, AD96810029 (terat.); Thornton s.n., 1889, Tempe Downs, MEL1003669 (fr.); Winkworth 1463, 4.vi.1958, 62 miles NNW of Alice Springs, NT (terat.); Winnecke s.n., 1883, Central Australia, MEL1003551, 1003552, (fl.,fr.).

South Australia: Carrick 2463, 2.x.1969, ca 38 km north-west of Yardea, AD (fl.,fr.); Eichler 17299, 6.ix.1963, along track to Mt.Davies ca. 65 km west of Musgrave Park H.S., AD (fl.); Helms s.n., 29.vi.1891, between camps 10 & 11, ca. 72 km west-north-west of Mt. Lindsay, AD96810043, MEL1003559 (fl.); Kempe 100, 1879, Fincke River, MEL (fr.); Kempe 333, 368, 1880, Fincke River, MEL (fl.,fr.); Lothian 1706, 11.viii.1963, ca. 100 km east of Dalhousie Springs, AD (fl.) - pollen sent to Palyn. Lab. Stockholm; Lothian 1719, 11.viii.1963, ca. 96 km east of Dalhousie Springs, AD (fl.); Reid s.n., 20.ix.1955, between Musgrave and Mann Ranges, ADW19219 (fl.,fr.); Schomburgk s.n., Central S.Aust. AD96906034 (fl.); Weber 148, 28.x.1966, Mt. Harriet road, ca. 45 km south of Musgrave Park Station, AD (fl.,fr.).

Queensland: Cornish s.n., 1885, Mulligan River, MEL1003561 (fr.).

Notes.

1. A single fruiting specimen from south-western South Australia (Lothian 4009, 2.vi.1967, 1 km S. of Maralinga check point, AD) differs from the typical specimens in several respects, viz. stems ± distinctly 4-ribbed, leaves thicker, lanceolate, midrib channelled above, prominent below, secondary veins distinct, fruits brown, usually 4-winged, sometimes 3-winged, ± oblong, 8.5 mm long, 5.5 mm wide, stamens probably 8, styles 2, locules 2, seeds 1(-2?). The wing venation is similar to the normal form. A decision on the taxonomic status of this form, deviating morphologically and geographically from the main population, must await the discovery of more adequate collections.

2. A number of collections from north-western Western Australia are distinguished by their swollen fruits.

11. *Haloragis trigonocarpa* F.v.Mueller, Fragm. 10(1876)84 [Typus: "Inter Yuin et Murchison's River; inter Alfred-Marie's Range et Rawlinson's Range; E. Giles." Lectotypus (Orchard): Giles s.n., Between Yuin and the Murchison River, MEL39524 (fr.)!; Isolectotypus: Giles s.n., Between Yuin and the Murchison River, MEL39529 (fr.)!] F.v.M., Census 1(1882)49; F.v.M., Trans. roy. Soc. Vict. 24(1888)137; F.v.M., Sec. Census 1(1889)85; Tate, Fl. S.Aust. (1890)101, 234; Schindler, Bot. Jb. 34, Beibl. 77(1904)5,29,30,31,35; Diels & Pritzel, Bot. Jb. 35(1904)445; Schindler, Pflrch 23(1905)58; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)468.

? *Haloragis caprae* Choiv. et A. Vacc, Atti Soc. Nat. Mat. Modena 65(1934)148-149 [Typus: "Nuova Zelanda, Isola sud, Westland, Kumara 20 aprile 1909 (G. Capra)." n.v. - see note 3.]

Annual herbs (5-)10-40 cm tall, stems erect or arcuate ascending, branching mainly at base, smooth or weakly 5 ribbed, glabrous or slightly scabrous with blunt 2-3 celled simple transparent hairs 0.2 mm long.

Leaves opposite at base becoming alternate above, linear to lanceolate, (2.0-)2.5-4.5(-5.5) cm long, 0.3-0.9(-1.2) cm wide, petiolate or subsessile with lamina grading into winged petiole, serrate with up to 10 teeth or sometimes almost entire, midrib channelled above, prominent below, lateral veins faint, at angle of 25^{o}-35^{o} to midrib, petiole up to 1.0 cm long.

Inflorescence an indeterminate spike of 3-7 flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper leaves. Primary bracts leaflike, green, fleshy, linear, 0.7-3.0 cm long, (0.5-)1.5-2.0 mm wide, midribbed, serrate or entire; secondary bracts brown, membranous, linear, 0.7-1.0 mm long, 0.1-0.2 mm wide, entire, deciduous; tertiary bracts as for secondary, 0.3-0.4 mm long.

Flowers 3-merous, on pedicel 0.5-0.6(-1.5) mm long. Sepals 3, cordate-rhomboid, 0.6-0.9 mm long, 0.9-1.2 mm wide, convex, midribbed, glabrous. Petals 3, red, hooded, tip ppporly defined, unguiculate, keeled, 2.0-2.7 mm long, 0.6-1.0 mm wide (keel to margin), glabrous. Stamens 6, filaments 0.2 mm long; anthers yellow to red, oblong, 1.5-2.3 mm long, 0.5 mm wide, nonapiculate, 4-locular, antipetalous anthers ca 0.2 mm shorter than antisepalous. Styles 3, yellow to red, clavate, 0.5 mm long, stigmas capitate. Ovary ovoid, 0.5-0.9 mm long, 0.7-1.0 mm wide, strongly 3-ribbed or -winged opposite the petals, smooth, 3-locular with 1 pendulous ovule per locule.

Fruit trigonous, 3-winged between sepals, 4.0-4.5(-6.0) mm long, 2.5-3.5 mm wide (including wings); wings woody, rounded at base, acute at apex, with strongly developed marginal vein and 3-5 transverse veins, area between veins membranous, translucent; body of fruit narrow ovoid, ± smooth, glabrous or rarely pilose with soft, simple, transparent, very fine unicellular hairs 0.1 mm long. Sepals persistent, erect, rhomboidal to broad-deltoid, 1.0-1.4 mm long, 1.4-1.6 mm wide, ± convex, prominent median vein and ± prominent median transverse vein, glabrous or rarely pilose with hairs as above; pericarp and septa woody, 3 locules, 1-3 seeds.

Distribution. (Map 2)

H. trigonocarpa is confined to Western Australia, where it occurs in the central, western and south-western regions outside the 14 inch per annum rainfall isohyet.

Ecology.

This species grows in open situations in the semi-arid mulga-mallee regions of south-western Western Australia between the (6-)8 and 14 inch rainfall isohyets. Collectors' notes include "red loamy alluvial flats" (Gardner, 9.ix.1927), "on stony hill" (George 2780), "in red loam with limestone" (George 6601), "open situations in red stony clay" (Orchard 1230), and "mulga scrub" (Speck 633). Because of the ephemeral nature of the plant, flowering and fruiting is irregular, but flowering specimens have been collected from April until September and fruiting specimens from July until April.

Specimens examined.

Western Australia: Aplin 1870, 9.ix.1962, 44 miles north of Norseman, PERTH (fr.) - voucher for alkaloid survey; Blackall s.n., -.ix.1939, Yandel near Lake Darlot, PERTH (fl.,fr.); Burbidge 2590, 19.ix.1947, 10 miles from Kalgoorlie on Coolgardie road, CANB (fl.,fr.); Burbidge 6479, 2.ix.1959, between Woodleigh Station and Wooramel R. bridge, CANB, PERTH (fr.); Campbell 191, -.viii.1899, Menzies, PERTH (fr.); Carolin 5878, 26.vii.1967, 69 miles east of Wiluna, SYD (fl.); Cusack 4, 1897, Fortescue River, Roebourne, MEL (fr.); Dean s.n., -.iii.1966, Merredin, PERTH (fr.); Diels 5205, West Australia, NSW99274 (fr.); Donner 3082, 20.x.1968, ca 38 km south of Coolgardie, AD, PERTH (fl., fr.); Donner 3084, 21.x.1968, ca 45 km south of Coolgardie, AD, PERTH (fl.,fr.); Eichler 20029, 30.ix.1968, ca 10 km east-north-east of Coolgardie, AD (fl.); Eichler 20040, 30.ix.1968, ca 35 km north of Widgiemooltha, AD, PERTH (fl.,fr.); Fitzgerald s.n., -.ix.1898, Broad Arrow, NSW98945, 98947 (fl.,fr.); Forrest s.n., 1882, Gascoyne River, MEL39527 (fl.); Gardner s.n., 9.ix.1927, Bardoc, N. of Kalgoorlie, PERTH (fr.); Gardner s.n., -.ix.1941, Gascoyne River, PERTH (fl.,fr.); Gardner 7543, 29.viii.1945, north of Guttoh, PERTH (fl.) - pollen sent to Palyn. Lab. Stockholm; Gardner 7897, 16.x.1945, 103 m E. of Meekatharra, PERTH (fr.); Gardner 9527, 26.xi.1949, Widgiemooltha, PERTH (fr.); George 693, 15.iv.1960, 28 m N. of Paynes Find, PERTH (fl.,fr.) - pollen sent to Palyn. Lab. Stockholm: George 2780, 22.viii.1961, 29 mls. E. of Malcolm, PERTH (fl.,fr.); George 4154, 30.viii.1962, 34 miles N. of Kalgoorlie, PERTH (fl.,fr.); George 4615, 2.vii.1963, 9 miles E of Rutters Soak, PERTH (fr.); George 5886, 22.ix.1963, Cundeelee Mission N. of Zanthus, AD, PERTH (fl.,fr.); George 6601, 25.v.1965, 5-6 miles S. of Exmouth, PERTH (fl.); George 8003, 13.ix.1966, 11 miles E.of Sandstone, PERTH (fl.,fr.); George 8698, 13.vii.1967, 17 miles N.E. of Beegull rockhole, Warburton road, PERTH (fr.); Giles s.n., between Yuin and the Murchison River, MEL39524, 39529 (fr.) - lecto- and isolecto-type of *H. trigonocarpa;* Helms s.n., W.A., NSW99276 (fl.,fr.); Helms s.n., -.vii.1899, Coolgardie, PERTH (fl.,fr.); Kelso s.n., -.x.1900, Broad Arrow, PERTH (fr.); King s.n., 1886, Lake Austin, MEL39525, 39526 (fr.); Kuchel 2140, 23.ix.1964, ca 25 km west of Coolgardie, AD (fl.,fr.); Maiden s.n., -.ix.1909, Laverton, AD96920051 (fr.); Merrall s.n., 1892, Parkers Range, MEL1003722 (fl., fr.); Orchard 1230, 29.ix.1968, ca 1½ km north of Widgiemooltha, AD (fl.,fr.); Orchard 1263, 30.ix.1968, ca 31 km north of Widgiemooltha, AD (fl.); Robinson 208, 27.x.1966, Lake Moore, PERTH (fr.); Royce 4396, 23.ix.1953, Comet Vale, PERTH (fr.); Royce 5227, 24.i.1956, 22 m. East of Boulder, PERTH (fr.); Speck 633, 5.ix.1957, 13 m. N.W. of Belele, PERTH (fl.,fr.); Tyson s.n., 1892, Upper Murchison R., MEL 1003657 (fr.); Tyson 17, 1898, Mt. Narryer, Murchison River, PERTH (fl.,fr.); Webster s.n., 1900, Coolgardie, NSW99275 (fr.); Weston s.n., 1892, Murchison River, MEL1003692 (fl.).

Notes.

1. The choice of a lectotype was necessary as Mueller cited two distinct collections with his description. No specimens of the second of these collections (between Alfred-Marie and Rawlinson Range) could be located,but two sheets of the first-mentioned collection (between Yuin and Murchison's River) exist in MEL. These two MEL collections differ in that one has glabrous fruits while the other has short, dense hairs between the wings and on the outside of the sepals. The first of these sheets is chosen as lectotype because its glabrous fruits represent the usual condition in the species, and because Mueller failed to mention hairs on the fruit; he described the plant as glabrous.

2. Several specimens on the edge of the area of distribution show anomalous features. The most northerly collection (Cusack 4) has fruits with swollen pericarps, while the most south-westerly collection (Dean s.n.), has 4-merous fruits. The fruits of two of the most

easterly collections (Gardner 7897, George 8698) have rounded wings with only weakly developed marginal veins, the fruit is larger than normal (6 mm long x 5 mm wide) and the sepals have weak lateral veins. These last two collections thus have some of the characters of *H. gossei*, suggesting introgression between the two species.

3. Although *H. caprae* was described from material allegedly collected in New Zealand, it matches *H. trigonocarpa* exactly, both in its description and in the figures given with the description. I have not seen the type. As the collector of the type specimen also visited Australia, it seems possible that a confusion of labels could have occurred. Until further collections are made in New Zealand, and differential characters between the two "species" are found, *H. caprae* should be considered as synonymous with *H. trigonocarpa*.

12. *Haloragis acutangula* F.v.Mueller, Trans. Vict. Inst. 1(1855)125 [Typus: "On ridges about Port Lincoln. C. Wilhelmi". Holotypus: Carl Wilhelmi s.n., February 1855, Hills near Port Lincoln, MEL38924 (fr.)! Isotypi: Wilhelmi s.n., Hills about Port Lincoln, K (Oldfield Hb.) (fr.)!; Wilhelmi s.n., Port Lincoln, K (Herb. F. Mueller) (fr.)!; Carl Wilhelmi s.n., Port Lincoln, MEL38926 (fr. & terat.)!; Carl Wilhelmi s.n., exam. Dr. ferd. Mueller, MEL38925 (fr.)!]; F.v.M., Hook. J. Bot. 8(1856)65; Benth. Fl. Aust. 2(1864)478; Tate, Trans. roy. Soc. S.Aust. 3(1880)64; F.v.M., Census 1(1882)49; F.v.M., Trans roy. Soc. Vict. 24(1888)136; F.v.M., Sec. Census 1(1889)85; Tate, Trans. roy. Soc. S.Aust. 12(1889)95; Tate, Fl. S.Aust. (1890)101, 234; Schindler, Pflrch 23(1905)57; Black, Trans. roy. Soc. S.Aust. 49(1925)275; Black, Fl. S.Aust. (1926)431, 2 ed. (1952)644; Blackall & Grieve, W.Aust. Wildfls., 3(1965)470.

Haloragis semiangulata Black, Trans. roy. Soc. S.Aust. 49(1925)275 [for type see under *H. acutangula* f. *semiangulata*]; Black, Fl. S.Aust. (1926)431, 2 ed. (1952)644.

Haloragis ciliata Black, Trans. roy. Soc. S.Aust. 49(1925)275 [for type see under *H. acutangula* f. *tetraptera*]; Black, Fl. S.Aust. (1926)431, 2 ed. (1952)644.

Figs: Black, Fl. S.Aust. (1926) fig 175D, 2 ed. (1952) fig 868D; Blackall & Grieve, W.Aust. Wildfls. 3(1965)470.

Perennial herb or subshrub, 20-30(-45) cm tall, erect or branches arcuate ascending, often rooting at the nodes in the lower part, stems 4-ribbed, ± woody particularly near the base, green to reddish purple, glabrous or scabrous, and then hairs short, ± curved (claw-like), 1-2-celled, with the lower cell often swollen, 0.1-0.3 mm long, often confined to the ribs.

Leaves all alternate (except first 2-3 pairs of seedling leaves, which are opposite), pale green, ± dull, linear to linear-lanceolate, 1.0-3.0(-5.0) cm long, 0.2-0.4 (0.8)cm wide, ± flat, sessile, entire or toothed, teeth deltoid or ± linear and usually confined to the upper part of the lamina, midrib usually faint, lamina soft, ± fleshy in life, glabrous or scabrous with hairs (as for stem) on both faces or confined to the margins.

Inflorescence an indeterminate spike of 1-7 flowered dichasia borne in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper leaves. Primary bracts leaflike, green, fleshy, lanceolate, 5.0-8.0(-15.0) mm long, 1.5-2.0(-5.0) mm wide, equal to or exceeding the fruit, glabrous, or scabrous only on margins; secondary bracts membranous, yellow-brown, lanceolate, 2.0-3.0 mm long, 0.7-1.0 mm wide, entire, ± no midrib; tertiary bracts (if present) membranous, yellow-brown, linear, 1.0-1.5 mm long, 0.3-0.4 mm wide.

Flowers 4-merous, usually all functional except those of the ultimate dichasial branches. Sepals 4, green, smooth or very faintly midribbed, deltoid, 0.8-1.0 mm long, 0.7-0.8 mm wide. Petals 4, green to red, hooded, unguiculate, glabrous or with a single row of hairs (as for stem) on the keel, tip erect, 2.4-3.0 mm long, 0.7-0.8 mm wide (keel to margir). Stamens 8, filaments 0.1-0.2 mm long; anthers yellow to red, 4-locular, non-apiculate, 1.6-1.9(-2.3) mm long, 0.4-0.5 mm wide, antipetalous ones ± equal to antisepalous ones or 0.1-0.2 mm shorter. Styles 4, yellow-green to pink or red, clavate, 0.6 mm long, stigmas ± capitate. Ovary turbinate, 0.6-1.0 mm long, 0.7-1.2 mm wide, ± 4-ribbed opposite the petals, 4-locular with a single pendulous ovule in each locule.

Fruits extremely variable between plants, constant within a single plant; ± ovoid with 4-longitudinal oblong or deltoid wings alternating with the persistent sepals, or wings absent or reduced to ribs or tubercles; tubercles present on the body of the fruit between the wing positions (i.e. below the sepals) or absent; fruit shape (including the wings) ovoid or cubical or turbinate or obturbinate or fusiform or pyramidal or globose (as a result of a uniformly swollen pericarp), (1.5-)2.0-3.0(-3.5) mm long, (1.3-)2.0-3.0(-4.0) mm wide, glabrous or with scabrous hairs as for the stems. Sepals persistent, deltoid, 1.0-1.2 mm long, 0.8-1.0 mm wide, smooth or midrib ± apparent, median basal callus weakly developed or absent, glabrous or scabrous. Fruit 4-locular, septa complete and ± woody, with 1-4 seeds (1 per locule). (Fig. 21)

<u>Distribution.</u> (Maps 5, 6)

H. acutangula is found in South Australia, mainly in coastal areas, from Encounter Bay to the Head of the Great Australian Bight. The only inland populations are in the Murray Mallee near Waikerie and in central Eyre Peninsula. A small population exists in Western Australia, on the mainland between Esperance and Albany, and on some islands of the Recherche Archipelago.

<u>Ecology.</u>

See under f. *acutangula*.

Plants in this species show an unusually large degree of variation, particularly in fruit form and ornamentation, but also in leaf shape and dentation, and in the presence or absence of stiff hairs.

Typically, the plants grow in somewhat disturbed habitats in open situations (semistabilized sand dunes, roadsides, quarries, etc.) in populations of several hundred individuals occupying an area perhaps one hundred metres in diameter. Within such a population most of the fruit, leaf and indumentum forms can usually be found, in various combinations. The distribution of the varying forms through the population seems to be random, although some local "clumping" may be present. Populations of this type have been observed by the author in the Murray Mallee (near Waikerie), on Yorke Peninsula (Moonta, Wallaroo, south of Cape Elizabeth, Pine Point, and Daly Head) and on Eyre Peninsula (Arno Bay, Porter Bay, Lincoln National Park, Kellidie Bay, Wangary, Mt. Hope, Elliston, Calca and Yalata). Comprehensive collections were made from these populations and from other smaller groups, in an effort to map the overall distribution of the species, as well as the distribution of the variation observed.

It was found that variation in fruit shape, leaf shape and indumentum show no correlation with each other, nor with geographical distribution. However, the extreme forms, particularly in the case of the fruits, appear at first sight to be completely unrelated, and in the past two of them have been given the rank of species (*H. ciliata* and *H. semiangulata*). For this reason, formal descriptions of some of the more common variants seems warranted, but at the level of formae, as the different taxa show no correlation of characters, are sympatric and appear to be readily interbreeding. The twelve formae described below accommodate with few exceptions all the present collections of *H. acutangula*. They are based only on the form of the mature fruits, and each forma has the complete range of variation in leaf and indumentum characters.

Key to the formae of *Haloragis acutangula* based on fully mature fruits.

(1) Body of the fruit bearing well defined longitudinal wings (1.5-)2-5 mm wide in the antipetalous positions.

(2) Tubercle present between the wings.

(3) Wings oblong, occupying the entire length of the fruit. ι. f. *subacutangula*

(3) Wings ± deltoid or falco-deltoid, confined to the upper part of the fruit. θ. f. *semiangulata*

(2) Tubercle not present between the wings, the body of the fruit smooth or rugose.

(4) Wings oblong, occupying the entire length of the fruit. λ. f. *tetraptera*

(4) Wings deltoid.

(5) Wing occupying the mid-position along the length of the fruit.

(6) Wing well developed, occupying most of the length of the fruit; the fruit (including wings) wider than long. ζ. f. occidentalis

(6) Wing weakly developed, occupying only the central part of the fruit, which is wingless above and below, fruit (including wings) longer than wide or isodiametrical. γ. f. *dentata*

(5) Wing terminal or basal along the length of the fruit.

(7) Wing in the upper part only. μ. f. *turbinata*

(7) Wing at the base only. η. f. *pyramidata*

(1) Body of the fruit lacking longitudinal wings in the antipetalous positions, or the wings reduced to ribs.

(8) Exocarp uniformly swollen, fruit globose, smooth or ± 4-ribbed.
δ . f. *inflata*

(8) Exocarp not swollen, fruit not globose.

(9) Tubercle present on body of fruit below sepal position.

(10) Ribs lacking tubercle, fruit basically oblong.
κ . f. *tetraglebosa*

(10) Ribs with a basal or median tubercle, fruit basically fusiform or obturbinate through fusion of adjacent tubercles.

(11) Ribs with a median tubercle, fruit fusiform
β. f. *annulata*

(11) Ribs with a basal tubercle, fruit obturbinate.
ε. f. *obturbinata*

(9) Tubercle absent, body of fruit smooth or slightly rugose below the sepal position.

(12) Ribs lacking a tubercle α. f. *acutangula*

(12) Ribs with a median tubercle γ. f. *dentata*

α. f. *acutangula*

Fruit oblong, longer than broad, wings absent or reduced to ribs, flat faces of fruit smooth or transversely wrinkled, (1.8-)2.0-2.5 mm long (excluding the sepals), 1.5-1.7 mm wide. (Fig. 21)

<u>Distribution</u>. (Map 5)

This forma is one of the most common, and occurs in nearly every population. It is confined to South Australia, and almost entirely to a coastal strip about 5 km wide. Records of its occurrence exist for Eyre Peninsula from Yalata to Cowell, for Yorke Peninsula from Wallaroo to Pine Point, for Kangaroo Island and for the Encounter Bay-Murray Bridge area.

Ecology.

The conditions under which this forma grows are identical with those of the other formae and will not be repeated for them. Two types of habitat are occupied by this species: either deep sand of semistabilized dunes, or shallow sandy soil over limestone. The plants usually grow in open situations with few associated species other than annual or perennial grasses. Collectors' notes include "on limestone near sea" (Copley 2444), "common plants on sand" (Copley 2445, "sand dunes" (Orchard 2068, 2071), "shallow sandy soil over limestone" (Orchard 2845, 2847), "cleared verge in recent roadside cutting" (Orchard 2851-2854), "foot of white sand dunes on edge of track" (Orchard 3026,3028) and "shallow sandy soil over limestone pavement" (Orchard 3130,3132,3137,3139). Pollination is probably mainly anemophilous (large anthers dangling on slender filaments at anthesis, large amounts of pollen) but in two collections (Orchard 2845,285 bees were observed collecting pollen. At least two different species are involved, a black bodied bee was the pollinator in the former case, a yellow bodied form (*Apis mellifera?*) in the latter. Flowering takes place during December-January(-February) and fruiting from December to March or April.

Specimens examined.

South Australia: Alcock C17B, 24.xi.1964, Sth. Cape Donnington, AD (fl.,fr.); Blackith & Blackith s.n., -.iv.1966, Pt.Elliston, MEL38932 (fr.); Cleland s.n., -.i.1922, Encounter Bay, AD968020564 (fl.); Cleland s.n., 2.iii.1926, Rocky River, Kangaroo Island, AD968020578 (fr.); Cleland s.n., 19.i.1940, Encounter Bay, AD968020559 (fl.,fr.); Cleland s.n., 18.i.1945, Encounter Bay, AD968020550, AD966032585 (fl.,fr.); Copley 2436, 5.i.1969, Wallaroo, North Beach, AD (fl.,fr.); Copley 2444, 2445, 19.i.1969, Proper Bay, Port Lincoln, AD (fr.); Copley 2521,2527, 5.iii.1969, intersection of Maitland-Pine Point & Ardrossan-Minlaton roads, AD (fl.,fr.); Copley 2625,2626,2627,2634, 27.vii.1969, ca 25 km south-east of Yalata on the dogfence, AD (fr.); Orchard 1870,1871, 9.i.1969, Murray Bridge-Karoonda road ca 18 km east of Murray Bridge, AD (fl.,fr.) - pollen of Orchard 1871 sent to Palyn. Lab. Stockholm sub nom. *H. ciliata;* Orchard 2049, 23.ii.1969, ca 2 km south-west of Moonta, AD (fr.); Orchard 2068,2071, 23.ii.1969, ca 13 km south of Cape Elizabeth, AD (fl.,fr.); Orchard 2803,2813, 14.xii.1970, ca 4 km west of Pine Point, AD (fr.); Orchard 2821, 14.xii.1970, ca 5 km south-west of Edithburgh, AD (fl.,fr.); Orchard 2824, 14.xii.1970, ca 2 km west of Wattle Point, AD (fl.,fr.); Orchard 2845,2847 ,15.xii.1970, ca 6 km south-west of Foul Bay settlement, AD (fl.,fr.); Orchard 2851-2854, 15.xii.1970, ca 3 km north-east of Stenhouse Bay settlement, AD (fl.,fr.); Orchard 2857, 15.xii.1970, ca 6 km north-west of Cape Spencer, AD (fl.,fr.); Orchard 2858, 15.xii.1970 ca 12 km north-west of Cape Spencer, AD (fl.,fr.); Orchard 2859,2860, 15.xii.1970, Brown's Beach, ca 13 km north of Cape Spencer, AD (fl.,fr.); Orchard 2863, 15.xii.1970, ca 6 km north-east of Daly Head, AD (fr.); Orchard 2867,2868, 15.xii.1970, Hardwicke Bay, ca 3 km north of Warooka, AD (fl.,fr.); Orchard 2878,2881, North Beach, Wallaroo, AD (fl.,fr.); Orchard 2966,2967, ca 6 km north-east of Arno Bay, AD (fr.); Orchard 3000,3002,3003,3009, 31.xii.1970, southern side of Porter Bay, Port Lincoln, AD (fr.); Orchard 3026,3028,31.xii.1970, ca 6 km east of Wanna Well, Lincoln National Park, AD (fr.); Orchard 3049,3051,3052,3058,3060, 1.i.1971, ca 5 km east of Coffin Bay settlement, Kellidie Bay National Park AD (fr.); Orchard 3070,3071, 2.i.1971, ca 3 km west of Coffin Bay settlement, AD (fl.,fr.); Orchard 3074, 2.i.1971, ca 3 km south-east of Wangary, AD (fl.,fr.); Orchard 3085,3086, ca 10 km north-north-west of Warrow, AD (fr.); Orchard 3090, 3091,3094,3096,3099,3100,3106, 2.i.1971, ca 7 km south-south-east of Mt. Hope, AD (fr.); Orchard 3116,3118,3119, 3122, 3.i.1971, ca 11 km north of Elliston, AD (fr.); Orchard 3130, 3132,3137,3139, 3.i.1971, ca 1 km west of Calca, AD (fr.); Orchard 3141, 4.i.1971, ca 30 km north of Streaky Bay, AD (fr.); Orchard 3149,3152, 3162,3167,3172,3174,3176,3178, 5.i.1971, alongside dog-proof fence at south-eastern end of Yalata Aboriginal Reserve, ca 19 km south of Waltabie Tank, AD (fl. ,fr.); Richards s.n., -.xi.1880, Point Sinclair, 50 miles east of Fowlers Bay, MEL38929 (fr.); Tepper s.n., -.xi.1879, Ardrossan, AD96810008 (fr.); Tepper s.n., 1880, Yorkes Peninsula, MEL38984,38997 (fr.); Wilhelmi s.n., -.ii.1855, Port Lincoln, MEL38924 (fr.) - holotype of *H. acutangula*; Wilhelmi s.n., MEL38925 (fr.) - isotype of *H. acutangula;* Wilhelmi s.n., Port Lincoln, MEL38926 (fr. + terat.) - isotype of *H. acutangula;* Wilhelmi s.n., Port Lincoln, K (Herb. F. Mueller & Oldfield Hb. - two sheets) (fr.) - isotypes of *H. acutangula* β. f. *annulata* Orchard, f. nov.

Fructus plusminusve isodiametrus; alae diminutae deltatae in medio fructu; callus inter alas praesens, alis conjungentibus annulus formans; 1.7-2.2 mm longus (sepala exclusa), 2.0-2.5 mm latus. Holotypus: A.E. Orchard 3008, 31.xii.1970, South Australia. Southern Eyre Peninsula. Sand dunes on southern side of Porter Bay, Port Lincoln, AD97107330 (fr.)! Isotypus: Still to be distributed.

Fruit fusiform, more or less isodiametric, wings poorly developed, deltoid, in a median position along the fruit; callus present between the wings, fusing with them to form an annulus; length 1.7-2.2 mm (excluding sepals), width 2.0-2.5 mm. (Fig. 21)

Distribution. (Map 5)

Only five collections of this forma are known, all from South Australia; three come from the 18th hole of the Moonta Golf Course (northern Yorke Peninsula) and two come from the sand dunes on the southern side of Porter Bay, Port Lincoln (southern Eyre Peninsula).

Ecology.

Soils as for f. *acutangula*. The flowering period is unknown, but fruits are present from December until February.

Specimens examined.

South Australia: Orchard 2043,2047,2050, 23.ii.1969, Moonta-Port Hughes road ca 2 km south-west of Moonta, on the 18th hole of Moonta Golf Course, AD (fr.); Orchard 3008, 31.xii.1970, sand dunes on southern side of Porter Bay, Port Lincoln, AD (fr.) - holotype of *H. acutangula* f. *annulata* Orchard 3013, 31.xii.1970, sand dunes on southern side of Porter Bay Port Lincoln, AD (fr.).

γ. f. *dentata* Orchard, f. nov.

Fructus plusminusve isodiametrus; alae in medio fructu minutae deltatae; callus inter alas absens; 3.0-3.5 mm longus (sepala exclusa), 2.5-3.0(-4.0) mm latus.

Holotypus: A.E. Orchard 3113, 2.i.1971, South Australia. Eyre Peninsula. Flinders Highway, ca 7 km south-south-east of Mt.Hope. (Mt.Hope is ca 40 km north-west of Cummins), AD97106142 (fr.)! Isotypi: Still to be distributed.

Fruits more or less isodiametric; wings very small (sometimes reduced to tubercles), deltoid, in a median position along the fruit (which is wingless towards the extremities); 3.0-3.5 mm long (excluding the sepals), 2.5-3.0(-4.0) mm wide.

Distribution. (Map 5)

This forma is confined to South Australia, collections having been made from northern Yorke Peninsula (Wallaroo and Moonta) and the coastal regions of Eyre Peninsula (Yalata to Port Lincoln, and Arno Bay).

Ecology.

Soil preferences are as for f. *acutangula*. The flowering period is unknown, but fruiting occurs from December to February.

Specimens examined.

South Australia: Orchard 2042, 23.ii.1969, ca 2 km south-west of Moonta on 18th hole of Moonta Golf Course, AD (fr.); Orchard 2877, 27.xii.1970, coastal sand dunes, North Beach, Wallaroo, AD (fr.); Orchard 2970, 30.xii.1970, Lincoln Highway ca 6 km north-east of Arno Bay, AD (fr.); Orchard 3010,3011, 31.xii.1970, sand dunes on southern side of Porter Bay, Port Lincoln, AD (fr.); Orchard 3054,3055, 1.i.1971, northern end of Kellidie Bay, ca 5 km east of Coffin Bay settlement, AD (fr.); Orchard 3087, 2.i.1971, Flinders Highway ca 10 km north-north-west of Warrow, AD (fr.); Orchard 3108, 2.i.1971, Flinders Highway ca 7 km south-south-east c Mt. Hope, AD (fr.); Orchard 3113, l.c., AD (fr.) - holotype of *H. acutangu* f. *dentata;* Orchard 3133,3138, 3.i.1971, ca 1 km west of Calca, AD (fr.); Orchard 3173, 6.i.1971, alongside dog-proof fence at south-eastern end of Yalata Aboriginal Reserve, AD (fr.).

6. f. *inflata* Orchard, f. nov.

Fructus globosus, laevis vel parum 4-costatus, exocarpio spongioso; 2.5-3.0 mm diameter.

Holotypus: A.E. Orchard 3114, 2.i.1971, South Australia. Eyre Peninsula. Flinders Highway, ca 7 km south-south-east of Mt. Hope. (Mt. Hope is ca 40 km north-west of Cummins.), AD97106144 (fr.)! Isotypi: Still to be distributed.

Fruit globular, smooth or slightly 4-ribbed, the exocarp spongy and swollen, 2.5-3.0 mm diam.

Distribution. (Map 5)

This forma is known from near Waikerie in the northern Murray Mallee, from Pine Point and Daly Head on Yorke Peninsula, and from several localities in southern Eyre Peninsula.

Ecology.

Soil preferences are as for f. *acutangula*. The plants are in flower in December, and fruit from December until January.

Specimens examined.

South Australia: Copley 2523, 5.iii.1969, intersection of Maitland-Pine Point & Ardrossan-Minlaton roads, AD (fr.); Orchard 1860, 16.xii.1968, ca 3 km south-east of Waikerie, AD (fl.,fr.); Orchard 1866, 16.xii.1968, ca 13 km west of Waikerie on road to Blanchetown, AD (fr.); Orchard 2808, 2810, 14.xii.1970, ca 4 km west of Pine Point on the Ardrossan-Port Julia road, AD (fr.); Orchard 2865, 15.xii.1970, ca 6 km north-east of Daly Head, AD (fl.,fr.); Orchard 2972,2974, Lincoln Highway ca 6 km north-east of Arno Bay, AD (fr.); Orchard 3018,3020, 31.xii.1970, Lincoln National Park, ca 1 km north of Pillie Lake, AD (fl.,fr.); Orchard 3089,3095,3109,3111, 2.i.1971, Flinders Highway, ca 7 km south-south-east of Mt. Hope, AD (fr.); Orchard 3114, l.c., AD (fr.) - holotype of *H. acutangula* f. *inflata*; Tietkins s.n., Yorke Peninsula, MEL38983 (fr.).

ε. f. *obturbinata* Orchard, f. nov.

Fructus plusminusve isodiametrus; alae diminutae deltatae basi fructu; callus inter alas praesens, alis conjungentibus annulus formans; 2.0-2.3 mm longus (sepala exclusa), 1.8-2.5 mm latus.

Holotypus: A.E. Orchard 3175, 6.i.1971, South Australia. Far West. Alongside dog-proof fence at south-eastern end of Yalata Aboriginal Reserve ca 19 km south of Waltabie Tank. (Waltabie Tank is on the Eyre Highway, ca 70 km east of the Head of the Great Australian Bight.), AD97107026 (fr.)! Isotypi: Still to be distributed.

Fruit ± isodiametric, wings deltoid, poorly developed, at base of the fruit; callus present between wings and fused with them to form an annulus or "skirt"; length 2.0-2.3 mm (excluding sepals), width 1.8-2.5 mm. (Fig. 21)

Distribution. (Map 5)

Confined to South Australia, this forma is found only in the coastal regions of southern and western Eyre Peninsula, from Yalata to Port Lincoln.

Ecology.

Soil preferences are as for f. *acutangula*. Flowering period is not known but fruiting occurs in December and January.

Specimens examined.

South Australia: Copley 2475, 26.i.1969, Sleaford Ave., Port Lincoln, AD (fr.); Orchard 3005, 31.xii.1970, sand dunes on southern side of Porter Bay, Port Lincoln, AD (fr.); Orchard 3024, 31.xii.1970, Lincoln National Park ca 6 km east of Wanna Well, AD (fr.); Orchard 3050,3059, 1.i.1971, northern end of Kellidie Bay ca 5 km east of Coffin Bay settlement, AD (fr.); Orchard 3103, 2.i.1971, Flinders Highway ca 7 km south-south-east of Mt.Hope, AD (fr.); Orchard 3136, 3.i.1971, ca 1 km west of Calca, AD (fr.); Orchard 3175, 6.i.1971, alongside dog-proof fence at south-eastern end of Yalata Aboriginal Reserve, AD (fr.) - holotype of *H. acutangula* f. *obturbinata*.

ζ. f. *occidentalis* Orchard, f. nov.

Fructus brevior quam latior; alae magnae deltatae in medio fructu vel parum infra medium, tota longitudo fructo occupans; callus inter alas absens; 1.5-2.0 mm longus (sepala exclusa), 2.0-2.5 mm latus.

Holotypus: R.D. Royce 6316, 19.ii.1960, 1 mile N of Esperance, W.A. Subshrub 12"-18" (30-45 cm) tall, on roadside, PERTH (fr.)!

Fruit somewhat flattened, broader than long; wings large, deltoid, at or just below the centre of the fruit and occupying the whole length; no callus between the wings; length 1.5-2.0 mm (excluding the sepals), width 2.0-2.5 mm.

Distribution. (Map 6)

This is the only forma known to occur outside of South Australia, being concentrated in the Esperance-Albany district of south-western Western Australia. Specimens very similar to the Western Australian plants are also known from Yalata and Mt.Hope on western Eyre Peninsula, South Australia.

Ecology.

Soil preferences are as for f. *acutangula*. Flowers are present in October and fruits from November until April.

Specimens examined.

South Australia: Copley 2633, 27.vii.1969, ca 25 km south-east of Yalata on dog fence, AD (fr.); Orchard 3101,3102,3104, 2.i.1971, Flinders Highway, ca 7 km south-south-east of Mt. Hope, AD (fr.); Orchard 3159, 5.i.1971, alongside dog-proof fence at the south-eastern end of Yalata Aboriginal Reserve, AD (fr.).

Western Australia: Bennett s.n., -.i.1941, Albany, PERTH (fr.); Gardner s.n., 18.xii.1940, Esperance, PERTH (fr.); O.I.C. Esperance 112, -.iv.1963 Esperance, on coastal sandhills, PERTH (fr.); Orchard 1726,1728, 23.x.1968, roadside sand dunes ca 3 km north-east of Esperance, AD (fl.); Royce 6316, 19.ii.1960, 1 mile north of Esperance, PERTH (fr.) - holotype of *H. acutangula* f. *occidentalis*; Willis s.n., 8.xi.1950, Boxer Island, Recherche Archipelago, MEL38930 (fr.); Willis s.n., 23.xi.1950, Middle Island, Recherche Archipelago, MEL38931 (fr.).

η. f. *pyramidata* Orchard, f. nov.

Fructus plusminusve isodiametricus vel brevior quam latior; alae magnae deltatae basi fructu; callus inter alas absens; 2.0-2.5 mm longus (sepala exclusa), 2.0-2.5 mm latus.

Holotypus: A.E. Orchard 3012, 31.xii.1970, South Australia, Southern Eyre Peninsula. Sand dunes on southern side of Porter Bay, Port Lincoln, AD97107357 (fr.)! Isotypi: Still to be distributed.

Fruit more or less isodiametric or slightly broader than long; wings deltoid, at the base of the fruit, callus between the wings absent; length 2.0-2.5 mm (excluding the sepals), width 2.0-2.5 mm.

Distribution. (Map 5)

This forma is confined to the coastal regions of southern and western Eyre Peninsula, South Australia, from Yalata to Port Lincoln.

Ecology.

Soil preferences are as for f. *acutangula*. The flowering period is unknown, but fruiting occurs from December to January.

Specimens examined.

South Australia: Orchard 3012, 31.xii.1970, sand dunes on southern side of Porter Bay, Port Lincoln, AD (fr.) - holotype of *H. acutangula* f. *pyramidata*; Orchard 3027, 31.xii.1970, Lincoln National Park ca 6 km east of Wanna Well, AD (fr.); Orchard 3092,3097,3098,3105, 2.i.1971, Flinders Highway ca 7 km south-south-east of Mt. Hope, AD (fr.); Orchard 3151, 5.i.1971, alongside dog-proof fence at south-eastern end of Yalata Aboriginal Reserve, AD (fr.),

θ. f. *semiangulata* (Black) Orchard, comb. et stat. nov.

Haloragis semiangulata J.M. Black, Trans. roy. Soc. S.Aust. 49(1925)275 [Typus: "Yalata (near Fowler's Bay)." Holotypus: R.Tate, s.n., 20.i.1879, South Australia. Western Eyre Peninsula. Yalata, ca

10 km north-west of Fowlers Bay, AD96808889 (fl.,fr.)!]; Black, Fl. S. Aust., (1926)431; 2 ed. (1952)644.

Figs: Black, Fl. S.Aust. (1926) fig. 175E; 2 ed. (1952) fig. 868E.

Fruit isodiametric or broader than long; deltoid wings present at top of the fruit, absent at base, callus present between wings, length 1.5-2.5 mm (excluding sepals), width 2.5-3.0 mm. (Fig. 21)

Distribution. (Map 6)

This forma has been collected in South Australia on coastal Eyre and Yorke Peninsulas from Yalata to Arno Bay and from Moonta to Pine Point.

Ecology.

Soil preferences are as for f. *acutangula*. The flowering period is unknown, but fruiting occurs from December until February (-May).

Specimens examined.

South Australia: Copley 36, 13.ii.1966, Bute to Snowtown roadside, ca 8 km from Bute, AD (fr.); Copley 2556,2561, 3.v.1969, Moonta, rise behind Showgrounds, AD (fr.); Copley 2629, 27.vii.1969, 15 miles S.E. of Yalata on dog fence, AD (±fr.); Orchard 2037,2044,2046, 23.ii.1969, ca 2 km south-west of Moonta on 18th hole of Moonta Golf Course, AD (fr.); Orchard 2807, 14.xii.1970, ca 4 km west of Pine Point on the Ardrossan-Port Julia road, AD (fr.); Orchard 2864,2866, 15.xii.1970, ca 6 km north-east of Daly Head, AD (fr.); Orchard 2962,2984, 30.xii.1970, Lincoln Highway, ca 6 km north-east of Arno Bay, AD (fr.); Orchard 3007, 31.xii.1970, sand dunes on southern side of Porter Bay, Port Lincoln, AD (fr.); Orchard 3053, 1.i.1971, northern end of Kellidie Bay, ca 5 km east of Coffin Bay settlement, AD (fr.); Orchard 3084, 2.i.1971, Flinders Highway ca 10 km north-north-west of Warrow, AD (fr.); Orchard 3089 bis, 3110, 2.i.1971, Flinders Highway ca 7 km south-south-east of Mt. Hope, AD (fr.); Orchard 3150,3160,3163,3177, 5-6.i.1971, alongside dog-proof fence at south-eastern end of Yalata Aboriginal Reserve, AD (fr.); Tate s.n., 20.i.1879, Yalata, ca 10 km north-west of Fowlers Bay, AD96808889 (fl.,fr.) - holotype of *H. semiangulata*.

ι. f. *subacutangula* Orchard, f. nov.

Fructus plusminusve longior quam latior; alae plusminusve magnae oblongae, tota longitudo fructu occupans; callus inter alas praesens; 2.2-2.5(-3.0) mm longus (sepala exclusa), 2.0-2.5 mm latus.

Holotypus: B.Copley 2557, 3.v.1969, South Australia. Yorke Peninsula. Moonta, behind Showgrounds. (Moonta is ca 130 km north-west of Adelaide on western coast.), AD96928615 (fr.)!

Fruit usually ± longer than wide; wings ± well developed, oblong, occupying the entire length of the fruit; callus present between the wings; 2.2-2.5(-3.0) mm long (excluding the sepals), 2.0-2.5 mm wide. (Fig. 21)

Distribution. (Map 6)

This forma, restricted to South Australia, is only known from northern Yorke Peninsula (Moonta and Pine Point) and from Port Lincoln.

Ecology.

Soil preferences are as for f. *acutangula*. Flowering period is unknown but fruiting occurs from December until May.

Specimens examined.

South Australia: Copley 2557, 3.v.1969, Moonta, behind Showgrounds, AD (fr.) - holotype of *H. acutangula* f. *subacutangula*; Orchard 2034, 2036,2039,2045, 23.ii.1969, ca 2 km south-west of Moonta on 18th hole of Moonta Golf Course, AD (fr.); Orchard 2804,2816, 14.xii.1970, ca 4 km west of Pine Point on the Ardrossan-Port Julia road, AD (fr.); Orchard 3001, 31.xii.1970, sand dunes on southern side of Porter Bay, Port Lincoln, AD (fr.);

κ. f. *tetraglebosa* Orchard, f. nov.

Fructus longior quam brevior, plusminusve rugosus alae costis deminutae; callus medianus inter costa praesens; 2.0-3.0 mm longus (sepala exclusa), 1.3-2.0 mm latus. (Fig. 21)

Holotypus: A.E. Orchard 3131, 3.i.1971, South Australia. Western Eyre Peninsula. Roadside, ca 1 km west of Calca. (Calca is ca 30 km south-east of Streaky Bay settlement.). Shallow sandy soil over limestone pavement, AD97106122 (fr.)! Isotypi: Still to be distributed.

Distribution. (Map 6)

This forma is confined to the coastal regions of Eyre Peninsula (Yalata to Arno Bay) and Yorke Peninsula (Moonta to Pine Point), South Australia. One collection (McDonald s.n.) was grown from seed collected near Lock in central Eyre Peninsula.

Ecology.

Soil preferences are as for f. *acutangula*. The flowering period includes December, and fruiting takes place from December to May.

Specimens examined.

South Australia: Copley 2524,2525, 5.iii.1969, intersection of Maitland-Pine Point & Ardrossan-Minlaton roads, AD (fr.); Copley 2555,2560, 3.v.1969, Moonta, rise behind Showgrounds, AD (fr.); Copley 2630, 27.vii.1969, ca 25 km south-east of Yalata on dog fence, AD (fr.); McDonald s.n., 1967, grown from seeds from Lock, AD96845299 (fr.); Orchard 2067, 23.ii.1969, sand dunes ca 13 km south of Cape Elizabeth, AD (fr.); Orchard 2811,2815, 14.xii.1970, ca 4 km west of Pine Point on the Ardrossan-Port Julia road, AD (fr.); Orchard 2861, 15.xii.1970, ca 6 km north-east of Daly Head, AD (fr.); Orchard 2976,2983, 30.xii.1970, Lincoln Highway ca 6 km north-east of Arno Bay, AD (fr.); Orchard 3004, 31.xii.1970, sand dunes on southern side of Porter Bay, Port Lincoln, AD (fr.); Orchard 3017, 31.xii.1970, Lincoln National Park, ca 1 km north of Pillie Lake, AD (fl.,fr.); Orchard 3131, 3.i.1971, roadside ca 1 km west of Calca, AD (fr.) - holotype of *H. acutangula* f. *tetraglebosa* Orchard 3135, l.c., AD (fr.); Orchard 3145,3148,3158,3161,3165,3168, 3169,3170, 5-6.i.1971, alongside dog-proof fence at south-eastern end of Yalata Aboriginal Reserve, AD (fr.).

λ. f. *tetraptera* Orchard, f. nov.

Fructus plusminusve isodiametrus vel latior quam longior; alae magnae oblongae tota longitudo fructu occupans; fructus inter alas laevis vel rugosus, callus absens; 2.0-2.5 mm longus (sepala exclusa), 2.0-3.0 (-4.0) mm latus.

Holotypus: A.E.Orchard 2035, 23.ii.1969, South Australia. Northern Yorke Peninsula. Moonta-Port Hughes road ca 2 km south-west of Moonta on 18th hole of Moonta Golf Course. (Moonta is on Spencer Gulf ca 18 km south of Wallaroo.), AD97111018 (fr.)! Isotypi: Still to be distributed.

Haloragis ciliata Black, Trans. roy. Soc. S.Aust. 49(1925)275 [Typus: "Murray Lands". Lectotypus (Orchard): Agric. Bureau s.n., 20.xii.1917, Geranium (Pinnaroo Rly), AD (fr.)! Isolectotypus (?): J.M. Black s.n., 20.xii.1917, Geranium (Pinnaroo Rly), MEL38935 (fr.)! Syntypus: J.B. Cleland s.n., 13.iv.1924, near Mannum, Riv. Murray, AD (fr.)]; Black, Fl. S.Aust. (1926)431; 2 ed. (1952)644.

Figs: Black, Fl. S.Aust. 2 ed. (1952) fig. 877.

Fruit isodiametric or wider than broad; wings oblong, well developed, occupying whole length of fruit, space between the wings smooth or rugose, callus absent; length 2.0-2.5 mm (sepals excluded), width 2.0-3.0 (-4.0) mm. (Fig. 21)

Distribution. (Map 6)

This form is one of the most common and widespread in the species although restricted to South Australia. It is known from Eyre Peninsula (Yalata to Cowell), Yorke Peninsula (Wallaroo to Pine Point), Fleurieu Peninsula (Brighton to Port Elliot) and Kangaroo Island. It is also the only forma known to occur in inland localities, having been collected from near Kimba (mid-northern Eyre Peninsula) and the Murray Mallee.

Ecology.

Soil preferences are as for f. *acutangula*. Flowering takes place from (August-)November until January and fruiting from (August-)November until April(-May).

Specimens examined.

South Australia: Agric. Bureau s.n., 20.xii.1917, Geranium, AD (fr.) - lectotype of *H. ciliata;* Adams s.n., 21.xi.1946, Sandalwood, ADW10095 (fl.,fr.); Black s.n., 20.xii.1917, Geranium, MEL38935 (fr.) - isolectotype of *H. ciliata;* Cleland s.n., 13.iv.1924, near Mannum, AD (fr.) - syntype of *H. ciliata;* Cleland s.n., 16.viii.1924, Karoonda, AD96803064 (fl.,fr.); Cleland s.n., 13.xii.1924, Brighton sandhills, AD968020565 (fl.,fr.); Cleland s.n., 25.i.1926, between Victor Harbour and Port Elliot, AD968020574 (fr.); Cleland s.n., 6.iii.1929, Rocky River, K.I., AD968020579 (fr.); Cleland s.n., 19.i.1934, Chiton Rocks, AD966032591 (fl.,fr.); Cleland s.n., 7.xii.1934, mouth of South-West River, K.I., AD96803094 (fl.); Cleland s.n., 24.i.1936, between Victor Harbour and Port Elliot, AD968020480 (fr.); Cleland s.n., 10.iv.1936, Cape Spencer, AD968020555 (fr.); Cleland s.n., 27.i.1940, mouth of South-West River, K.I., AD968020567 (fr.); Cleland s.n., 18.xii.1941, near Lake Wangary, AD968020560 (fl.); Cleland s.n., 26.xii.1953, Port Elliot, AD968020570 (fl.,fr.); Cleland s.n., 16.iii.1963, Rocky River, K.I., AD96410058 (fl., fr.-terat.) - pollen sent to Palyn. Lab. Stockholm; Cleland s.n., 8.iv.1967, near Mouth of Marne, AD96727028 (fr.); Cleland 30, 2.xii.1913, Alawoona, AD, NSW (fl.,fr.); Cleland 46, 2.xii.1947, Alawoona, NSW (fl.,fr.); Copley 2452, 21.i.1969, 20 miles north of Cowell, AD (fr.); Copley 2457, 25.i.1969, Fishery Bay, Pt. Lincoln, AD (fr.); Copley 2526, 5.iii.1969, intersection of Maitland-Pine Point & Ardrossan-Minlaton roads, AD (fl.,fr.); Copley 2558, 2559, 3.v.1969, Moonta behind Showgrounds AD (fr.); Copley 2593, 26.vii.1969, ca 50 km west of Kimba, AD (fr.); Copley 2950, 29.xii.1969, 20 miles east of Kimba, AD (fl.,fr.); Hunt 3345, 17.xii.1970, Parsons Reserve Waitpinga, AD (fl.); Ising s.n., 9.i.1937, Karoonda, AD96803148 (fr.); Ising s.n., 24.i.1937, Wynarka, AD966032013(fr.); Orchard 1853, 16.xii.1968, ca 16 km west of Waikerie on road to Blanchetown, AD (fr.); Orchard 1865, 16.xii.1968, ca 13 km west of Waikerie, AD (fr.); Orchard 1872, 9.i.1969, Perponda, AD (fr.); Orchard 1873, 9.i.1969, ca 15 km south of Waikerie on the road to Karoonda, AD (fr.); Orchard 2035, 23.ii.1969, ca 2 km south-west of Moonta on 18th hole of Moonta Golf Course, AD (fr.) - holotype of *H. acutangula* f. *tetraptera;* Orchard 2038, 2040, 2048, l.c., AD (fr.); Orchard 2069,2072, 23.ii.1969, sand dunes ca 13 km south of Cape Elizabeth, AD (fr.); Orchard 2407,2410,2413, 10.xii.1969, ca 1 km south of Moonta, AD (fl.); Orchard 2802,2805,2806,2809,2812,2814, 14.xii.1970, ca 4 km west of Pine Point on the Ardrossan-Port Julia road, AD (fr.); Orchard 2855,2856, 15.xii.1970, ca 3 km north-east of Stenhouse Bay settlement, AD (fl.,fr.); Orchard 2869, 15.xii.1970, ca 5 km south of Port Rickaby on the track to The Bluff, AD (fl.,fr.); Orchard 2880, 27.xii.1970, coastal sand dunes, North Beach, Wallaroo, AD (fr.); Orchard 2961,2963,2964,2965,2969,2975, 2977,2978,2986, 30.xii.1970, Lincoln Highway ca 6 km north-east of Arno Bay, AD (fl.,fr.); Orchard 2999,3006, 31.xii.1970, sand dunes on southern side of Porter Bay, Port Lincoln, AD (fr.); Orchard 3022,3023, 31.xii.1970 Lincoln National Park, ca 5 km east of Wanna Well, AD (fr.); Orchard 3048, 3057,3061, 1.i.1971, northern end of Kellidie Bay ca 5 km east of Coffin Bay settlement, AD (fr.); Orchard 3082, 2.i.1971, Flinders Highway, ca 10 km north-north-west of Warrow, AD (fr.); Orchard 3112, 2.i.1971, Flinders Highway, ca 7 km south-south-east of Mt.Hope, AD (fr.); Orchard 3117, 3.i.1971, Flinders Highway, ca 11 km north of Elliston, AD (fr.); Orchard 3129,3134, 3.i.1971, ca 1 km west of Calca, AD (fr.); Orchard 3147,3153,3171, 5-6.i.1971, alongside the dog-proof fence at the south-eastern end of Yalata Aboriginal Reserve, AD (fl.,fr.); Rohrlach 162, 15.ii.1959, ca 36 km west-north-west of Kimba, AD (fr.); Tate s.n., -.xi.1889, southern Yorke Peninsula, AD96810047 (fl.).

μ. f. *turbinata* Orchard, f. nov.

Fructus plusminusve isodiametrus vel latior quam longior; alae diminutae vel magnae deltatae in apice fructu; fructus inter alas transverse rugosus callus absens; 1.5-2.0 mm longus (sepala exclusa), 2.0-2.5 mm latus.

Holotypus: A.E. Orchard 3120, 3.i.1971, South Australia. Eyre Peninsula. Flinders Highway, ca 11 km north of Elliston. (Elliston is ca 185 km west of Cowell on western coast of Eyre Peninsula.), AD97106076 (fr.)!

Isotypi: Still to be distributed.

Fruit more or less isodiametric or broader than long; the wings deltoid, well- or poorly-developed, at the top of the fruit; between the wings the fruit is flattened and transversely rugose, lacking a callus; length 1.5-2.0 mm (excluding the sepals), width 2.0-2.5 mm.

Distribution. (Map 6)

This forma is known from the coastal regions of Eyre Peninsula from Yalata to Arno Bay and of Yorke Peninsula from Wallaroo to north of Port Wakefield. One collection, probably belonging here, has been made from Meningie near Encounter Bay.

Ecology.

Soil preferences are as for f. *acutangula*. Flowering is known to occur from December to January and fruiting from December to February.

Specimens examined.

South Australia: Copley 922, 1.xii.1966, ca 1½ km east-north-east of Bute on Snowtown road, AD (fl.,fr.); Copley 2432, 1.i.1969, Wallaroo North beach, AD (fl.,fr.); Copley 2522, 5.iii.1969, intersection of Maitland-Pine Point & Ardrossan-Minlaton roads, AD (fr.); Orchard 2041, 23.ii.1969, ca 2 km south-west of Moonta on 18th hole of Moonta Golf Course, AD (fr.); Orchard 2051,2052, 23.ii.1969, Port Hughes, ca 2 km east of the jetty, AD (fr.); Orchard 2412,2414, 10.xii.1969, ca 1 km south of Moonta, AD (fl.,fr.); Orchard 2862, 15.xii.1970, ca 6 km north-east of Daly Head, AD (fr.); Orchard 2879, 27.xii.1970, coastal sand dunes, North Beach, Wallaroo, AD (fr.); Orchard 2968,2971, 2973, 2985, 30.xii.1970, Lincoln Highway, ca 6 km north-east of Arno Bay, AD (fr.); Orchard 3019, 31.xii.1970, Lincoln National Park, ca 1 km north of Pillie Lake, AD (fl.,fr.); Orchard 3025,3029, 31.xii.1970, Lincoln National Park, ca 6 km east of Wanna Well, AD (fl.,fr.); Orchard 3056, 1.i.1971, northern end of Kellidie Bay, ca 5 km east of Coffin Bay settlement, AD (fr.); Orchard 3083, 2.i.1971, Flinders Highway,ca 10 km north-north-west of Warrow, AD (fr.); Orchard 3093, 2.i.1971, Flinders Highway, ca 7 km south-south-east of Mt. Hope, AD (fr.); Orchard 3120, 3.i.1971, Flinders Highway, ca 11 km north of Elliston, AD (fr.) - holotype of *H. acutangula* f. *turbinata;* Orchard 3121, l.c., AD (fr.); Orchard 3146, 3154, 3164, 5-6.i.1971, alongside dog-proof fence at south-eastern end of Yalata Aboriginal Reserve, AD (fl.,fr.); Williams 2415, 5.xii.1965, Meningie near Coorong, AD (fl.,fr.).

Notes.

1. The choice of a lectotype for *H. ciliata* was necessary as two different collections in AD were annotated by Black, without either being nominated as the (holo-)type. While either of these two collections seem to be equally qualified to serve as lectotype, the one chosen contains slightly more and better preserved material. A collection in the Melbourne Herbarium (MEL38935) is probably a duplicate of the lectotype.

13. *Haloragis aspera* Lindley in Mitchell, Journ. Trop. Aust. (1848)306 [Typus: leg. Mitchell, 13.ix.1846, open grassy plains east of the united channel of Rivers Nive and Nivella. Holotypus: Lieut.-Col. Sir T.L. Mitchell 624, 1846, Victoria R. Sub. Tropical New Holland. CGE (fl.,fr.)!]; A. Gray, Bot. U.S. Expl. Exped. 1(1854)627; F.v.M., Key Syst. Vict. Pl. 1(1887-8)262; F.v.M., Trans. roy. Soc. Vict. 24(1888)136; Tate, Trans. roy. Soc. S.Aust. 12(1889)95; F.v.M., Sec. Census 1(1889)85; F.v.M. & Tate, Trans. roy. Soc. S.Aust. 13(1890)101; Tate, Trans. roy. Soc. S.Aust. 13(1890)117; Tate, Fl. S.Aust. (1890)101, 234; Koch, Trans. roy. Soc. S.Aust. 22(1898)111; Moore, Hdbk. Fl. N.S.Wales (1893)185; Dixon, Pl. N.S.Wales (1906)129.

Haloragis pinnatifida A. Gray, Bot. U.S. Expl. Exped. 1(1854)627 [Typus: "Hab. New South Wales; on Hunter's River." Holotypus: Wilkes s.n., Hunter's River, New South Wales, US47835 (fl.,fr.)!]; Hook. f., Fl. Tasm. 1(1856)119; F.v.M., Census 1(1882)50; Schindler, Pflrch. 23(1905)46.

Haloragis ceratophylla [non Endl.] Benth., Fl. Austr. 2(1864)478 p.p.; Tepper, Trans. roy. Soc. S.Aust. 3(1880)38; Tate, Trans. roy. Soc. S.Aust. 3(1880)64, 6(1883)96, 12(1889)93; Black, Trans. roy. Soc. S.Aust. 38(1914)467.

H. heterophylla var. *capreolicornis* Schindler, Pflrch. 23(1905)46 [Typus: "Australien: Victoria, Neu-Sud-Wales, (Sidney-Herb. n.6, 10, 11a), Queensland (Lhotsky, F.v.Mueller). Tasmanien (Lhotsky, Stuart). - Herb. Barb.-Boiss., Berlin, Breslau, Deless., Petersb., Wien." Lectotypus (Orchard): C. Stuart s.n., Van Diemansland, LE (fl.,fr.)! Isolectotypi: C. Stuart s.n., Van Diemansland, HBG, MEL1003762 p.p., W. (fl.)!; Syntypus: Dr. Lhotzky, Terra de Van Dieman, G (Hb. Deless.) (fr.)!];

Britten, J. Bot. 45(1907)136; Maiden & Betche, Census N.S.Wales Pl. (1916)158.

H. heterophylla var. *glaucifolia* Schindler, Pflrch. 23(1905)46 [Typus: "Australien: Victoria (Wawra It. Cob. n.506), Sud-Australien (Koch n. 295). Neu-Sud-Wales (Sidney-Herb. n.8, 15). - Herb. Berlin, Gottingen, Petersb., Wien." n.v. Isosyntypi: Betche s.n., -.ix.1900, Paroo River District, N.S.W., NSW113156 ("15") (fl.)!; Koch 295, -.iii.1898, Mt. Lyndhurst, South Australia, BRI080034 (fr.)!; Koch 295, -.iv.1898, Mt. Lyndhurst, S.A., NSW99203 (fr.)!; Koch 295, -.v.1898, -.x.1899, Mt. Lyndhurst, AD96906021 (fl.,fr.)!; Koch 295, -.x.1899, Mt. Lyndhurst, AD96803792 (fr.)!; Walter s.n., -.x.1900, Wimmera Distr., NSW9836 ("8") (fr.)!]; Maiden & Betche, Census N.S.Wales Pl. (1916)158; Black, Trans. roy. Soc. S.Aust. 41(1917)49, 43(1919)40; Eichler, Suppl. Black's Fl. S.Aust. (1965)245.

Haloragis heterophylla var. *aspera* (Lindl.) Schindler, Pflrch. 23(1905)46; Maiden & Betche, Census N.S.Wales Pl. (1916)158; Black, Trans. roy. Soc. S.Aust. 41(1917)644; Ewart, Fl. Vict. (1931)883.

Haloragis heterophylla var. *rigida* Schindler, Pflrch. 23(1905)46 [Typus: "Australien: Victoria (F.v.Mueller) - Herb. Berlin, Halle, Petersb., Wien." Lectotypus (Orchard): Ferd. von Mueller s.n., Ovens River, Victoria, LE (fl.)! Isolectotypus: Ferd. von Mueller s.n., Victoria. Ovens River, NSW113157 ex W (st.)! Syntypus: Ferd. Mueller s.n., Austr. felix, LE (fl.)!]

Haloragis heterophylla var. *pinnatifida* (A. Gray) Maiden & Betche, Census N.S.Wales Pl. (1916)158.

Haloragis heterophylla var. *ceratophylla* [non Schindler] Blackall & Grieve, W.Aust. Wildfls. 3(1965)470.

Perennial herb (12-)18-25 cm tall, perennating by very deep underground stolons; stems annual, erect, herbaceous, smooth, scabrous with simple, spreading hyaline 3-4-celled hairs, hooked at tip, 0.1-0.3(-0.5) mm long, or rarely glabrous.

Leaves grey-green, ± glaucous, alternate (sometime opposite at base), lanceolate to narrow-ovate, length 2.0-4.0(-5.0) cm, width (0.5-)0.8-1.5 cm, acute at tip, tapering gradually to base, sessile, margin thickened, entire or (1-)6-16-toothed, the teeth deltoid or falco-deltoid, 0.1-0.3 mm long, midrib indistinct on upper surface, prominent below, lateral veins indistinct, hairs as for stems on both faces, hairs on margins often thicker, curved, not hooked at tip.

Inflorescence an indeterminate spike of dichasia of (1-)3-5 flowers in the axils of alternate primary bracts. Lateral inflorescences rarely borne in the axils of the upper leaves. Primary bracts leaf-like, 1.0-1.7 cm long, 0.3-0.7 cm wide, green, fleshy, entire or serrate with 2-6 teeth, midribbed, scabrous with hairs as for stems; secondary bracts membranous, brown to whitish, linear, 1.2-1.4 mm long, 0.2-0.3 mm wide, entire, fimbriate with hairs as for stem; tertiary bracts membranous, brown to whitish, linear, 0.8-0.9 mm long, 0.2-0.3 mm wide, entire, fimbriate with hairs as for stem.

Flowers 4-merous, on pedicels 0.1-0.2 mm long. Sepals 4, deltoid, 1.5-1.7 mm long, 0.8-1.0 mm wide, lacking midrib, scabrous on outer face with hairs as for stem. Petals 4, red to green, hooded, tip erect, shortly unguiculate, 2.1-3.0 mm long, 0.6-0.9 mm wide (keel to margin), scabrous. Stamens 8, filaments 0.1-0.2 mm long; anthers yellow, oblong, 1.3-2.3 mm long, 0.2-0.3 mm wide, 4-locular, nonapiculate, all the same length. Styles 4, 0.2 mm long, stigmas capitate, red-purple, fimbriate. Ovary globular, 1.4-1.5 mm long, 1.0-1.5 mm wide, not ribbed, scabrous, 4-locular with 1 pendulous ovule per locule.

Fruits 1-3 per axil, on pedicel (0.1-)0.3-0.6 mm long, globular to pyriform or ovoid, (2.0-)2.5-3.0(-4.5) mm long, (1.8-)2.5-3.0 mm wide, ± 4-or 8-ribbed in upper part, ± smooth or rugose or verrucose in lower part, rarely glabrous, usually scabrous with hairs as for stems; sepals persistent, erect, deltoid to narrow deltoid, (0.8-)1.0-1.5 mm long, 0.4-0.8 mm wide, usually with small median callus at base, scabrous; endocarp and septa woody, exocarp membranous, not swollen, 4-locular, 1-4 seeds. (Fig. 24)

Distribution. (Map 7)

This species is well represented by collections from Victoria (except for Gippsland), central and western New South Wales, southern Queensland, central and southern Northern Territory, and northern and eastern South Australia. Three collections are known from Tasmania.

Ecology.

Haloragis aspera favours heavy clay soils which are flooded for a short time after rain. It has a deep, branching, perennial stoloniferous rootstock by which an established plant can colonize a wide area. This feature makes the plant a serious weed in cultivated ground, particularly in the Darling Downs region of southern Queensland. Collectors' notes include "depression amongst *Melaleuca lanceolata*, growing up through *Chorizandra enodis*" (Beauglehole 29776); "clayey sandy soil, inter-sand-ridge flats" (Boyland 304); "in grey clay on extensive flats flooded from Coopers Creek" (Everist 7412); "common in claypan forming part of creek bed between dunes" (Orchard 757); "Cattle appear to like eating this plant. It is a pest in our cultivation paddocks, as nothing else will thrive where it grows. It has a long root and when cut off by the plough to any usual depth merely shoots up again as sturdy as ever, and cultivation appears to improve its growth rather than hinder it." (Tosh s.n., BRI080026). Flowering usually occurs from August until March (-May) and fruiting from September until May.

Specimens examined.

Tasmania: Lhotsky s.n., Terra de Van Dieman, G (fr.) - syntype of *H. heterophylla* var. *capreolicornis*; Oakden 20, 1866, between Launceston and Ross, MEL(fl.,fr.); Stuart s.n., Van Diemansland, HBG, LE, MEL1003762 p.p., W (fl.,fr.) - lectotype & isolectotypes of *H. heterophylla* var. *capreolicornis*.

Victoria: Beauglehole 17013, -.x.1949, LIttle Desert, S. of Kaniva, BEAUGLEHOLE (st.); Beauglehole 17014, -.x.1948, Wail near Dimboola, BEAUGLEHOLE (fl.,fr.); Beauglehole 17018, 14.iii.1951, Murray River opposite Bonnie Doon, BEAUGLEHOLE (fl.,fr.); Beauglehole 17032, 8.ii.1959, Jung N.E. of Horsham, BEAUGLEHOLE (fr.); Beauglehole 28396, 17.ix.1968, Wyperfeld National Park, BEAUGLEHOLE (st.); Beauglehole 29729, 22.xi.1968, Mt. Arapiles, BEAUGLEHOLE (fr.); Beauglehole 29776, 23.xi.1968, S.W. side of Mt. Arapiles, BEAUGLEHOLE (fl.); Beauglehole & Finck 29322, 13.x.1968, N. side of Wyperfeld National Park, BEAUGLEHOLE (fl.); Beauglehole & Willis 17033, 16.x.1960, Hattah Lakes National Park, BEAUGLEHOLE (fl.); Bissill 21, Ravenswood, MEL39090 (st.); D'Alton s.n., Nhill, MEL38977, (fl.,fr.); Davis s.n., 1890, Wimmera, MEL39131 (fl.); Eckert 166, 1890, Wimmera, MEL (fl.); Eckert 267, 1891, Wimmera, MEL (fr.); Gray 4035, 24.i.1957, Horsham Cemetery, CANB (fr.); Green 95, Ararat Plains, MEL (st.); King s.n., 1892, Murray River, MEL1003663 (fl.); Landy & Beauglehole 9589, 5.xi.1960, Wyperfeld National Park, BEAUGLEHOLE (fr.); Meebold 21883, -.xii.1936, Bacchus Marsh, AD (fr.); Mueller s.n., Ovens River, LE, NSW (fl.) - lecto- and isolecto-types of *H. heterophylla* var. *rigida*; Mueller s.n., Austr. felix, LE (fl.) - syntype of *H. heterophylla* var. *rigida*; Mueller s.n., You-Yangs, MEL38994 (fr.); Mueller s.n., Murray River, MEL39010 (fr.); Mueller s.n., Wimmera, MEL39035 (fl.,fr.); Mueller s.n., -.xii.1850, Murray, MEL39014, 39015 (fr.); Mueller s.n., -.i.1874, Upper Hume's River at Towong, MEL39125, 39126 (fl.); Mueller s.n., -.iii.1893, Ovens River, MEL1003660 (fr.); Pye s.n., -.i.1913, Dookie, MEL38979 (fr.); Reader s.n., 21.xii.1891, Shire of Dimboola, MEL39075 p.p. (fl.); Reader s.n., 4.xi.1892, Shire of Dimboola, MEL38978 (fl.,fr.); Reader 11, 12, 14, 19.xi.1892, near Dimboola, MEL (fl.,fr.); Reader 15, 16, 4-6.xi.1892, Wimmera, MEL (fl.,fr.); Robbins 17110, 1940, Derby, BEAUGLEHOLE (fr.); Sullivan 3, 12.xi.1873, Moyston, MEL (fl.); Sullivan 7, 14.vi.1872, Moyston, MEL (fl.);

Swindley 1557, 21.iii.1963, "Serendip" Lara, MEL (fl.); Walter s.n., Wimmera, CANB186502 (fl.,fr.); Walter s.n., Grampians, CANB186503 (fl.,fr.); Walter s.n., -.xi.1899, Grampians, NSW113160 p.p. (fl.,fr.); Walter s.n., -.x.1900, Wimmera distr., NSW9836 (fr.) - isosyntype of *H. heterophylla* var. *glaucifolia;* Williamson 1447, 5.ix.1913, Mildura, MEL (fl.).

New South Wales: Abrahams s.n., -.ix.1910, Louth, NSW103146 (fl.); Baeuerlen 121, -.iii.1885, Delegate District, MEL(fr.); Baeuerlen 304, 1887, near Wilcannia, MEL (fr.); Betche s.n., -.ix.1883, Bourke, NSW 99204 (fl.); Betche s.n., 2.x.1886, Byrock, NSW99244 (fl.); Betche s.n., -.ix.1900, Paroo River District, NSW113156 (fl.) - isosyntype of *H. heterophylla* var. *glaucifolia;* Betche 1, 2.x.1886, Byrock, MEL38969 (fr.); Boorman s.n., -.v.1906, Eauabolong, NSW99199, 99201 (fl.,fr.); Boorman s.n., -.v.1906, Lake Cudgellico, NSW99088 (fr.); Boorman s.n., -.ix.1912, Nulty-Toorale, AD96905129, BRI080041, NSW99198, SYD (fl.,fr.); Boorman s.n., -.x.1912, Arrara-Lake Eliza, AD96921172 (fl.); Boorman s.n. -.x.1912, Wanaaring-Uriseno, NSW99200 (fr.); Bruckner s.n., Hillston, MEL39021 (fr.); Campbell s.n., -.ii.1966, Collie, NSW99048 (fl.); Carson s.n., -.iii.1887, Namoi River, MEL39132 (fl.,fr.); Clark s.n., -.ix.1912, Euralah via Walgett, NSW103123 (fl.); Collier 6, -.vii.1910, Yandama Station, NSW (fl); Cotter s.n., Cawarral, MEL38961 (fl.,fr.); Crouch s.n., Brookong near Urana, MEL38960 (fl.); Dallachy & Goodwin s.n., Darling River, MEL38976, 39037 (fl.,fr.); Fawcett s.n., Richmond River, MEL39136 (fr.); Flemons s.n., -.viii.1949, Trangie, NSW99179 (st.); Forde s.n., Wentworth, NSW99177 (fr.); Forde 10, Darling River, MEL (fr.); Forde 13, Lower Darling, MEL (fl.); Gloster s.n., 8.ix.1960, Albemarle Stn. via Broken Hill, ADW22705 (fl.); Hamilton s.n., 8.iv.1912, Menangle, NSW99245 (fr.); Henderson s.n., 10.xi.1945, banks of Wabool, NSW99193 (fr.); Henshall s.n., Tapio Station 6 miles north of Buronga, NSW113154 (fl.,fr.); Holding s.n., 1889, junct. of the Darling & Murray Rivers, MEL39119 (fl.); Horan s.n., -.i.1913, Cadgellico via Condoblin, NSW99194 (fr.); Johnson 547/124, 1.vi.1947, Wanaaring, NSW (fr.); Johnson & Constable s.n., 13.iii.1959, Edward River, Moulamein, AD96920053 (fr.); Jones s.n., 19.vi.1937, Narromine, NSW99178 (fr.); Kelk s.n., -.i.1908, Narromine, NSW99180 (fl.); Kennedy s.n., 1886, Yandarlo via Wilcannia, MEL38963 (st.); King s.n., 1887, Evelyn Creek north of Barrier Range, MEL38959, 38971 (fl.,fr.); Loveridge s.n., -.ii.1958, Tamworth, NSW99053 (fl.,fr.); Maiden s.n., 4.i.1890, Wooyeo, Cudgellico, NSW99057 (fr.); Martensz 1765, 20.i.1964, Tero Creek Station, CANB (fr.); Martensz s.n., 1.xii.1968, l.c., CANB192876 (fl.); Martensz 4153, 4155, 4156, 4157, 3.xii.1968, l.c., CANB192878 (fl.); McBarron 11274, 13.x.1965, Bourke, NSW (fl.,fr.); McDougall s.n., Bourke district, NSW99087 (fl.,fr.); Mein s.n., Lower Edward's River, MEL39022 (fl.,fr.); Michael 796, Kelsey Creek, BRI (fl.,fr.); Morris 484, -.ii.1920, Broken Hill, NSW (fr.); Morris 820, 1.x.1921, Milparinka, ADW, BRI, NSW (fl.,fr.); Morwood s.n., 6.xi.1941, beyond Dalby, BRI080176 (fl.,); Mueller s.n., Bogan, MEL39024 (fl.,fr.); Mueller s.n., -.ix.1878, Lachlan R., MEL38970 (fl.); Neilson s.n., between Darling and Coopers Creek, MEL39017 (fl.,fr.); Officer s.n., -.ii.1904, Zara via Hay, NSW 99056, (fr.); Phelps 2, 3, 19.x.1955, "Glen Eden', Rowena, NSW (fl.); Rupp s.n., -.vi.1916, Jerilderie, MEL39049 (st.); Schneider s.n., 1870, Barcoo, MEL39016 (fr.); Smart s.n., 7.iv.1955, Berrigan district, NSW

99190 (fl.); Tate s.n., 10.vi.1883, Depot Creek, AD96810025 (fl.,fr.); Thom 9, -.iii.1885, Wagga Wagga, MEL (fl.,fr.); Tour s.n., Wentworth, MEL39009 (fl.,fr.); Toyster s.n., 1884, Barringun, MEL38973 (fr.); Warren s.n., -.x.1907, Narromine, NSW99181 (fl.); Whaite 1729, 17.viii.1954, 1 mile W. of Hay, NSW (fr.); Whaite 1858, 25.ii.1955, Lake Yanga, NSW (fr.); Wilkes s.n., Hunter River, US47835 (fl.,fr.) - holotype of *H. pinnatifida;* Woolls s.n., Paramatta, MEL39081 (fl.,fr.); Wurfel s.n., -.iii.1885, Bourke, MEL38968 (fl.,fr.).

<u>Queensland</u>: Bailey s.n., -.xii.1875, Warwick BRI079981 (fl.); Barton 265, 267, 1807, Armadilla between the Warrego and Marawa, MEL (fl.); Beckler 53, Warwick, MEL (fr.); Bick 91, -.xi.1910, 'Glenormiston' Georgina River, BRI (fr.); Boorman s.n., -.viii.1912, Mt.Perry, NSW 99095 (fl.); Boorman s.n., Rockhampton, MEL39033, 39034, NSW99176 (fl., fr.); Boyland 304, 26.ix.1966, 56 miles W.N.W. of Birdsville, BRI, MEL (fl.); Carrick 1927, 20.viii.1968, S. bank of Coopers Creek near Nappa Merrie, AD (fl.); Clemens s.n., -.x.-.xi.1945, BRI019035, 080023 (fl., fr.); Clydesdale s.n., -.v.1950, L. Herron, Bowenville, BRI080036 (fl.); Clydesdale 101, 2.ix.1948, Pittsworth, BRI (st.); Courtice s.n., 15.vii.1960, Biloela, BRI024858 (st.); Cruice s.n., 2.iii.1964, 'Tummaville', Yandilla, BRI051879 (fl.); Daintree s.n., Kennedy district, MEL39000 (st.); Everist 7412, 2.viii.1963, South Galway about 40 miles S.W. of Windorah, BRI (fl.); Flegler s.n., 7.iii.1966, 8 miles S. of Jandowae, BRI063726 (fr.); Hartmann 512, Condamine River, BRI (fl.); Hayward s.n., 24.iv.1961, Noola Plains, Brigalow, BRI (st.); Henry s.n., 1889, Georgina River, MEL1003683 (fl.,fr.); Holland & Gnauck 1267, 7.vi.1952, 'Barrington' west of Bollon, CANB (fr.); Jackson 424. 13.viii.1962, Nappa Merrie Station, AD (fl.,fr.); Johnson & Pedley s.n., 15.x.1954, Cluden, south east of Taroom, BRI080020 (fl.); Maiden s.n., -.iii.1909, Dulacca, NSW103124 (fl.); Pollock s.n., 5.xii.1938, Willowvale Road, Warwick, BRI080175 (st.); Tosh s.n., 14.v.1935, Brigalow, BRI080026 (st.); Tosh s.n., -.xi.1940, Brigalow, BRI080035 (fr.); Wedd s.n., -.ii.1894, St. George, BRI079982 (fr.); White s.n., -.xii.1912, Greenmount, BRI080012, 080013 (fr.); White s.n., -.v.1916, Wallumbilla, BRI080015 (fr.); White 3447, 3.iii.1927, Clermont, BRI (fr.); White 9599, 25.x.1933, Roma, BRI (fl.,fr.); Winterton s.n., 30.xi.1954, Rosewood, BRI080038, CANB30338 (fr.);

<u>Northern Territory</u>: Beauglehole 27945, 29.vii.1968, 10.7 m N.N.W. of Old Andado Homestead, BEAUGLEHOLE (st.); Cleland 60, -.viii.1931, Cockatoo Creek, NSW (fr.); Giles s.n., -.v.1875, near Alice Springs, MEL38989 (fl.,fr.); Ising s.n., 24.viii.1931, Horse Shoe Bend, AD96803129 (fl.,fr.); Latz 146, 11.ii.1968, Beenleigh Bore, Manners Creek Station, AD (fl.,fr.); Latz 308, 11.xii.1968, Kings Canyon, AD (fl.,fr.); Latz 967, 5.xi.1970, 7m. E. Docker River Settlement, AD (fl.,fr.); Lazarides 5176, 5.v.1955, 9.5 miles N.N.W. of Alice Strings Township, CANB, NT (fl.,fr.); Lazarides 5261, 12.v.1955, 12 miles W.S.W. of Argadargarda Station, BRI, CANB (fr.); Mitchell 624, 1846, Victoria R., CGE (fl.,fr.) - holotype of *H. aspera;* Nelson 1340, 13.viii.1964, 0.7m. S.W. Atherrita bore, Todd River Stn., NSW, NT (st.); Nelson 1771, 1772, 18.x.1968, C.S.I.R.O. Nursery, 7m. S.S.E. Alice Springs, AD (fl.,fr.); Nelson 1794, 3.xii.1968, 9m. S.W. of Alice Springs, AD (fr.); Nelson 1849, 13.iii.1969, Harry Creek,

32½ m. N. Alice Springs, AD (fl.); Orchard 757, 13.vii.1968, Old Andado, AD (fr.); Orchard 784, 14.vii.1968, New Crown Station, AD (st.).

South Australia: Alcock 865, 23.xii.1965, Tumby Bay, AD (fl.,fr.); Alcock 3143, 12.xi.1969, Big Heath National Park, AD (fl.); Andrewartha s.n., 25.ii.1937, Yarilla, ADW1756 p.p. (st.); Andrewartha s.n., -.v.1938, Purple Downs Stn., ADW8304 (fr.); Aston s.n., -.viii.-.ix.1961, Christmas Water, ca 32 km north of Lake Eyre North, AD96218086 (fl.); Barker 275, 2.iii.1968, banks of Siccus River between Curnamona and Erudina, AD (fr.); Beauglehole 20864, 17.x.1966, 95m S. of Oodnadatta, BEAUGLEHOLE (fl.); Beauglehole & Kraehenbuehl 17030, 8.viii.1964, midway between Bordertown and Victorian-S.A. border, BEAUGLEHOLE (fl.); Black 4, 2.x.1916, Woolshed Flat, NSW (fl.); Brummitt s.n., 10.xi.1892, World's End, AD96211025 (fl.,fr.); Carrick 1855, 16.viii.1968, Murnpeowie, AD (st.); Carrick 1872, 1880, 17.viii.1968, 55 m. South of Innamincka, AD (fl.); Carrick 1897, 17.viii.1968, Coopers Creek, Innamincka crossing, AD (fl.,fr.); Cleland s.n., 10.xi.1892, World's End, AD96803288 (fr.); Cleland s.n., 7.i.1927, Hamilton (Creek) Bore, AD966032579 (fl.,fr.); Cleland s.n., 13-14.viii.1934, south of Goyders Lagoon, AD96803287 (fl.); Cleland s.n., 22.viii.1934, Karathapana Waterhole on Birdsville Track, AD96803278 (fl.,fr.); Cleland s.n., 4.ii.1937, Murray Bridge, AD96803303 (fl.,fr.); Cleland s.n., 27.v.1937, Malkia Springs, AD96808387 (fr.); Cleland s.n., 5.ix.1941, Nepabunna ca 50 km east of Copley, AD96808403 (fl.); Cleland s.n., 16.xii.1941, Tod River, AD96803301 (fr.); Cleland s.n., 12.xi.1942, Kingston, AD968020582 (fl.,fr.); Cleland s.n., 24.ix.1945, Rocky Hill, Ernabella, AD966032580a (fl.,fr.); Cleland s.n., 28.ix.1945, between Everard and Musgrave Ranges, AD96803292 (fl.,fr.); Cleland s.n., 1.x.1945, Ooodnadatta, AD966032580b (fl.,fr.); Cleland s.n., 8.v.1946, Swan Reach, AD96803295 (fl.,fr.); Cleland s.n., 8.v.1946, Manurka, AD96803141 (fr.); Cleland s.n., 25.i.1947, near Finnis Railway Station, AD96803071 (fr. - terat.); Cleland s.n., 14.xii.1949, near Glenelg, AD968020580 (fl.); Cleland s.n., 28.i.1950, Snake Lagoon, Flinders Chase, AD96803290 (fr.); Cleland s.n., 13.iv.1950, Mt. Illbillie Everard Range, AD96803257 (fl.,fr.); Cleland s.n., 20.iv.1950, Upsan Downs, AD96803331 (fr.); Cleland s.n., 28.xi.1950, Gerard near Berri, AD96803302 (fr.); Cleland s.n., 15.xii.1952, Young St., Goodwood, AD96808400 (fl.,fr.); Cleland s.n., 1.iii.1953, Goodwood, AD96808355 (fl.); Cleland s.n., 19.v.1953, Goodwood, AD96803296 (fr.); Cleland s.n., 26.xi.1954, Snake Lagoon, Flinders Chase, AD96803293 (fl.); Cleland s.n., 21.iv.1955, Kingston Punt, AD96803349 (fr.); Cleland s.n., 17.ix.1956, Cowarie, AD96803297 (fr.); Cleland s.n., 24.ix.1956, Bunyeroo, AD96803300 (fl.); Cooper s.n., 3.x.1950, Wilpena Creek, Martin's Well, AD96803121 (fl.); Copley 137, 14.iii.1966, Section 167, Hd. of Wiltunga, AD (fl.,fr.); Copley 829, 28.x.1966, ca 1 km north of Bute, AD (fl.,fr.); Copley 965, 19.xii.1966, Snowtown, AD (fr.); Copley 1072, 19.i.1967, ca 3 km from Alford on Bute road, AD (fl.,fr.); Copley 2224, 4.ix.1968, ca 65 km north of Leigh Creek, AD (fl.); Copley 2245, 5.ix.1968, below Yourambulla Caves, AD (fl.); Copley 2414, 4.xii.1968, 8 miles south of Bute, AD (fr.); Copley 2429, 23.xii.1968, ca 1½ km east of Kadina, AD (fr.); Copley 2482, 5.ii.1968, Sec. 285, Hd. Koolunga, AD (fl.,fr.); Copley & Rowe 2535, 5.iii.1969, Redhill, AD (fl.,fr.); Crocker s.n., 7.vi.1939, flood plain of Hale River, AD96810013 (fr.); Crocker 2, 23.vii.1939, Warburton River, AD (fl.,fr.); Dodson s.n., 13.ix.1967, north-east of Mulka Homestead, AD96820161 (fl.); Eichler 12732, 18.ix.1956, Arcoona Creek Valley, AD (fl.,fr.); Eichler 13794, 20.iv.1957, ca 6.5 km west of Berri, AD (fr.); Ellis 70, 27.i.1964, Marleston, AD (fl.,fr.); Filson 3418, 3.x.1960, Coopers Creek, Innamincka, AD (fr.); Giles s.n., 1882, near Mt. Everard, MEL39005, (fl.,fr.); Gill 241, 19.xi.1891, north of Hergott, MEL (fr.); Greenfield s.n., -.v.1935, Purple Downs Station, ADW1756 p.p. (fr.); Hill 1202, 22.x.1963, Siccus River Crossing, AD (fr.); Hill 7139, 19.iv.1946, Maitland, ADW (fr.); Hilton 1363, 9.iv.1955, Lyndhurst Stn., ADW (fl.); Howitt s.n., 1861, Coopers Creek, MEL39027 (st.); Hunt 378, 11.xi.1961, ca 10 km west of Naracoorte, AD (fl.); Hunt 528, 9.xii.1961, ca 10 km south of Naracoorte, AD (fl.,fr.); Hunt 583, 20.xii.1961, near Struan Creek, AD (fr.); Hunt 1471, 23.xii.1962, Hd. of Killanoola, AD (fl.,fr.); Hunt 1549, 7.iv.1963, ca 10 km W. of Naracoorte, AD (fr.); Hunt 1742, between Keith and Padthaway, AD (fl., fr.); Ising s.n., 7.ix.1931, Oodnadatta, AD96803144 (fl.); Ising s.n., -.viii.1932, Hamilton River, Pedirka, AD96803143 (fr.); Ising s.n., 27.x.1934, Lucindale AD96830362 (fl.); Ising s.n., 12.xii.1934, Wolseley, AD96830363 (fr.); Ising s.n., -.xi.1950, Macumba Stn., AD (fl.,fr.); Ising s.n., 24.ix.1955, Evelyn Downs, Oodnadatta, AD96634053 (fl.); Ising 476, 1.x.1918, Oratunga, Moolooloo, AD (fl.,fr.); Kain 539, -.iii.1962, Owen, ADW (fr.); Kempe 334, 1880, Fincke River, MEL (fl.); Kemp 443, 1882, Fincke River, MEL (fl.,fr.); Koch 295, -.iii.1898 to -.x.1899, Mt. Lyndhurst, AD, BRI, NSW (fr.) - isosyntypes of *H. heterophylla* var. *glaucifolia;* Kraehenbuehl 1800, 23.x.1966, Freeling Cemetery, AD (fl.); Kuchel 2510, 17.viii.1968, ca 165 km north-east of Murnpeowie Station, AD (fl.); Lord s.n., 24.iv.1950, Alberga Creek near Todmorden, MEL39041 (fr.); Lothian 1104, 3.x.1962, Parachilna Gorge, AD (fr.); Lothian 2490, 27.ix.1963, Nepabunna Mission, AD (fl.); Lothian 2525, 27.ix.1963, Italowie Gorge, AD (fl.,fr.); Lothian 3058, 7.xi.1964, Pitchi Ritchi Pass, AD (fr.); Lothian 3198, 11.xi.1964, ca 11 km east of Angepena Homestead, AD (fl.); Lothian & Francis 473, 27.viii.1960, 1 mile south of Qld/S.A. border fence, AD (fl.,fr.); Millard s.n., Warburton River, AD96810058, (fl.,fr.); Mills s.n., 18.xii.1913, Woolshed Flat, NSW103154 (fr.); Mueller s.n., Gawler River, MEL39008 (fl.,fr.); Mueller s.n., -.x.1851, Cudnaka, MEL 39018 (fr.); Murray s.n., 2.iv.1930, Pernatty Station, AD96817164 (st.); Orchard 308-319, 14.iv.1968, bed of river Siccus on Curnamona-Artipena Springs road, AD (fr.); Orchard 321, 14.iv.1968, Artipena Springs, AD (fr.); Orchard 345, 15.iv.1968, Artipena Springs, AD (fr.); Orchard 608, 609, 610, 27.vi.1968, ca 32 km north of Myrtle Springs H.S., AD (fr.) Orchard 615, 28.vi.1968, bed of Leigh Creek, AD (st.); Orchard 616, 617, 619, 28.vi.1968, ca 32 km west of Marree, AD (fr.); Orchard 1842, 1843, 29.xi.1968, bed of Siccus River, AD (fr.); Orchard 2587, 11.x.1970, ca 10 km south-east of Curramulka, AD (fl.); Orchard 3047, 1.i.1971, ca 16 km west-north-west of Port Lincoln, AD (fr.); Reid s.n., 11.vi.1963, Pandie Pandie Stn., ADW26433 (fr.); Reid s.n., 15.x.1963, Innamincka Stn., ADW26431 (fl.); Richards s.n., 1889, Mt. Ogilvie, MEL38938 (fr.); Rohrlach 74, 31.i.1959, ca 25 km south of Kimba, AD (fr.); Spooner 396, 22.iii.1969, Gascoyne Ave., Hillcrest, AD (fl.,fr.); Symon s.n., 13.xi.1958, Winulta Post Office Corner, ADW20386 (fl.,fr.); Symon s.n., 1.v.1962, Renmark, ADW25269 (fr.); Symon 3283, 13.ii.1965, Everglades

Bore, ADW (fl.,fr.); Tate s.n., 5.iii.1883, Mannum, AD96810026 (fr.); Tate s.n., 7.v.1894, ca 50 km north of Oodnadatta, AD96810056 (fl.,fr.); Tepper s.n., -.xi.1879, Muloowortie near Ardrossan, AD968061232 (fl.); Tepper s.n., 25.x.1887, Freeling, AD96811111 (fl.,fr.); Tepper s.n., 4.ii.1888, Mt.Pleasant, AD96811102 (fr.); Tepper 602, 1879, Yorke Peninsula, MEL (fl.); Tepper 809, 1888, Yorke Peninsula, MEL (fr.); Tepper 1124, 12.xi.1882, Reynella Cr., Morphettvale, MEL (fl.,fr.); Tough s.n., 16.ii.1938, Northfield, AD966021157 (fr.); van Dam 9, 15.vi.1969, ca 70 km south of Kingoonya, AD (fr.); Walter s.n., Tattiara country, MEL39118 (fl.); Warren 12, 2.ix.-,Finniss Springs, AD (fr.); Weber 735, 24.x.1968, Mernmerna, AD (st.); Whibley 2347, 16.viii.1968, ca 150 km north-east of Murnpeowie, AD (fl.); Whibley 2351, 17.viii.1968, ca 5 km north of Tinga-Tingana, AD (fl.); Whibley 2478, 19.viii.1968, ca 15 km north-east of Innamincka, AD (fr.); Whibley 2522, 23.viii.1968, ca 20 km south of Moolawatana, AD (fl.); Wigg s.n., 16.i.1958, Todmorden homestead, ADW19232 (fl.,fr.); Wollaston s.n., 14.x.1968, Wilpena Creek, AD96848050 (fr.);

Notes.

1. The choice of a lectotype for *H. heterophylla* var. *capreolicornis* was necessary because Schindler cited a number of collections after his description. Of these collections, only the Stuart sheet in LE and the Lhotsky sheet in G bore determinavit slips in Schindler's handwriting. The former was preferred as it contained both flowers and fruits and because duplicates exist in HBG, MEL and W.

2. The name *H. heterophylla* var. *glaucifolia* similarly required lectotypification. However, no collections cited and annotated by Schindler could be located. A Betche collection in NSW bearing the number 15 (= "Sidney Herb. 15" ?), Koch collections with the number 295 (in AD, BRI and NSW) and a Walter collection in NSW with the number 8 (= "Sidney Herb. 8" ?) agree with each other and with the description, and can probably be regarded as isosyntypes.

3. The name *H. heterophylla* var. *rigida* required lectotypification because Schindler based the name on at least two different Mueller collections. The LE collection from Ovens River was chosen as lectotype

because its stated locality most closely matches the one cited by Schindler, and because a duplicate exists in NSW.

4. The occurrence of functionally female flowers, in which the anthers are rudimentary, up to 1 mm long and indehiscent, is quite common. The flowers are irregularly distributed among normal bisexual flowers with anthers at least 2 mm long. Both types of flowers set normal fruits. On the other hand, a Maiden collection (NSW103124) appears to be functionally male, with apparently normal flowers but abortive fruits.

5. *H. aspera* is one of the most widely distributed species of the genus in Australia. As such, it acts as the nucleus for a number of satellite species, viz. *H. heterophylla, H. glauca* and *H. uncatipila*. Introgression between the satellite species is unknown but intermediates between *H. aspera* and each of the others occur to various extents.

a. Intergrade material between *H. aspera* and *H. heterophylla*.

These plants often resemble *H. heterophylla* but have broader leaf segments, with pinnatifid instead of digitate arrangement, and (sometimes) larger fruits. Examples are known from coastal New South Wales(Fawcett MEL39139, Woolls MEL39081,39087; Wilkes US - "H. pinnatifida"), Victoria and south-eastern South Australia (Beauglehole & Kraehenbuehl 17030; Hunt 583).

b. Intergrade material between *H. aspera* and *H. glauca*.

These plants can resemble either parent species, having either the ± entire glaucous leaves of *H. glauca* or the toothed, greener leaves of *H. aspera*, but in either case, beset with stiff, curved (not hooked) hairs up to 0.3-0.5 mm long. Collections of these plants are particularly frequent from the River Darling and its northern and eastern tributaries in central New South Wales and southern Queensland, as well as the

Lachlan and Murrumbidgee Rivers, and to a lesser extent, the River Murray. Examples include Betche NSW99204; Boorman NSW99198, 99199; Forde 10,13; Barton 265, 267; Beckler 53; Tosh BRI080026, 080035.

c. Intergrade material between *H. aspera* and *H. uncatipila*.

These plants have leaf shape and indumentum density intermediate between the parent species. The fruit shape and exocarp texture may also be intermediate. Examples are Symon 2683, Beauglehole 10171, 25336, Latz 283.

See *H. uncatipila* note 1.

14. *Haloragis uncatipila* Orchard, sp. nov.

Suffrutex perennis rotundatus 40-80 cm altus, scabrosus pilis patulis teneris simplicibus 2-3-cellularis pellucidis apice uncatis 0.1-0.5 longis dimidio longitudinum ipsorum distantibus. Folia alterna late lanceolata vel anguste ovata 10-20 dentata deltoidea (dentes 1-3 mm longi) sessilia (2.5-)4.0-5.0 cm longa 0.6-1.5 cm lata, scabra. Flores 4-merous, in spicis dichasiorum sessilium (1-)3-5-florum. Fructus virides vel rubri vel brunnei globosi laeves vel rugulosi sessiles vel in pedicellis 1-2 mm longis scabri 3.5-4.5 mm longi 4.0-4.5(-5.0) mm lati; sepala persistentes erecta vel reflexa deltata 1.2-1.7 mm longa 1.2-1.7 mm lata; endocarpus lignosus exocarpus sufflatus fungosus; septa lignosa loculi quattuor semina 1-4. Holotypus: A.E. Orchard 900, 19.vii.1968, Northern Territory. Barkly Tableland. Stuart Highway, 14 miles (ca 24 km) north of Tennant Creek. Isolated plants 12" high growing in open disturbed areas in low lying, somewhat swampy red sandy loam, AD97124268 (fl.,fr.)! Isotypi: Still to be distributed.

Perennial subshrub 40-80 cm tall, not clonal, forming a round bush, stems arcuate ascending, not ribbed, green to reddish; major stems ± prostrate, woody, perennial, branched; minor stems erect, herbaceous, annual, unbranched; all stems densely scabrous with fine 2-3-celled simple transparent hairs hooked at the tip.

Leaves alternate, relatively thin, sessile, broad-lanceolate to narrow-ovate, (2.5-)4.0-5.0 cm long, 0.6-1.5 cm wide, tapering evenly and equally to each end, dentate with 10-20 deltoid, evenly distributed teeth 1-3 mm long, margin slightly revolute, midrib slightly channelled above, prominent below, lateral veins indistinct, scabrous on both surfaces with hairs as for stems.

Inflorescence an indeterminate spike of (1-)3-5-flowered dichasia in the axils of primary bracts. Lateral inflorescences sometimes borne in the axils of the upper leaves. Primary bracts leaflike, broad-lanceolate 1.5-2.5 cm long, 0.5-0.8 cm wide, green, fleshy, serrate, midribbed, sessile, diminishing towards spike apex, scabrous with hairs as for stem; secondary bracts linear-lanceolate, (1.5-)2.0-2.5 mm long, 0.2-0.4 mm wide, green, ± fleshy or membranous, entire, midribbed, scabrous on margins; tertiary bracts membranous, linear, 0.7-1.0 mm long, 0.1-0.2 mm wide, scabrous on margins.

Flowers tetramerous, ± sessile or very shortly pedicellate. Sepals 4, deltoid to subcordate, 1.2-1.4 mm long 1.0-1.2 mm wide, green, lacking midrib, scabrous. Petals 4, yellow to green, hooded, tip horizontal or erect, not very shortly unguiculate, 2.8-3.3 mm long, 0.7-0.8 mm wide (keel to margin), scabrous-pilose on keel. Stamens 8, filaments 0.2 mm long; anthers yellow to reddish, oblong, (2.3-)2.6-3.0 mm long, 0.5 mm wide, 4-locular, nonapiculate, antisepalous anthers ca 0.4 mm shorter than antipetalous ones. Styles 4, green-reddish, clavate, 0.4-0.5 mm long, stigmas capitate, fimbriate. Ovary ovoid, 1.2-1.4 mm long, 1.2-1.5 mm wide lacking ribs, scabrous-pilose, 4-locular with 1 pendulous ovule per locule.

Fruits 1-2(-3) per axil, green, red or brown, slightly depressed globose 3.5-4.5 mm long, 4.0-4.5(-5.5) mm wide, smooth or rugulose, ± sessile or on pedicel 1-2 mm long, scabrous with hairs as for stems; sepals persistent, erect or reflexed, deltoid, 1.2-1.7 mm long, 1.2-1.7 mm wide; endocarp and septa woody, exocarp swollen, spongy; 4 locules, 1-4 seeds. (Fig. 24; Plate 15)

Distribution. (Map 8)

This species is confined to central Australia. Records of its occurrence include the Everard and Musgrave Ranges of north-western South Australia, the Warburton and Blackstone Ranges of mid-eastern Western Australia, and most of southern and central Northern Territory.

Ecology.

H. uncatipila grows on a wide range of soils, avoiding only heavy clays. It is found in both mountain ranges, where creek beds are the preferred habitat, and on the plains, where it mainly occurs in naturally or artificially disturbed areas such as creek floodouts and roadsides. It is usually found in spinifex (*Triodia*) - mulga (*Acacia aneura*) associations, particularly on the plains, and usually exists as ± isolated round bushes in open situations in this community. Collectors' notes include "in red sand with spinifex and scattered shrubs" (George 8731), "rare on red, skeletal sand with Eucalyptus brevifolia and Triodia pungens" (Lazarides 5875) and "on bank of creek at bottom of gorge in black loam amongst decaying litter. Ground stony" (Orchard 800). Flowering and fruiting has been recorded at most times of the year, probably being dependent on the incidence of significant rainfall, but is concentrated in the period March to August.

Specimens examined.

South Australia: Beauglehole 10171, 24.vi.1965, Everard Park, Illbillie Well area, BEAUGLEHOLE (st.); Beauglehole 25336, 27.vi.1968, E.S.E. of Mt. Illbillie, BEAUGLEHOLE (fr.); Cleland s.n., 10.viii.1933, rockhole 10 miles north of Ernabella, AD96803308 (st.); Cleland s.n., 16.iv.1950, Ernabella, AD96803330 (fr.); McDonald s.n., 10.ix.1968, western Everard Ranges, AD96848049 (fr.); Symon s.n., 11.viii.1962, Mt.Woodroffe, AD96424155, ADW26430 (fr.); Symon 3341, -.ii.1965, between Betty & Ronald' Well, Everard Park Stn., ADW (fl.,fr.).

Western Australia: Chippendale s.n., 26.iii.1958, White Range, 5m N.W.

Arltunga Mission, CANB74498, NSW99171, NT4105 (fr.); Cleland s.n., 26.vi.1958, Blackstone Range, PERTH (fr.); Forrest 78, 1874, Forrest Expedition, MEL (fl.); George 8731, 16.vii.1967, 4 miles E. of Winburn Rocks, E. of Warburton Mission, AD, PERTH (fr.); Symon 6986, 21.v.1971, near Landringan Cliffs, AD, ADW (fl.,fr.).

Northern Territory: Beauglehole 10491, 9.vii.1965, Red Bank Gorge, BEAUGLEHOLE (st.); Beauglehole 20347, 9.x.1966, Kings Canyon, BEAUGLEHOLE (fl.); Beauglehole 24181, 24.vii.1967, Ormiston Gorge, BEAUGLEHOLE (fr.); Beauglehole 26087, 8.vii.1968, Kings Canyon, Lower Gorge, BEAUGLEHOLE (fr.); Carolin 7921, 23.viii.1970, 21 miles North of Rabbit Flat on Tanami Road, AD (fl.,fr.); Chippendale s.n., 31.v.1955, 15 miles S.E. Newland Bore, Elkedra NT1194, (fl.,fr.); Chippendale s.n., 26.vi.1955, 11 m. S. Barrow Creek, BRI022084, CANB70132, MEL39047, NSW99173, NT5328 (fl.,fr.); Chippendale s.n., 14.vii.1956, 41m. S. Hookers Creek, AD96008107, CANB55769, MEL39044, NT2327 (fr.); Chippendale s.n., 24.viii.1956, 40.9 m W. Hermannsburg, CANB74497, MEL39046, NSW103117, NT2633 (fr.); Chippendale s.n., 23.x.1956, 3m. W. Anitowa H.S.,AD96534104, BRI080007, NSW99205, NT3147 (fr.); Chippendale s.n., 21.vi.1960, 36 m. W. Soudan, AD97049245 (fl.,fr.); Cleland s.n., 28.viii.1950, Gosse Range, AD966042133 (fr.); Gardner 11738 22.iii.1953, Standley Chasm, MEL, NT, PERTH (fl.,fr.); Ising s.n., 25.vii.1936, McDonald Downs Station, AD96803157 (fr.); Kempe 11, -.iii.1885, James Range, MEL (fl.,fr.); Lazarides 5875, 29.viii.1956, 30 miles E. of Bonney Well, CANB92578 (fl.,fr.); Latz 283, 11.xii.1968, Kings Canyon, AD97008218 (fr. terat.); Latz 754, 4.viii.1970, 13m. S. Mongrel Downs Homestead, AD971030069 (fl.,fr.); Must 235, 237, 19.vii.1968, 14m. N. Tennant Creek, Stuart Highway, NT, PERTH (fl.,fr.); Orchard 800, 16.vii.1968, Standley Chasm, AD (fr.); Orchard 900, 19.vii.1968, Stuart Highway, 14 miles north of Tennant Creek, AD (fl.,fr.) - holotype of *H. uncatipila;* Orchard 901, l.c., AD (fr.); Orchard 927, 928, 21.vii.1968, Stuart Highway, 181 miles north of Alice Springs, AD (fr.); Orchard 930, 21.vii.1968, Stuart Highway, 168 miles north of Alice Springs, AD (fr.); Perry 2346, 4.vii.1949, 19 miles N.N.E. of Inverway Station, BRI, CANB, MEL, NT, PERTH (fr.); Perry 3512, 22.iii.1953, Standley's Chasm, BRI, CANB, NT, PERTH (fr.); Symon 6907, 17.v.1971, 26 m. S.E. of Tanami, AD, ADW (fr.); Symon 6914, 17.v.1971, 33 m. N.E. of Tanami, AD, ADW (fl.,fr.); Symon 6933, 17.v.1971, 29 m. N.E. of Wilson Creek Bore, AD, ADW (fl.,fr.); Tate s.n., Haast's Bluff, AD96810009 (st.); Tate s.n., Henbury, AD96810057 (fl.,fr.); Tate s.n., 1894, slopes of Mt. Sonder, AD96810041 (fl.,fr.); Tate s.n., 8.v.1894, McDonald Ranges, AD96810024 (fr.); Tietkins s.n., 1889, Mt.Sonder, MEL1003688, 1003689 (fr.);
van Dam 95, 23.vi.1969, ca 170 km west of Wave Hill, AD (fl.,fr.).

Notes.

1. Some collections from the Musgrave and Everard Ranges (e.g. Symon 2683, Beauglehole 10171, 25336) and from Kings Canyon, George Gill Range (e.g. Latz 283) are intermediate in some leaf and fruit characters

between *H. uncatipila* and the (generally) more southerly *H. aspera*, suggesting some introgression between these species (see *H. aspera*, Note 6c.).

2. Specimens from the McDonnell Range (e.g. Orchard 800, Tate AD96810024) tend to be more densely pilose than specimens from the plains to the north, and have the sepals reflexed in the fruit instead of erect. However, collections are still insufficient to recognize these forms as distinct taxa.

3. As in some other species, *H. uncatipila* has some flowers functionally female by abortion of the stamens. The female flowers appear to be randomly distributed in the inflorescence.

15. *Haloragis glauca* Lindley in Mitchell, J. Trop. Aust. (1848)91 [Typus: not cited, near R. Narran. Holotypus: Lieut-Col. Sir T.L. Mitchell 31, 1846, Sub-Tropical New Holland, CGE (fl.,fr.)!]; Benth., Fl. Aust. 2(1864)479; F.v.M., Census 1(1882)49; Petersen, Pflfam. III. 7(1893)232; Schindler, Pflrch. 23(1905)44, 45; Schindler, Feddes Repert. 9(1911)123; Maiden & Betche, Census N.S.Wales Pl. (1916)158; Ewart, Fl. Vict. (1931)884, fig. 308.

Haloragis tetragyna var. *glabrescens* Bailey, Qld. Dept. Agric. Bull. 13(1896)9 [Typus: "Hab. Darr River, C.W. deBurgh Birch. Diamantina, Dr. Thos. L. Bancroft. Georgina, F.M.B." n.v. Neotypus (Orchard): White s.n., -.iv.1919, Landsborough River BRI011135 (fr.)!]; Bailey, Qld. Fl. 2(1900)556; Bailey, Comp. Cat. Qld. Pl. (1913)174.

Haloragis glabrescens (Bailey) C.T. White, Proc. roy. Soc. Qld. 53(1942) 201-228 [based on *Haloragis tetragyna* var. *glabrescens* Bailey].

Perennial herb, 30-50 cm tall, rootstock perennial, perennating by a deep stoloniferous system, stems erect or procumbent, annual, herbaceous, sometimes rooting from lowermost nodes, smooth or weakly 4-ribbed, green to reddish, sparsely branched except at base, glaucous, glabrous or scabrous with curved, semiappressed, 1-2-celled hairs 0.1-0.2 mm long.

Leaves alternate or subopposite, narrow lanceolate to oblanceolate, (2.0-)3.5-4.5(-5.0) cm long, (0.2-)0.3-0.8(-1.1) cm wide, ± sessile or very shortly petiolate, blunt at apex, tapering gradually to base, ± entire or very finely serrulate with up to 12 teeth 0.5-1.0 mm long, midrib slightly channelled above, prominent below, lateral veins obscure, departing at 20°-35° to midrib, glaucous, scabrous on margins with very short curved, appressed, unicellular hairs up to 0.1 mm long, glabrous on both faces or scabrous on upper surface only.

Inflorescence an indeterminate spike of 1-3 flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences sometimes occur in the axils of the upper leaves. Primary bracts leaflike, green-glaucous, linear to lanceolate; secondary (and tertiary) bracts membranous, brown, linear.

Flowers 4-merous, on pedicel 0.5-0.6 mm long. Sepals 4, linear-lanceolate, 1.0-1.2 mm long, 0.5-0.6 mm wide, lacking midrib, glabrous or scabrous on margins and outer face. Petals 4, green to yellow, hooded, tip erect, very shortly unguiculate, keeled, 1.8-2.6(-3.0) mm long, 0.5-0.7(-0.8) mm wide (keel to margin), scabrous on keel with hairs as for leaves. Stamens 8, filaments 0.1-0.2 mm long; anthers yellow, oblong, 1.8-2.0(-2.5) mm long, 0.2-0.3(-0.4) mm wide, nonapiculate, 4-celled, antipetalous anthers 0.1-0.2 mm shorter than antisepalous ones. Styles 4, clavate, 0.2-0.4 mm long, stigmas capitate. Ovary globular to hemispherical, 0.4-0.6(-0.8) mm long, 0.5-0.8 mm wide, ± verrucose to extremely rugose, glabrous or scabrous, 4-locular with 1 pendulous ovule per locule.

Fruit 1-2(-3) per axil, globular to pyriform, slightly verrucose or covered in lobed appendages up to 1.5 mm long; 4-locular, 1-4 seeded.

Haloragis glauca exists as two distinct forms, which may grow together (e.g. Perry 68, White BRI080000 & 011135), but can be distinguished as follows:

1. Fruit globular to pyriform, ± 4-8-ribbed in upper part, verrucose in lower part; usually ± glabrous plants. α. f. *glauca*

1. Fruit globular or ovoid, covered with long spreading multilobed and/or simple ± woody processes up to 1.5 mm long; usually more scabrous plants. β. f. *sclopetifera*

α. f. *glauca*

Perennial herb; habit, stems as for species; leaves oblanceolate, (2.0-)3.5-4.5 cm long, 0.6-0.8(-1.1) cm wide, ± entire or very finely serrulate, somewhat rounded at apex, tapering gradually to base, petiole up to 5 mm long or absent, glaucous, glabrous on both faces, scabrous on margins. Primary bracts lanceolate, 3.0-6.0 mm long, 0.5-0.8 mm wide, entire, glabrous except for margins; secondary bracts 0.5-0.7 mm long, 0.1-0.2 mm wide, entire, glabrous; tertiary bracts 0.1-0.2 mm long.

Fruit on pedicel 0.7-1.0 mm long, globular to pyriform, 2.0-2.5 mm long, 1.8-2.8 mm diam., ± 4-8-ribbed in upper part, verrucose in lower part, glabrous or rarely scabrous; sepals persistent, erect, linear, 1.1-1.2 mm long, 0.4-0.5 mm wide; 4-locules, pericarp and septa ± woody, 1-4 seeds.

Distribution. (Map 8)

This forma has a disjunct distribution, with one centre in the Barkly Tableland of north-eastern Northern Territory and north-western Queensland, and the other in central and northern New South Wales.

Ecology.

Most collectors record this forma as growing in heavy black or grey clay soils, often in or associated with seasonal creeks. Notes include "in black soil at edge of dried waterhole in small creek" (Latz 574); "occasional in depression in heavy soil; grassland" (Perry 1548) and "common as clumps in irrigation channel" (McBarron 11323). Flowering plants have been collected from (January-)February until July(-October) and fruiting plants from October until June(-July).

Specimens examined.

New South Wales: Beadle s.n., Darling R., Bourke, SYD (fr.); Beadle s.n., -.v.1940, Franklin, SYD (fl.,fr.); Beadle s.n., -.ii.1941, Co. Franklin, SYD (fl.,fr.); Boorman s.n., -.xi.1903, Brewarrina, MEL38974, NSW113162 ("13") (fr.); Boorman s.n., -.vi.1907, Burren Junction, NSW99055 (fr.); Boorman s.n., -.x.1912, Arrara-Lake Eliza, NSW99051 (fr.); Charley s.n., 21.v.1962, Fowlers Gap, NE014659 (fr.); Coasley s.n., 18.xi.1946, Griffith, NSW99058 (fl.); Constable 4643, 27.x.1963, Buckanbee homestead, 10 miles east of Tilpa, NSW71134 (fr.); Forde 11, Darling River, MEL38964 p.p. (fl.); Green s.n., -.ii.1951, Gunnedah, NSW99050 (fl.); Mackay s.n., 1890, Clover Creek, Bourke, MEL1003666 (fr.); Mackay 115, 1890, Clover Creek near Bourke, MEL (fr.); Manager, Trigg & Co. Station s.n., -.i.1927, Fort Burke, NSW99022 (fr.); McBarron 11323, 14.x.1965, 4 miles N. of Bourke, NSW (fl.); Swain s.n., -.iii.1965, Yanco-Narrandera area, NSW99049 (fl.,fr.); Whaite 1745, 8.i.1955, 21 miles S. of Jerilderie, NSW33567 (fl.,fr.); Wurfel s.n., -.iii.1885, Bourke, MEL38967 (fl.,fr.).

Queensland: Mitchell 31, 1846, subtropical New Holland, CGE (fl.,fr.) - holotype of *H. glauca*; Pedley 2034, 29.v.1966, near Georgina River ca 25 miles SSW of Camooweal, BRI (fr.); White s.n., -.iv.1919, Landsborough River, BRI011135 (fr.) - neotype of *H. tetragyna* var. *glabrescens*.

Northern Territory: Latz 574, 22.iv.1970, Boree Ck., Brunette Downs, AD (fl.,fr.); Perry 68 p.p., 25.vi.1947, 37.3 mls Anthony's Lagoon-Adder W.H.-Eva Downs, CANB (fr.); Perry 1548, 18.vi.1948, 15 miles W.N.W. of Rankine River Police Station, BRI, CANB, NSW, NT, PERTH (fl.,fr.); Perry 1614, 10.vii.1948, 15 miles N.N.W. of Creswell Station, BRI, CANB, NT, PERTH (fl.,fr.).

Notes.

1. The collection of White (BRI011135) is annotated "type of H. glabrescens". As this species was based on *H. tetragyna* var. *glabrescens* Bailey it must have the same type, so White's specimen has no formal type status. However, as none of the specimens cited for *H. tetragyna* var. *glabrescens* have been located in the present study,

the White collection may give some indication of the correct application of this name. It certainly gives an indication of White's concept of *H. glabrescens*, as another collection (BRI080000) with the same collector and locality, belongs to *H. glauca* f. *sclopetifera* and is not annotated as type material. As it appears that the type of *H. tetragyna* var. *glabrescens* may be lost, the White collection mentioned above is chosen as neotype.

2. A number of collections from New South Wales (e.g. Boorman s.n., Burren Junction, & Arrara-Lake Eliza; Coasley s.n.; Borde 11; Manager Trigg & Co. Station s.n.; and Wurfel s.n.) are more scabrous and have more prominently toothed leaves than is normal for the species, suggesting introgression with the sympatric *H. aspera*, q.v.

β. f. *sclopetifera*(F.v.M.)Orchard, comb. et stat. nov.

Haloragis sclopetifera F.v.Mueller, Trans. roy. Soc. Vict. 24(1888)136 [Typus: "Norman River and Spear Creek (Th. Gulliver), and from Aramac Creek (Dr. Poulton)." Lectotypus (Orchard: Dr. Poulton s.n., Aramac Creek, MEL39077 (fl.,fr.); Syntypus: T.A. Gulliver 1076, Spear Creek, MEL39079 (fr.)!]

Perennial herb; habit, stems as for species; leaves narrow-lanceolate, 2.0-3.5(-5.0) cm long, (0.2-)0.3-0.6 cm wide, ± entire or serrate with up to 10 small teeth, rounded at apex, tapering gradually to base, ± sessile, glaucous, lightly scabrous (rarely glabrous) on upper surface, glabrous below, densely scabrous on margins. Primary bracts linear, 6.0-8.0 mm long, 0.7-1.0 mm wide, entire, scabrous;

secondary bracts linear, 0.7 mm long, 0.1-0.2 mm wide, entire. Fruit on pedicel 1.0-2.0 mm long, ovoid, 3.0-4.5 mm long, 3.5-5.5 mm diameter, covered with long spreading multilobed and/or simple ± woody processes up to 1.5 mm long, scabrous; sepals persistent, erect, linear, 1.0-1.5 mm long, 0.5-1.0 mm wide, scabrous; pericarp and septa ± woody, 4 locules, 1-4 seeds.

Distribution. (Map 8)

This forma is confined almost entirely to the "Channel Country" of central and north-western Queensland. One collection is known from north-western South Australia and one from north-eastern Northern Territory.

Ecology.

The ecological preferences of this forma are apparently very similar to those of f. *glauca*. Heavy grey or dark brown clays in or near watercourses form the usual habitat, but the plant also invades cultivated areas, spreading and perennating via its deep stoloniferous rootstock. Collectors' notes include "procumbent herb on river flats" (Davidson 372); "Gully in *Astrebla lappacea* grassland. Heavy dark brown soil. Wet places in rainy season." (Hubbard 7770); "restricted to channels where it is very common and very prominent" (Kennedy 46); and "on cultivated land formerly used as market garden; plant growing abundantly and pest to cultivation" (Pearce s.n. BRI061804). Flowering occurs from (February-)May until August(-November) and fruiting occurs throughout most of the year.

Specimens examined.

Queensland: Armit 964, Normanton, MEL39076 (fr.); Armit 964, Saxby River, MEL39204 (fr.); Burbidge 5351, 9.v.1956, Walker's Creek, S.W. of

Hughenden, CANB (fl.,fr.); Burbidge 5374, 11.v.1956, 20 miles S. of Hughenden on Muttaburra Rd., CANB (fl.,fr.); Carolin 6373, 23.viii.1967, Diamantina Lakes, SYD (fl.,fr.); Davidson 372, -.v.1953, 3 m. N. of Longreach, BRI (fl.,fr.); Gulliver s.n., -.vii.1876, "Iffley" between Normanton and Cloncurry, BRI079984 (fr.); Gulliver 1076, Spear Creek, MEL (fr.) - syntype of *H. sclopetifera;* Hubbard 7770, 17.ii.1931, Marathan Station, W. of Hughenden, BRI (fl.,fr.); Kennedy 46, Elderslie, Winton, BRI (fl.,fr.); Pearce s.n., 27.ix.1965, Longreach, BRI061804 (fl. fr.); Poulton s.n., Aramac Creek, MEL39077 (fl.,fr.) - lectotype of *H. sclopetifera;* Poulton s.n., tributaries of the Thomson River, MEL 39078 (fr.); Speck 4796, 9.viii.1954, near Dalgonally Station, AD, BRI, CANB, MEL, NSW, NT, PERTH (fl.,fr.); White s.n., -.viii.1916, Flinders River, BRI080002 (fr.); White s.n., Landsborough River, BRI080000 (fr.); White s.n., -.iv.1919, Muttaburra, BRI080003 (fr.).

Northern Territory: Perry 68 p.p., 25.vi.1947, 37.3 mls Anthony's Lagoon-Adder W.H.-Eva Downs, CANB (fr.).

South Australia: Cleland s.n., 18.viii.1934, Diamantina River at Pandie Pandie, AD96803076 & Herb. Black (fl.,fr.).

Note.

1. The choice of a lectotype for *H. sclopetifera* was necessary as Mueller cited three different collections with the description. Poulton's collection was chosen in preference to Gulliver's specimen from Spear Creek, because the former had both flowers and fruit, while the latter bore fruit only. Gulliver's specimen from Norman River was not amongst the collections examined.

16. *Haloragis foliosa* Bentham, Fl. Aust. 2(1864)477 [Typus: "W. Australia. Between Moore and Murchison rivers, Drummond, 6th Coll. n.82." Holotypus: Jas. Drummond 82, 1853, Between Moore & Murchison Rs. W.Australia, K (fl.)'. Isotypi: Jas. Drummond 82, 6th collection, Between Moore and Murchison Rivers, CGE (fl.)!; Drummond 82, Coll. 6., Nov. Holl. Swan River, G (herb. DC)!; J. Dr. 82, Haloragis foliosa Bth. Murchison River, MEL38956 (fl.)!; J. Drummend 82, Haloragis foliosa Bentham. Calyx lobes large, MEL38957 (fl.)!]; F.v.M. Census 1(1882)49, Sec. Census 1(1889)85; Schindler, Pflrch. 23(1905)47. fig. 13K; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)470.

Fig.: Schindler, Pflrch. 23(1905) fig. 13K.

Perennial herb 30-40 cm tall, stems erect, red to green, sparsely branched, smooth or weakly 5-ribbed, sparsely scabrous with simple, 3-4 celled, transparent, ± straight or hooked hairs 0.2-0.4 mm long.

Leaves subopposite at base, becoming alternate above, sessile, linear-lanceolate, 3.0-4.5 cm long, 0.3-0.7 cm wide, serrate in upper part with 4-8 deltoid teeth 1.0-2.0 mm long, acute at tip, tapering gradually to base, midrib weakly channelled above, prominent below, lateral veins obscure, sparsely scabrous with hairs as for stems.

Inflorescence an indeterminate spike of 1-3 flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper leaves. Primary bracts lanceolate, 0.9-1.2 cm long, 0.2-0.25 cm wide, leaflike, green ,fleshy, serrate, midribbed, scabrous on margins; secondary bracts linear-lanceolate, 1.7-2.1(-3.0)mm long, 0.4-0.7 mm wide, brown, membranous, scabrous on margins; tertiary bracts as for secondary, 1.0-1.5 mm long.

Flowers 4-merous. Sepals 4, ovate-cordate, 1.3-1.9 mm long, 1.1-1.2 mm wide, midribbed, otherwise smooth, tip very shortly acuminate, hooked hairs on margin. Petals 4, hooded, tips erect, very shortly unguiculate,keeled, 3.0-3.2 mm long, 1.0-1.3 mm wide (keel to margin), scabrous on keel. Stamens 8, filaments 0.2-0.3 mm long; anthers oblong, 2.4-2.7 mm long, 4-locular, nonapiculate, ± all equal in length. Styles 4, clavate, 0.5-0.6 mm long, stigmas capitate. Ovary hemispherical to obconical, 1.0-1.4 mm long, 0.8-1.0 mm wide, strongly 8-ribbed, scabrous with hooked hairs, 4-locular, 1 pendulous ovule per locule.

Fruits unknown.

Distribution. (Map 7)

This species is confined to the mid-western coastal region of Western Australia.

Ecology.

Nothing is recorded.

Specimens examined.

Known only from the type collections which are listed above.

Notes.

1. This is a poorly known species. In most characters it agrees with *H. aspera*, with which it could be considered synonymous were it not for its broad, cordate sepals. It is also very closely related to *H. aculeolata* and *H. scoparia*. More collections, particularly fruiting specimens, are needed to ascertain the affinities and proper status of this taxon.

17. *Haloragis platycarpa* Bentham, Fl. Aust. 2(1864)478 [Typus: "Swan River, Drummond, 1st Coll. and n. 705." Holotypus: Presumably at K, n.v. Isotypi: Drummond 705, 1843, Swan River, G (Herb. Boissier) (st.)!; Drummond 705, I. coll., Australia, ad fl. Cygnorum, LE (fr.)!; J. Dr. 705, W.A., MEL39217, 39218, 39219 (fr.)!; Drummond 705, Nov. Holl. aust. occ., W (fr.)!]; F.v.M., Census 1(1882)49, Sec. Census 1(1889)85; Schindler, Bot. Jb. 34, Beibl. 77(1904)31; Schindler, Pflrch. 23(1905)48; Gardner, Enum., (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)467.
Figs: Schindler, Pflrch. 23(1905) fig 13L-N.

Perennial(?) herb 30 cm tall, stems erect, herbaceous, profusely branched, green to red, 4-5 ribbed, glabrous except for scattered, unicellular, rounded, transparent, papillose hairs 0.1-0.2 mm long.

Leaves alternate or subopposite below, alternate above, dark green on upper surface, lighter green below, linear to narrow oblanceolate, (2.0-)4.0-4.5 cm long, 0.4-0.5 cm wide (excluding teeth), tapering gradually to base, strongly but sparsely toothed in upper part, teeth 3-5, narrow deltoid, 2-3 mm long, midrib weakly channelled above, prominent below, glabrous.

Inflorescence an indeterminate spike of 1-3 flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences borne in the axils of the upper leaves. Only the central flower of the dichasium is functional. Primary bracts leaflike, 8.0-10.0 mm long, 1.0-1.5 mm wide, green, fleshy, midribbed, serrate; secondary bracts brown, membranous, linear, 0.9mm long, 0.2 mm wide, entire; tertiary bracts brown, membranous, linear, 0.5 mm long, 0.1 mm wide, entire.

Flowers 4-merous, on pedicels 0.2-0.3 mm long. Sepals 4, ovate, 0.6-0.8 mm long, 0.4-0.5 mm wide, not ribbed, papillose on outer face. Petals 4, hooded, tip erect, keeled, 1.7-2.0 mm long, 0.5-0.6 mm wide, glabrous or sparsely papillose on keel. Stamens 8, filaments 0.2 mm long; anthers yellow, oblong, 1.4-1.5 mm long, 0.3-0.4 mm wide, 4-celled, nonapiculate. Styles 4, clavate, stigmas capitate. Ovary depressed globose, 0.4 mm long, 0.8 mm wide, not ribbed, papillose, 4-locular.

Fruits 1 per axil, depressed globose, 1.7-2.5 mm long, 3.5-4.0 mm wide, very weakly 4-ribbed between sepals in upper part, otherwise smooth, densely minutely papillose; sepals persistent, erect, deltoid, 1.0-1.2 mm long, 1.0-1.2 mm wide, weakly midribbed, somewhat sunken into apex of fruit, sparsely papillose; fruit 4-locular, endocarp and septa woody, exocarp swollen, spongy; 1-4 seeds.

Distribution. (Map 7)

Known only from the Swan River district of Western Australia.

Ecology.

Nothing is recorded.

Specimens examined.

Known only from the type specimens (q.v.) and a Drummond collection, lacking a collector's number, date and exact locality (MEL1003719 (fl.)).

Notes.

1. No specimen among those examined could reasonably be considered to be the holotype. There was no specimen of this species in material obtained on loan from K, and the presumed duplicate type collection in MEL had not been annotated by Bentham.

2. The relationships of this species are obscure. Until further

collections are made, *H. platycarpa* is placed near *H. foliosa* mainly on the basis of general resemblance and phytogeography.

18. *Haloragis aculeolata* Benth., Fl. Aust. 2(1864)477 [Typus: "W.Australia, Clarke." Holotypus: Mr. Clarke s.n., S.W. Austr., MEL38923 (fr.)! Isotypus: Mr. Clarke s.n., S.W. Aust., K (ex Oldfield Hb.) Hb. Hook. !]; Benth., Fl. Aust. 2(1864)477 sub *H. tenuifolia;* F.v.M., Census, 1(1882)49, Sec. Census 1(1889)85; Schindler, Pflrch. 23(1905)53; Gardner, Enum. (1931)99; Blackall & Grieve, W. Aust. Wildfls. 3(1965)471.

Erect perennial herb 30-40 cm tall, stems sparsely branched at base, green, weakly 5-ribbed, (sparsely) scabrous with curved or hooked, 2-3-celled semitransparent hairs 0.1-0.3 mm long.

Leaves alternate, sessile, linear,(1.5-)2.5-3.5 cm long, 0.1-0.25cm wide (excluding teeth), serrate with (2-)6-8 linear-deltoid teeth 1-3 mm long, midrib channelled above, prominent below, lateral veins obscure, scabrous with hairs as for stem.

Inflorescence an indeterminate spike of 1-3-flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper 10-15 leaves. Primary bracts green, fleshy, linear, 6-11 mm long, 0.7-0.9 mm wide, entire, midribbed, scabrous; secondary bracts brown, membranous, linear, 1.5-1.7 mm long, 0.2-0.3 mm wide, glabrous or scabrous only on margin; tertiary bracts brown, membranous, linear, 0.6-0.7 mm long, 0.1-0.2 mm wide.

Flowers 4-merous on pedicel up to 1.0 mm long. Sepals 4, green, ovate, 1.0-1.3 mm long, 0.7-0.9 mm wide, subacuminate, lacking midrib, scabrous on margins. Petals 4, green,hooded, tip erect, unguiculate, 2.5-2.7 mm long, 0.7-1.0 mm wide, scabrous on keel. Stamens 8, filaments 0.2 mm long; anthers yellow, oblong, 1.7-1.9 mm long, 0.4 mm wide, 4-celle nonapiculate, antipetalous stamens ca 0.2 mm shorter than antisepalous ones. Styles (1-)2-3, clavate, 0.5 mm long, stigmas capitate. Ovary ovoid, 0.9-1.0 mm long, 0.6-1.0 mm wide, 4-ribbed, glabrous or scabrous, (1-)2-3 locular with 1 pendulous ovule per locule.

Fruits 1(-2) per axil, ovoid to pyriform, 1.8-2.0 mm long, 1.5-1.9 mm wide, weakly 4-ribbed between sepals, otherwise ± smooth, or slightly rugose in lower part, glabrous (or scabrous ?), sepals persistent, erect, deltoid, 0.8-0.9 mm long, 0.6-0.8 mm wide, lacking midrib, scabrous on margins; fruit 2-3 locular, pericarp and septa woody, 1-3 seeds.

Distribution. (Map 7)

This species is confined to south-western Western Australia, from Perth to Esperance.

Ecology.

Very little has been recorded. The collection George 10484 was growing "in clay soil ... along firebreak in *Euc. flocktoniae* association" and those of Eichler (20251) and Orchard (1725) were found on a roadside. Flowering occurs from October until December; the fruiting period is unknown.

Specimens examined.

Western Australia: Clarke s.n., S.W. Aust., K, MEL38923 (fr.) - types of *H. aculeolata;* Eichler 20251, 15.x.1968, north-west corner of Location 1159, Shire of Esperance, AD, PERTH (fl.); George 10484, 12.xi.1970, Reserve 29860 - One Mile Rocks, between L. King and Ravensthorpe, PERTH (fl.); Morrison s.n., 26.xii.1901, Cannington, CANB136636 (fl.); Orchard 1725, 21.x.1968, Location 1160, Shire of Oldfield, AD (fl.).

Notes.

1. There is considerable variation between the collections assigned to this species. The type collection has a sparse indumentum of curved hairs, but a glabrous, 2-3-celled fruit. Morrison's collection closely matches the type, but has a single-celled fruit. Eichler's collection has an indumentum of mixed curved and hooked hairs, and the ovary is weakly pilose, and 2-3-celled. The collections of George and Orchard match that of Eichler, but have an extremely densely pilose ovary. More collections of this species are needed to resolve these differences.

2. The affinities of this species are with *H. aspera*, from which *H. aculeolata* differs in its 2-3-locular ovary. *H. aculeolata* is probably also fairly closely related to *H. scoparia*.

19. *Haloragis scoparia* Fenzl, Enum. Pl. Hueg. (1837)45 [Typus: "Swan River (Hugel.)" Holotypus: Huegel s.n., Australasia. Swan River, W (fl.)! Isotypi: Swan River (Huegel), W (fl.)!; Haloragis scoparia Fenzl ! specimen authenticum, MEL39273 (fl.)!]; Walp., Rep. 2(1843)99; Benth., Fl.Aust. 2(1864)477; F.v.M., Census 1(1882)49, Sec. Census 1(1889)85; F.v.M., Trans. roy. Soc. Vict. 24(1888)133; Petersen, Pflfam. III.7(1893)232; Schindler, Bot. Jb. 34, Beibl. 77(1904)24; Schindler, Pflrch. 23(1905)53; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)471.

Perennial(?) herb 30-60 cm tall, rootstock unknown, stems herbaceous, smooth, glabrous, sparsely branched.

Leaves subopposite below, alternate above, linear to narrow-lanceolate, 4.0-6.0(-7.5) cm long, 0.2-0.4(-0.7) cm wide (excluding teeth), sessile, entire or sparsely serrate in upper part with 2-4(-8) deltoid teeth 1-3(-5) mm long, midrib obscure on upper surface, prominent below, lateral veins not apparent, glabrous.

Inflorescence an indeterminate spike of 1-3-flowered dichasia in the axils of primary bracts. Lateral inflorescences absent or borne in the axils of the upper 3-11 leaves. Primary bracts leaflike, green, fleshy, linear, 7.0-10.0 mm long, 1.0-1.5(-2.0) mm wide, entire, weakly midribbed, glabrous; secondary bracts brown, membranous, linear, 1.3-1.7 mm long, 0.3 mm wide; tertiary bracts brown, membranous, linear, 0.6-0.8 mm long, 0.1-0.2 mm wide.

Flowers 4-merous, on pedicel 0.5-0.7 mm long. Sepals 4, ovate, 0.9-1.0 mm long, 0.7-0.8 mm wide, lacking midrib, glabrous. Petals 4, hooded, tip erect, keeled, 1.7-2.1 mm long, 0.6-0.7 mm wide (keel to margin), glabrous. Stamens 8, filaments 0.3 mm long; anthers yellow, oblong, 1.8-2.0 mm long, 0.3-0.4 mm wide, 4-celled, nonapiculate, antipetalous anthers ca 0.2 mm shorter than antisepalous ones. Styles 2, clavate, 0.5-0.6 mm long, stigmas capitate. Ovary ovoid, 0.8-0.9 mm long, 0.7-0.9 mm wide, not ribbed, glabrous, 2-locular with 1 pendulous ovule per locule.

Fruits 1(-2) per axil, ovoid, 1.9-2.4 mm long, 1.5-1.7 mm wide; 4-ribbed between sepals, ribs very weakly membranous-winged in central part, body of fruit weakly transversely rugose in lower part between ribs; sepals persistent, erect, deltoid, 0.9 mm long, 0.8 mm wide, lacking midrib; 2 locules, pericarp and septum ± woody, 1-2 seeds.

Distribution. (Map 7)

This species is known only from the Swan River district near Perth, Western Australia.

Ecology.

Nothing is recorded about habitat preference, soils etc. Drummond's collection in G (Hb. Deless.) has July as the date of collection, and bears both flowers and fruits.

Specimens examined.

Western Australia: Drummond s.n., W.A., MEL39272, 39301 (fl.,fr.); Drummond 4th coll. 82, -.vii.1848, Swan River, G (Herb. Boissier, Herb. Deless.), MEL39271, NSW99278, 99279 (fl.,fr.); Huegel s.n., Swan River, MEL39273, W (2 sheets (fl.)) - types of *H. scoparia*.

Notes.

1. Drummond's collection (NSW99279 ex W) has some flowers with only a single style and 1-locular ovary.

2. The relationships of this species are probably with *H. aculeolata* and (possibly) *H. foliosa*. More collections are badly needed to clarify the position.

20. *Haloragis heterophylla* Brongniart in Duperrey, Voy. Coq. Bot. (1829-1834)t.68A [Holotypus: loc. cit., t.68A!]; Gray, Bot. U.S. Expl. Exped. 1(1854)627; Benth., Fl. Aust. 2(1864)478, 483; Tate, Trans. roy. Soc. S.Aust. 3(1880)64; F.v.M., Census 1(1882)50, Sec. Census 1(1889)86; Bailey, Synop. Qld. Fl. (1883)157; F.v.M., Key Syst. Vict. Pl. 2(1885)22, 1(1887-8)262; Field Nats., Trans. roy. Soc. S.Aust. 8(1885)185; F.v.M., Trans. roy. Soc. Vict. 24(1888)135; Tate, Trans. roy. Soc. S.Aust. 12(1889)95; Tate, Fl. S.Aust. (1890)101, 234; Moore, Hdbk. Fl. N.S.Wales (1893)185; Bailey, Qld. Fl. 2(1900)554, 555; Schindler, Bot. Jb. 34.Beibl. 77(1904)31; Schindler, Pflrch. 23(1905)45, 46; Dixon, Pl. N.S.Wales (1906)129, 130; Bailey, Comp. Cat. Qld. Fl. (1913)174; Maiden & Betche, Census N.S.Wales Pl. (1916)158; Black, Fl. S.Aust. (1926)430; Domin, Bibl. Bot. 89(1929)1034; Black, Fl. S.Aust. (1952)643; Evans in Beadle, Evans & Carolin, Hdbk. Vasc. Pl. Syd. Dist. (1963)174; Eichler, Suppl. Black's Fl. S.Aust. (1965)245.

Haloragis ceratophylla Zahlbr. ex. Endl., Atakta Bot. (1834)16 [Typus: "Crescit in Novae Hollandiae orae occidentalis sinu Schoalwater Bay dicto. (Ferd. Bauer)" Holotypus: Endl., l.c., t.15 (del. Bauer)!]; Fenzl, Enum. Pl. Hueg. (1837)45; Walp., Rep. 2(1843)99; Benth., Fl. Aust. 2(1864)478, 479, 483; F.v.M., Census 1(1882)49; Bailey, Synop. Qld. Fl. (1883)156; F.v.M., Key Syst. Vict. Pl. 2(1885)22; Bailey, Qld. Fl. 2(1900)554.

Haloragis filiformis A. Gray, Bot. U.S. Explor. Exped. 1(1854)628 [Typus: "Hab. New South Wales; in the vicinity of Hunter's River." Holotypus: Wilkes s.n., Hunter's River, New South Wales, US47834 (fl.,fr.)!];

Haloragis heterophylla var. *filiformis* (Gray) Bentham, Fl. Aust. 2(1864)483.

Haloragis heterophylla var. α. *ceratophylla* (Endl.) Schindler, Pflrch. 23(1905)46; Maiden & Betche, Census N.S.Wales Pl. (1916)158.

Haloragis heterophylla var. β. *capreolicornis* [non Schindler] Schindler, Pflrch. 23(1905)46 p.p. [Typus: Comprising those syntypi (and other specimens determined by Schindler) of *H. heterophylla* var. *capreolicornis* Schindler which differ from the lectotypus, and are therefore excluded from that varietas (q.v., sub *H. aspera*)] Britten, J.Bot. 45(1907)136.

Haloragis heterophylla var. *linearis* Black, Fl. S.Aust. 2 ed. (1952)643, nom. inval. (cf. Eichler, Suppl. Black Fl. S.Aust. (1965)245 pro nom. inval.)

Figs: Brongn. in Duperr., Voy. Coq. Bot. (1829-1834)t.68A; Endl., Atakta Bot. (1834)t.15.

Annual or perennial herb, perennating from a deep lateral rootstock, stems erect, (15-)25-50 cm tall, green, herbaceous, 4-ribbed, scabrous with simple, 2-3-celled, hyaline, spreading hairs, 0.2 mm long and hooked at the tip, or rarely glabrous. Leaves opposite or alternate, sessile (linear-)trifid to multifid in upper half, divisions digitate or successive, margins entire, segments (and undivided lamina) 1-2 mm wide, acute, lamina (incl. segments) broadly spathulate, (1.0-)1.5-3.0 cm long, 0.5-1.0(-2.0) cm wide, midrib weakly developed in undivided part, scabrous with hairs as for stems.

Inflorescence an indeterminate spike of 1-3(-4)-flowered dichasia borne in the axils of primary bracts. Lateral inflorescences occur in the axils of the upper leaves. Primary bracts linear, (3.0-)4.5-5.0 mm long, 0.5-0.7 mm wide, margins entire, green, fleshy, midrib absent, scabrous with hairs as for stems; secondary bracts membranous, brown, linear, 0.3-0.6 mm long, 0.1 mm wide, scabrous on margins.

Flower 4-merous. Sepals 4, narrow-deltoid, 0.8-1.2 mm long, 0.3-0.5 mm wide, not ribbed, scabrous. Petals 4, hooded, tip erect, shortly unguiculate, 2.2-2.8 mm long, 0.6-0.8 mm wide (keel to margin). Stamens 8, filaments 0.1-0.2 mm long; anthers red, oblong, 1.3-1.5(-2.4) mm long, 0.2-0.4 mm wide, 4-locular, non-apiculate, all equal in length. Styles 4, clavate, stigmas capitate, reddish. Ovary globular, 0.6-0.8 mm diam., lacking ribs, scabrous, 4-locular, with 1 ovule per locule.

Fruits 1-2 per axil, pedicellate on stalk 0.5-0.7 mm long, pyriform, body of fruit 1.5-2.4 mm long, 1.3-1.8 mm wide, longitudinally 4-ribbed between sepals, irregularly or ± transversely wrinkled in the lower part, ± smooth in the upper part; sepals erect, ± enclosing styles, 0.8-1.2 mm long, 0.4-0.6 mm wide; exocarp slightly woody, 1-4 seeds. (Fig. 24)

Distribution. (Map 8)

This species is widespread in Victoria (except the extreme north-west), eastern New South Wales and eastern Queensland. It is rare in South Australia, being confined to a few localities in the South-East and in the southern Mt. Lofty Range. No specimens of this species from Tasmania are known to exist, and it seems probable that the plants formerly recorded from Tasmania under the name *H. heterophylla* all belong to *H. aspera*.

Ecology.

H. heterophylla is largely confined to the wetter temperate regions of the east coast. Within this region, the plants are usually found in creek beds or swampy areas, and can be a serious weed in pastures or crops. Little preference for particular soil types is apparent. Collectors' notes include "a weak growing herb, growing in permanent moist places amongst *Cyperus*, sedges, etc." (Boorman NSW99223), "on banks of moist gully" (Everist & Webb 1383), "common in very wet peaty habitat in pasture" (Hoogland 3104), "occurs in patches in a cult. paddock & has an extremely deep rooting system which has rendered the area useless for growing annual crops. It is growing in heavy clay soil." (Johnson NSW99233), "sandy soil" (Leigh S289), "dark grey sandy loam, more or less swampy" (Moore 2418), "deep yellow podsolic soil on porphyry & sed. shale" (Moore 2769), "½ acre patch in grain sorghum paddock in heavy chocolate soil" (Speed NSW99229), and "in brown loam on grassy hill with *Eucalyptus tesselaris* and *Eucalyptus melanophloia*" (Everist 7612). Flowering occurs from (October-)November until January (-May) and fruiting from November to March(-May).

Specimens examined.

South Australia: Anon., s.n., Grunthal [= Lobethal], AD96810027 (fr.); Behr s.n., Barossa, MEL1003762 (fl.); Behr s.n., -.i.1849, Barossa Range, MEL39104 (fl.); Cleland s.n., 17.ii.1948, Horr's Drift ca 15 km west of Mt. Schank, AD96803069 (fr.); Cleland s.n., 17.ii.1948, Rork's Drift ca 9 km west of Mt. Schank, AD (fl.,fr.); Cleland s.n., 18.xii.1948, National Park, AD96803068 (st.); Cleland s.n., 30.xii.1948, Natl. Park, AD (fl.,fr.); Cleland s.n., 16.ii.1952, National Park, AD96803075 (fr.); Griffith 6, 27.xi.1910, Myponga, NSW (fl.,fr.); Mueller 125, Barossa, HBG (fl.); Tepper s.n., 14.ii.1884, Ambleside, AD96811103 (fr.).

Victoria: Baeuerlen 55, ?.iii.1885, Genoa district, MEL (fl.); Beauglehole 570, -.i.1946, Gorae West, Portland, BEAUGLEHOLE (fl.); Beauglehole 21827, 16.xi.1966, McDonald Park, Ararat, BEAUGLEHOLE (st.); Beauglehole 30153, 21.xii.1968, 1½m. ENE of Halls Gap, BEAUGLEHOLE (fl.); Beauglehole 30331, 20.i.1969, Moora Track, Grampians, BEAUGLEHOLE (fr.); Beauglehole 30609, 24.ii.1969, W. boundary of Yarram Park, Grampians, BEAUGLEHOLE (fl.); Beauglehole 30699, 22.v.1969, Brim Creek, NE of Geranium Springs, Grampians, BEAUGLEHOLE (st.); Beauglehole 30833, 24.vi.1969, W. side of Picnic Rocks - along Mockinya Creek, Grampians, BEAUGLEHOLE (st.); Beauglehole, Rogers & Finck 33367, 7.i.1970, ± 1m. from Wulgulmerang-

Suggan Buggan road, off Benambra road, BEAUGLEHOLE (fl.); French s.n., 1886, Upper Murrey, MEL1003736 (fl.); Mueller s.n., Australia, W(fl.,fr.)- syntypes (2) of *H. heterophylla* var. *capreolicornis*; Mueller s.n., -.i.1885, Snowy River, MEL39128 (fl.,fr.); Mueller s.n., -.i.1875, Upper Loddon, MEL39061 (fl.); Orchard 1914, 9.ii.1969, Moora Track, Grampians, AD (st.); Orchard 1924, 9.ii.1969, ca 4 km north-east of Halls Gap, AD (fr.); Orchard 1965, 11.ii.1969, Dwyer's Creek on Halls Gap-Dunkeld road, AD (fl.); Orchard 2636, 5.xii.1970, Black Mountain, ca 10 km north of Wulgulmerang, AD (fl.); Reader s.n., 21.xii.1891, Shire of Dimboola, MEL39075 p.p. (fr.); Reader 8, 1892, Wimmera, MEL (fr.); Reader 17, 20.xii.1891, near Dimboola, MEL (fr.); Reader 30, Port Phillip, MEL (fl.); Sullivan 20, -.xi.1878, Moyston, MEL (fl.); Williamson s.n., -.xii.1901, Euroa, MEL39129 (fr.); Williamson s.n., -.xii.1901 & -.i.1902, Gooram, Euroa, NSW99219 (fr.); Williamson 9, 1893, Hopkins River, MEL (fl.); Willis s.n., 18.i.1964, Yan Yean-Woodstock road, MEL39043 (fl.,fr.).

New South Wales: Brown 4430, Iter Australiense,(Port Jackson - Britten (1907)),MEL (fl.,fr.); Caley s.n., Parramatta, UPS (fl.); Cutting 4, 4.iv.1955, Cootamundra district, NSW (fl.,fr.); Baeuerlen s.n., -.xi.1891, Ballina, NSW99230 (fl.,fr.); Bauerlen 218, -.xii.1886, Monaro district, MEL (fl.); Baeuerlen 227, -.xii.1886, Twofold Bay district, MEL (fl.,fr.); Baeuerlen 294, -.xii.1884, Braidwood district, MEL (fl.); Beadle s.n., 1.xii.1950, Co. Forbes, SYD (fl.); Beckler s.n., Clarence River, MEL 39103 (fr.); Beckler s.n., River Arne, MEL39094 (fr.); Beeton s.n., 30.iii.1962, near Royal Canberra Golf Course, CBG014045 (fl.,fr.); Betche s.n., 29.x.1886, Glen Innes, NSW113153 ('11a') (fl.) - syntype of *H. heterophylla* var. *capreolicornis*; Betche s.n., -.xii.1891, Wallangarra, NSW99226 (fl.); Betche 9, -.i.1888, Michelago, NSW (fl.,fr.); Bonton 20, 1890, Lachlan River, MEL (fl.); Boorman s.n., -.xi.1900. Tuggerah, NSW113152 ('10') (fl.) - syntype of *H. heterophylla* var. *capreolicornis*; Boorman s.n., -.xi.1906, Manildra, NSW99085 (fl.,fr.); Boorman s.n., -.xii.1907, Blayney, AD96921187 (fl.); Boorman s.n., -.i.1908, Orange, NSW103142 (fl.,fr.); Boorman s.n., -.v.1914, Wallangarra, NSW99225 (fr.); Boorman s.n., 28.i.1918, Wallangarra, AD96920068 (fr.); Breakwell s.n., -.xii.1913, Moruya, NSW98999 (fl.,fr.); Breakwell s.n., -.xi.1914, Glen Innes, NSW99212 (fl.,fr.); Burbidge & Gray 6105, 18.xii.1958, 7m. from Kambah Pool turnoff on Tharwa Rd., A.C.T., CANB (fl.,fr.); Burbidge & Gray 6130, 18.xii.1958, lower slopes of Mt. Tennant, A.C.T., CANB (fl., fr.); Caley s.n., Nova Holland., NSW113151 (st.); Campbell s.n., 1882, New England, MEL39059 (fl.,fr.); Campbell s.n., -.xi.1906, Wollar, Mudgee, NSW99084 (fl.,fr.); Carter s.n., -.i.1885, Moonan Brook, Hunters River MEL39073 (fl.); Cleland s.n., 25.xi.1916, Pilliga scrub, Narrabri, AD96905114 (fl.,fr.); Congrave 7, 1893, sources of the Lachlan River, MEL (fl.,fr.); Crawford 527, 4.iii.1885, Moona-Walcha, MEL (fl.,fr.); Davis 2, Dumaresq Creek 2 miles above University, Armidale, NSW (fl.,fr.); Eaves s.n., Broadwater, MEL39113 (fl.); Evans s.n., -.xii.1925, Mt. Druit, SYD (fl.); Evans s.n., -.i.1950, E. of Orange, SYD (fr.); Everist & Webb 1383, 23.xi.1946, near Maryland River on Stanthorpe-Woodenbong road, BRI, CANB (fl.); Gauba s.n., Canberra, A.C.T. CBG013183 (fl.,fr.); Golsby s.n., -.xii.1916, Bumbaldry, NSW99216 (fl.,fr.); Hazes 12, -.iii.1908, Ashford, NSW (fl.,fr.); Herrington s.n., 10.iii.1954, Scone, NSW99241 (fl.,fr.); Hickey s.n., -.xii.1884, Maryland, MEL39053 (fl.);

Hoogland 3104, 20.xii.1952, near Tidbinbilla Homestead along Hurdle Creek, A.C.T., CANB (fl.); Johnson s.n., -.iii.1953, Cooninoo, Moree, NSW99233 (fl.); Leigh S289, 3.xii.1964, Milewa State Forest, 25 miles S. of Deniliquin, NSW (fl.,fr.); Maiden & Boorman s.n., -.xii.1903, Jennings, NSW9835 ('6') (fl.) - syntype of *H. heterophylla* var. *capreolicornis*; Mair s.n., 23.x.1951, Dripstone, NSW99240 (fl.); Mair 113, 23.xii.1931, C.S.I.R.O. paddock, A.C.T., CANB (fl.,fr.); Marshall s.n., 7.i.1947, Gowrie via Tamworth, NSW99221 (fl.); McBarron 810, 5.iv.1947, The Glen - Tumbarumba, NSW (fl.,fr.); McBarron 2588, 17.xi.1948, Walla Walla rd., Gerogery, NSW, SYD (fl.); McBarron 2768, 8.xii.1948, Bungowannah, NSW (fl.); McBarron 3304, 15.v.1949, Gerogery, NSW, SYD (fl.,fr.); McBarron 14891, 10.ii.1968, Minto, NSW (fl.); McBarron 14919, 22.ii.1968, Wilde's Meadow near Robertson, NSW (fl.); McBarron 14961, 22.ii.1968, Glenquarry nr.Moss Vale, NSW (fl.,fr.); McKee s.n., 18.i.1948, Ben Lomond, NSW99228 (fl.,fr.);McKee 407, 4.xi.1952, Boree, 20 m. W. of Orange, SYD (fl.,fr.); Moore 2418, 11.iii.1953, swamp at N. end of L. George, CANB (fl.,fr.); Moore 2769, 10.xi.1953, 10 miles from Canberra on Yass Rd., CANB (fl.); Moore 2810, 30.xi.1968, Yass-Boorowa, 6 miles from Hume Highway, CANB, NSW (fl.,fr.); Mueller 51, Illawarra, MEL1003655 (fl.); Paltridge 203, 28.xi.1931, Glen Elgin, CANB (fl.); Perrott s.n., New England, MEL39069 (fr.); Perrott s.n., 1871, Armidale, MEL39122 (fr.); Rupp s.n., -.xi.1913, Sydenham, Barraba, MEL39048 (fl.); Rupp 9, -.i.1907, Warialda, NSW (fl.,fr.); Rupp 18, 29.i.1914, Bolivia, NSW (fl.,fr.); Rupp 19, 29.i.1914, Glen Innes, NSW (fl.,fr.); Roe AR696, 20.iv.1950, Chiswick, Armidale, CANB, NE (st.); Salasoo 2929, 29.xii.1964, ca 1 mile NW of Grenfell, NSW (fl.,fr.); Schultz s.n., 1951, Penrith, SYD (fr.); Speed s.n., 22.xi.1966, Gunnedah, NSW99229 (fl.); Stuart 245, New England, MEL39133 (fl.); Wenholz s.n., -.iii.1913, Glen Innes, NSW99238 (fl.); White s.n., 6.xii.1951, Bloomfield, Orange, NSW99239 (fl.); White - Haney 62D76, 25.ii.1930, Glen Elgin, CANB (fl.,fr.); Wilkes s.n., Hunter's River, US47834 (fl.,fr.) - holotype of *H. filiformis*; Woolls s.n., Cumberland County, MEL39083 (fl.,fr.); Woolls s.n., Paramatta, MEL39106 (fr.); Yarrington s.n., nr. Maitland, NSW99222 (fr.).

Queensland: Armit 847, Mt. Surprise, MEL (fl.,fr.); Bailey s.n., Brisbane, BRI080009 (fr.); Bailey s.n., Brisbane River, BRI080011, CHR114019 (fl.,fr.); Bailey s.n., -.x.1875, Brisbane River, BRI080029 (fl.,fr.); Beckler s.n., Warwick, MEL39082, 39105, 39137 (fl.,fr.); Biddulph s.n., Nagoa River, MEL39130 (fr.); Boorman s.n., -.xi.1904, Stanthorpe, NSW 99223 (fl.,fr.); Bowman s.n., 1870, Herbert River, MEL39067 (fr.); Brown s.n., Kebbel [= Keppel] Bay, MEL39065 (fl.); Dovey 205, 27.ix.1933, Rosedale, BRI (fl.); Eichler 20737, 8.vii.1970, Nordello's Lagoon near Walkamin, AD (fl.,fr.); Everist 6162, 8.ii.1960, Strathgarve, 21 miles south of Warwick, BRI (fl.,fr.); Everist 7612, 17.xi.1963, Byron Creek, about 19 miles ENE of Esk, BRI (fl.); Henderson H384, 7.iii.1968, Strathgarve, 21 miles south of Warwick, BRI (fr.); Henderson H392, 7.iii.1968, Applethorpe ca 4 miles N. of Stanthorpe, BRI (fl.,fr.); Hubbard 4092, 20.ix.1930, near Kuraby, BRI (fl.); Hubbard 5134, 17-18.xi.1930, on top of Main Range near Gurulmundi, BRI (fr.); Jackes s.n., 13.iv.1964, top of Mt. Stuart, Townsville, Herb. Uni. College of Townsville (fr.); Kenny s.n., 1.xi.1906, Gympie, BRI (fl.); Keys 127, Mount Perry, BRI (fl.,fr.-terat.); Leichhardt, s.n., Moreton Bay, MEL39096 (fl.); Longman s.n., -.i.1911, Toowoomba, NSW99217 (fl.,fr.); Martin s.n., 13.v.1962, Carinya, north of Mitchell, BRI038525 (fl.,fr.); Martin s.n., 21.v.1962, Hodgson, near Roma, BRI033107 (fl.,fr.); Mueller s.n., Burdekin River, MEL39095 (fl.,fr.); O'Shanesy 149, 20.viii.1867, Rockhampton, MEL (fl.); Pedley 981, 18.iv.1962, 23 miles south-east of Texas, BRI (fl.,fr.); Smith 774, 29.i.1940, Racecourse Creek N.E. of Wallangarra, BRI (fl.,fr.); Stuart 72, Nov., Moreton Bay, MEL (fl.); White s.n., 9.x.1909, Brisbane Coopers Plains, BRI080010 (fl.,fr.); White s.n., 1.vii.1916, Upper Brisbane River, BRI079985, NSW99218 (fl.,fr.); White s.n., -.x.1916, Chermside near Brisbane, BRI080025 (fl.,fr.); White s.n., -.x.1921, Crow's Nest, BRI080016 (fl.).

Notes.

1. Although Endlicher based the species *Haloragis ceratophylla* on a Bauer specimen "in Herb. Mus. Caesar.", no collection from that herbarium, among those examined, matches the one cited. Until such a specimen is discovered, the species is based on Bauer's drawing in Endlicher's publication.

2. Schindler's *H. heterophylla* var. *capreolicornis* was based on at least eight different collections, and therefore required lectotypification. The lectotype, chosen to be a specimen definitely annotated by Schindler, is conspecific with *H. aspera*, but several of the syntypes (NSW9835 - "Sidney Herb. 6", NSW113152 - "Sidney Herb. 10", NSW113153 - "Sidney Herb. 11a", W (2 sheets, leg. Mueller)) agree with *H. heterophylla* and are placed under that species.

3. The name of Black's varietas, *H. heterophylla* var. *linearis* is invalid as no Latin diagnosis was published (Eichler, 1965). The following specimens were annotated by J.M. Black with this varietal name: J.B. Cleland s.n., 17.ii.1948, Rork's Drift, 9 miles W. of Mt. Shank, S.E., AD (fl.,fr.); J.B. Cleland s.n., 30.xii.1948, Natl. Park, AD (fl.,fr.). These specimens belong to *H. heterophylla* and do not deserve recognition on an infraspecific rank. As the name was not validly published no lectotypification is required.

21. *Haloragis myriocarpa* Orchard, sp. nov.

Herba perennis 30-60 cm alta, folia linearia ad teretia sessilia basin versus subopposita apicem versus alterna, submucronata (2.0-)2.5-4.5 cm longa, 0.7-1.0(-1.5) mm lata. Flores 4-meri, in pedicellis usque ad 0.2 mm longos; sepala et petala et styli 4, stamina 8, loculi 4, uniovulati, ovulis pendulis. Fructus 3-7 fasciculati, ovoidei ad subpyriformos, 8-costati vel 4-angulati plus 4-costati, transverse rugosi basin versus, 0.6-0.8 mm longi, 0.5-0.7 mm lati (sepala exclusa), loculi 4, septa membranacea, pericarpium sublignosum, semina 1-4. Typus: B. Copley 3369, 16.i.1971, Area of erect plants at roadside just south of 30 miles post north of Kingston S.E. To 60 cm, bright green, Damp lowlying site with Callistemon. Holotypus: AD97127110 (fl.,fr.)! Isotypi: Still to be distributed.

Haloragis mucronata [non (Nees) Benth.]. Benth., Fl. Aust.2(1864) 475p.p. [non *Goniocarpus mucronatus* Nees]; F.v.M., Census 1(1882)49, Sec. Census 1(1889)85 p.p.; F.v.M., Key Syst. Vict. Pl. 2(1885)22.

Haloragis digyna [non Labill.] F.v.M., Key Syst. Vict. Pl.1(1887-8) 262; F.v.M., Trans. roy. Soc. Vict. 24(1888)137 p.p.; Ewart, Fl. Vict. (1931)884.

Haloragis mucronata var. *trachycarpa* Black, Fl. S.Aust. (1926)431. [Typus: "Myponga" Lectotypus (Orchard): H.H.D.G. [Griffith] s.n., 24.i.1909, Myponga, AD (fl.,fr.)! Syntypus: Anon. s.n., 15.iv.1927, Myponga, AD (fr.)!].

Fig: Black, Fl. S.Aust. 2 ed. (1952) fig. 875 sub. nom. *H. digyna*

Perennial herb 30-60 cm tall, roots numerous, adventitious rootstock small, stems erect, numerous subwoody, ± smooth or weakly 4-ribbed, branching mainly from base, glabrous.

Leaves sessile, opposite or subopposite at base, becoming alternate above, linear to terete, (2.0-)2.5-4.5 cm long, 0.7-1.0(-1.5) mm wide, submucronate, ± channelled below, margins entire or very weakly tubercular toothed, ribs not apparent, glabrous or very sparsely scabrous on margins with short, thick curved, 1-2 celled translucent hairs up to 0.1 mm long.

Inflorescence an indeterminate spike of 5-7 flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences are borne in the axils of the upper 4-10 leaves. Primary bracts leaflike, green, fleshy, linear-lanceolate, 4.5-6.0 mm long, 0.5-1.7 mm wide, mucronate, glabrous or scabrous as for leaves; secondary bracts membranous, brown, lanceolate 0.5-0.8 mm long, 0.3 mm wide; tertiary bracts as for secondary bracts, 0.3-0.4 mm long, 0.1-0.2 mm wide; quaternary bracts etc. up to 0.3 mm long.

Flowers 4-merous, ± sessile or on pedicels up to 0.2 mm long, protandrous. Sepals 4, green to red, narrow deltoid, 0.6-0.9 mm long, 0.4-0.8 mm wide, smooth or midribbed. Petals 4, red, hooded, tip erect, unguiculate, (2.0-)2.2-2.7 mm long, 0.6 mm wide (keel to margin). Stamens 8, filaments 0.1 mm long; anthers oblong, 1.3-1.5 mm long, 0.4-0.5 mm wide, red to yellow, 4-celled, nonapiculate. Styles 4, clavate, 0.3 mm long, stigmas capitate. Ovary ovoid to hemispherical, 0.3-0.5 mm long, 0.5-0.6 mm wide, 4-angled opposite the petals, 4-ribbed opposite the sepals, 4-locular with 1 ovule per locule.

Fruits 3-7 per axil ± sessile or on pedicels 0.2-0.5 mm long, green to red-purple, ovoid to subpyriform, 1.2-1.5 mm long, 1.0-1.4 mm wide, 8-ribbed, or 4-angled plus 4-ribbed, weakly transversely rugose in lower part, glabrous; sepals persistent, erect, deltoid, 0.6-0.8 mm long, 0.5-0.7 mm wide, lacking midrib; 4-locular, septa membranous, pericarp subwoody, 1-4 seeds. (Fig. 23; Plate 16)

Distribution. (Map 9)

H. myriocarpa is confined to south-eastern South Australia and south-western Victoria, in the coastal strip from Adelaide to about Portland.

Ecology.

This species has been found only in swampy areas, either in heath-type vegetation,or associated with shrubs such as *Melaleuca*. Collectors' notes include "damp lowlying site with *Callistemon*" (Copley 3369); "heathland swamp, associated with *Prasophyllum hartii*" (Beauglehole 352); "river under dense bushes, rare" (Tepper 519); and "growing on grey to black soil; made appearance when paddock unstocked" (Secker s.n.). Flowering has been recorded from December to February, and fruiting from December until April.

Specimens examined.

Victoria: Allitt s.n., Portland, MEL38943 (fl.,fr.); Beauglehole s.n., -.ii.1947, "Jennings" near Surrey River, Corae, MEL38942 (fr.); Beauglehole 352, -.xii.1947, Gorae West, BEAUGLEHOLE (fl.,fr.); Beauglehole 17017, 9.xii.1950, Gorae West, Portland, BEAUGLEHOLE (fl.); Beauglehole 17026, 2.i.1960, ± 7m E. of Glenelg River mouth, Long Swamp, BEAUGLEHOLE (fl.); Beauglehole 33405, 12.ii.1970, Kentbruck Heath, 6m. direct N.N.W. of Mt. Kincaid, BEAUGLEHOLE (fl.,fr.).

South Australia: Anon s.n., 15.iv.1927, Myponga, AD (fr.) - syntype of *H. mucronata* var. *trachycarpa*; Cleland s.n., 20.i.1951, Lower Black Swamp ca 25 km N.N.E. of Victor Harbour, AD96803074 (fr.); Copley 3369, 16.i.1971, just south of 30 miles post, north of Kingston, AD (fl.,fr.) - holotype of *H. myriocarpa*; H.E.D.G. [Griffith] s.n., 24.i.1909, Myponga, AD (fl.,fr.) - lectotype of *H. mucronata* var. *trachycarpa*; Mueller s.n., Onkaparinga, MEL38944 p.p. (fl.); Mueller s.n., Murray scrub, MEL38944 p.p. (fr.); Mueller s.n., -.i.1852, ad flumen Onkaparinga, MEL38945 (fr.); Mueller s.n., Murray desert, MEL38946 (fl.); Mueller s.n., 1876, Lake Bonney, MEL38951, 38952 (fr.); Secker s.n., 2.i.1941, Reedy Creek, ADW4377 (fl.); Tepper 519, 21.i.1882, -.ii.1883, Clarendon, AD, MEL (fl.).

Notes.

1. The choice of a lectotype for *H. mucronata* var. *trachycarpa* was necessary as the type sheet in AD contained two collections from Myponga, both annotated by J.M. Black. The one chosen was preferred because it possessed both flowers and fruits, and contained more material than the other collection relegated to syntype.

2. The collection of Secker differs from all others in being completely glabrous.

3. Several writers have reported the occurrence of "*H. digyna*" or "*H. mucronata*" in New South Wales (e.g. Moore (1893), Dixon (1906), Maiden & Betch (1916). As collections of genuine *H. digyna* are only known from as far east as Eyre Peninsula, it is likely that the species involved is *H. myriocarpa*, or an entire-leafed form of *H. heterophylla*, if indeed any such plant exists. No collections have been seen to support this record, which apparently dates from Mueller (1882).

4. The epithet "*myriocarpa*" reflects the appearance of the fruiting spike where clusters of 3-7 fruits are closely associated.

22. *Haloragis digyna* Labill., ~~Nov~~. Holl. Pl. Sp. 1(1805)101, t. 129. [Typus: "Habitat in terra Van Leuwin." Holotypus: Specimen n.v., Labill., l.c., t. 129!] Sprengel (ed.), Syst. Veg. 2(1825)261; DC., Prod. 3(1828)67; Nees in Lehm, Pl. Preiss. 2(1848)226; Sonder, Linnaea 28(1856)231; Montr., Mem. Acad. Lyon 10(1860)199. Benth., Fl. Aust. 2(1864)475; F.v.M., Census 1(1882)49; Tate, Trans. roy. Soc. S.Aust. 7(1884)72; F.v.M., Trans. roy. Soc. Vict. 24(1888)137 p.p.; F.v.M., Sec. Census 1(1889)85; Tate, Trans. roy. Soc. S.Aust. 12(1889)95; Tate, Fl. S.Aust. (1890)101, 234 p.p.; Petersen, Pflfam. III.7(1893)232; Schindler, Bot. Jb. 34, Beibl. 77(1904)24; Schindler, Pflrch. 23(1905)12, 52; Gardner, Enum. (1931)99; Black, Fl. S.Aust. 2 ed. (1952)643 p.p.; Blackall & Grieve, W.Aust. Wildfls. 3(1965)468.

Gonocarpus mucronatus Nees in Lehm, Pl. Preiss. 2(1848)225 ('Goniocarpus') [Typus: "In solo sublimoso silvae ad fluvium Vasse-river (Sussex). Decembri a. 1839. Herb. Preiss. 1221." Holotypus: n.v. Isotypi: Preiss 1221, 1843, Nova Holland. occid., LE (fl.)!; Preiss 1221, Vasse River (Sussex) Nov. Holl. occid., MEL38949 (fl.,fr.)!; Preiss 1221, MEL38948 (fr.)!].

Haloragis mucronata (Nees) Benth., Fl., Aust. 2(1864)475 p.p.; Schomburgk, Fl.,S.Aust. (1875)40 p.p.; Tate, Trans. roy. Soc. S.Aust. 3(1880)64, 6(1883)156; F.v.M., Census 1(1882)49, Sec. Census 1(1889)85 p.p.; Black, Fl. S.Aust. (1926)430 p.p.

Fig: Schindler, Pflrch. 23(1905) fig. 15e.

Perennial herb, 20-40 cm tall, perennating and spreading from a deep lateral rootstock, stems erect or ascending, profusely branched, smooth, green or reddish, glabrous or sparsely scabrous with semi-appressed, 1-2 celled simple hyaline hairs 0.1-0.2 mm long.

Leaves opposite or subopposite at base, alternate above, linear, (1.0-)1.5-2.0(-2.3) cm long, (1.0-)1.5-2.0 mm wide, sessile, flattened, midrib and veins obscure, entire or weakly serrate with 1-4 teeth, submucronate, scabrous on margins with hairs as for stems.

Inflorescence an indeterminate spike of 3-7 flowered dichasia in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper 2-6 leaves. Primary bracts leaflike, green, fleshy, linear, 5.0-9.0 mm long, 1.0-1.5 mm wide, entire, scabrous on margin; secondary bracts brown, membranous, linear, 1.0-1.2 mm long, 0.1-0.2 mm wide, scabrous; tertiary bracts brown, membranous, linear-lanceolate, 0.6 mm long, 0.1-0.2 mm wide, scabrous.

Flowers 2-3(-4)-merous, all functional except some on ultimate branches, on pedicels 0.4-0.5 mm long. Sepals 2-3(-4), green, deltoid, 0.6-0.7 mm long, 0.4-0.6 mm wide, lacking midribs, scabrous. Petals 2-3(-4), red, hooded, tip horizontal or erect, unguiculate, 2.2-2.3 mm long, 0.7 mm wide (keel to margin), scabrous on keel. Stamens 4-6(-8), filaments 0.2 mm long; anthers yellow, oblong, 1.7-1.9 mm long, 0.2-0.3 mm wide, 4-locular, nonapiculate, antisepalous anthers ca 0.1-0.2 mm longer than antipetalous ones. Styles (1-)2-3, clavate, 0.5 mm long, stigmas capitate. Ovary ovoid or trigonous, 0.7-0.8 mm long, 0.5-0.6 mm wide, 3-4-ribbed or-angled, otherwise smooth, scabrous, locules same number as styles, 1 ovule per locule.

Fruits 1-3 per axil, ovoid-trigonous, 1.3-1.5 mm long, 0.9-1.0(-1.4)mm wide, weakly ribbed opposite sepals and petals, verrucose in lower part or smooth, scabrous; sepals persistant, erect, deltoid, 0.6-0.7(-1.0)mm long, 0.5-0.7(-1.0)mm wide, lacking midrib; fruit 1-3 locular, pericarp and septa ± woody, 1 seed per locule. (Fig. 23)

Distribution. (Map 9)

Scattered collections are known from near Busselton in south-western Western Australia, to near Cummins on southern Eyre Peninsula in South Australia.

Ecology.

Little is known of the soil and habitat preferences of this species. A Copley collection (2459) had the annotation "a few plants at roadside" while Copley 2978 grew as "a clump in grass at road corner". Orchard 2993 (probably from the same population as Copley 2978) was growing in heavy red clay-loam amongst introduced grasses on a cleared roadside bank. Flowering occurs from November until December, and fruiting from December until January.

Specimens examined.

Western Australia: Bate, s.n., 1886, Eucla, MEL38955 (fr.); Brooke s.n., 1885, Israelite Bay, MEL38954 (fr.); Maxwell s.n., S.W. Austr., MEL38953 (fl.,fr.); Oliver (?) s.n., Eucla, MEL1003694 (fr.); Preiss 1221, Nova Holland. occid., Vasse River, LE, MEL (fl.,fr.) - types of *G. mucronatus*.

South Australia: Alcock 2553, 12.xi.1968, road between Sections 13 & 16, Hundred of Cummins, AD (fl.); Copley 2459, 25.i.1969, 4 miles west of Butler Tanks, AD (fr.); Copley 2978, 1.i.1970, 16 miles east of Yeelanna, AD (fr.); Orchard 2993, 30.xii.1970, ca 13 km west of Ungarra on road to Yeelanna, AD (fl.,fr.).

Notes.

1. The fruits in the collections of Brooke and Oliver have swollen pericarps, differing in this respect from all other specimens. The hairs on Oliver's collection are slightly hooked at the tip, approaching the condition of those of *H. aspera* and its associated species.

2. Several authors, including Bentham and Mueller, have recorded *H. digyna* as '*H. mucronata*' from Victoria, New South Wales and south-eastern South Australia. The records from New South Wales apparently originate from Mueller (1882), but do not seem to be supported by specimens. The records of the species in Victoria and south-eastern South Australia date from Bentham (1864). The collections cited by Bentham from Victoria, and Mueller's collections from South Australia belong in *H. myriocarpa*, while Brown's collection from Kangaroo Island is flowering material of *H. acutangula*.

23. *Haloragis tenuifolia* Bentham, Fl. Aust. 2(1864)477 [Typus: W.Australia, Drummond, 4th Coll. n. 86." Holotypus: n.v. - see note. Isotypi: J. Drummond IV.86, Australia, ad fl. Cygnorum, LE (fl.,fr.); J. Dr. 86, W.A., MEL39299 (fl.,fr.); Drummond 4th Collection No. 86, 1848, W.Australia, NSW99269 ex BM (fl.,fr.); J. Drummond 4th ser. No.86, Swan R., W. (fl.,fr.)]; Benth., Fl. Aust. 2(1864)477 (sub. *H. aculeolata*); F.v.M., Census 1(1882) 49, Sec. Census 1(1889)85; F.v.M., Trans. roy. Soc. Vict. 24(1888)137 ('*H. tennifolia*'); Petersen, Pflfam. III.7(1893) 232; Schindler, Bot. Jb. 34 Beibl. 77(1904)5, 30; Diels & Pritzel, Bot. Jb. 35(1904)447; Schindler, Pflrch. 23(1905)54; Britten, J. Bot. 45(1907) 136; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)471.

Annual herb 23-30(-50) cm tall, glabrous, stems erect, herbaceous, ± unbranched, smooth or very weakly 4-ribbed, rooting at the lower nodes.

Leaves alternate, sessile, pinnatifid, segments 0.5-2.0 cm long, 0.1-0.15 cm wide, midrib obscure above, weakly prominent below, lamina (1.5-)3.0-5.0 cm long, 0.5-2.0 cm wide (including segments).

Inflorescence an indeterminate spike of 1-3(-5) flowered dichasia in the axils of primary bracts. Lateral inflorescences absent. Primary bracts leaflike, pinnatifid or linear, 0.5-3.0 cm long, rapidly reduced in length and dissection towards apex, segments 0.5-0.7 mm wide; secondary bracts brown, membranous, linear, 0.7-0.8 mm long, 0.1-0.2 mm wide; tertiary bracts brown, membranous, linear, 0.5-0.6 mm long, 0.1 mm wide.

Flowers 3-merous (rarely occasional flowers 2-merous), on pedicel 0.2-0.5 mm long. Sepals 3, broadly ovate, 0.5-0.6 mm long, 0.6-0.7 mm wide, not ribbed. Petals 3, hooded, tip rounded, keeled, unguiculate, 2.7-3.0 mm long, 0.7-0.9 mm wide (keel to margin). Stamens 6, filaments 0.2-0.3 mm long; anthers yellow, oblong, 2.5-2.6 mm long, 0.3-0.4 mm wide, nonapiculate, 4-celled, antipetalous anthers 0.1-0.2 mm shorter than antisepalous ones. Styles 3, clavate, 0.4-0.5 mm long, stigmas capitate. Ovary ovoid, 0.5-0.7 mm long, 0.4-0.7 mm wide, longitudinally 3-lobed opposite petals, 3-channelled opposite sepals.

Fruit 1-3(-5) per axil, on pedicel 0.7 mm long, ovoid, 1.7-2.4 mm long, 0.9-1.6 mm wide, trigonous, smooth or slightly rugose, lobes between sepals rounded; sepals persistent, erect, deltoid, (0.4-) 0.5-0.9 mm long, (0.5-)0.6-0.9 mm wide; fruit 3-locular, pericarp and septa ± woody, 1-3 seeds.

Distribution. (Map 9)

H. tenuifolia is confined to the Darling Ranges - Swan River area near Perth, Western Australia.

Ecology.

From the general appearance of the plant, and the sparse collectors' notes, it seems likely that *H. tenuifolia* grows in damp or swampy places, probably in grassy or sedge dominated habitats. Collectors' notes include "in moist places" (Koch 1792) and "in inundatis exsiccatis arenoso - lutosis" (Diels 1811). Flowering and fruiting specimens have been collected in November and December.

Specimens examined.

Western Australia: Anderson s.n., 19.xii.1930, Midland Junction, PERTH (fl.,fr.); Diels 1811, Byfield's Mill, NSW (fl.,fr.); Drummond IV, 86, 1848, Swan River, LE, MEL, NSW, W (fl.,fr.) - types of *H. tenuifolia*; Koch 1792, -.xi.1907, Wooroloo, AD, MEL, NSW (2 sheets) (fl.,fr.); Koch 1675 p.p., -.xi.1906, Darling Range, NSW (fl.,fr.).

Notes.

1. No specimen among those examined from K or MEL could reasonably be considered to be the holotype of this species, as they all lacked the indication of being from Drummond's 4th collection. Specimens from LE, NSW (ex BM) and W all bore this information, and are undoubtedly isotypes. The holotype may be in BM, but collections from this herbarium were not available during the present study.

2. *H. tenuifolia* very closely resembles *H. brownii*, differing mainly in its trimerous flowers and fruits and (usually) more slender foliage.

24. *Haloragis brownii* (Hook. f.) Schindler, Bot. Jb. 34. Beibl. 77(1904) 5, 6, 25, 30, 31, et Pflrch. 23(1905)54; Maiden & Betche, Census N.S. Wales Pl. (1916)158; Black, Fl. S.Aust. (1926)431, 2 ed.(1952)643; Ewart, Fl. Vict. (1931)883; Gardner, Enum (1931)99; Curtis, Stud. Fl. Tas. 1(1956)189; Blackall & Grieve, W. Aust. Wildfls. 3(1965)472.

Meionectes brownii Hook. f. in Hook., Ic. Pl. 4(1841)t.306. [Typus: "Van Dieman's Land, near Circular Head, in wet places, Mr. R. Gunn, (n.883)" Holotypus: Mr. Gunn 883, 1837, Van Ds. Land, K (herb Hook.) (fl.,fr.)!] Walp., Rep. 2(1843)98 ['Meionectis brownei']; Walp., Rep. 5(1846)671 ['Meionectis']; Nees in Lehm., Pl. Preiss. 2(1848)225 ['Mejonectes Brownii']; Hook. f., Fl. Tas. 1(1856)123; Benth., Fl. Aust. 2(1864)486; Tate, Trans. roy. Soc. S.Aust. 3(1880)63; Baillon, Nat. Hist. Pl. 6(1880)479; F.v.M., Census 1(1882)50; F.v.M., Key Syst. Vict. Pl. 2(1885)22; Moore, Hdbk. Fl. N.S.Wales (1893)186; Petersen, Pflfam. III.7(1893)233; Rodway, Tas. Fl. (1903)49; Dixon, Pl. N.S.Wales (1906)130.

Meionectes preissii Nees in Lehm., Pl. Preiss. 2(1848)224-225 [Typus: "In arenosis ad marginem lacus Mongerslake (Perth) d.9.Febr.a.1839. Herb. Preiss. No. 2385." Holotypus: n.v. Isotypi: L. Preiss 2385, 9.ii.1839, In arenosis ad marginem lacus "Monger's lake" (Perth), LE (fl.,fr.)!; Preiss 2385, 9.ii.1839, In arenosis ad marginem lacus "Mongerslake" (Perth), MEL1003464 (fl.)!; Preiss 2385, 1843, Swan River, G (herb. DC) (fl.,fr.)!].

Haloragis meionectes [F.v.M., Trans. roy. Soc. Vict. 24(1888)137, comb. not made] F.v.M., Key Syst. Vict. Pl. 1(1888)261 (nom. illeg.; 'Meionectes Brownii' is quoted as a synonym); Tate, Trans. roy. Soc. S.Aust. 12(1889)95; F.v.M., Sec. Census 1(1889)86; Tate, Fl. S.Aust.

(1890)101, 234; Diels & Pritzel, Bot. Jb. (1904)446.

Haloragis breviloba Schindler, Bot. Jb. 34. Beibl. 77(1904)5, 30, et Pflrch. 23(1905)56 [Typus: "West Australien: Swan River (Diels n.5494) - Herb Berlin." Holotypus: B, n.v. (destroyed). Isotypi: Diels 5494, West Australia, NSW113148 ex B (fl.)!; L. Diels 5494, 12.xi.1801, West Australien: Swan River. Guildford, MEL38934 (fl.)!]; Britten, J. Bot. 45(1907)136; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)472.

Figs: Hook., Ic. Pl. 4(1841) pl.306; Black, Fl. S.Aust. 2 ed. (1952) fig.876; Blackall & Grieve, W.Aust. Wildfls. 3(1965)472.

Herbaceous aquatic or semiaquatic plants, annual or perennial, growing either on damp shaded soil near water, when the stems are decumbent and ± supported by surrounding vegetation, or else in stagnant or slowly flowing fresh water up to 60 cm deep, when only the tips of the stems bearing flowers and fruits are emergent. Stems 10-40 cm long on land, up to 1 m or more in water, rooting at nodes, not or faintly longitudinally ribbed, glabrous.

Leaves alternate, ovate, pinnatipartite, 2.0-4.0(-5.5) cm long, 2.0-3.5(-4.0) cm wide, glabrous, midrib obscure; the lobes also pinnatipartite (at least in lower leaves), 1.5-2.0 mm wide in emergent leaves, less than 1 mm wide in submerged leaves, mid-vein present in all but the smallest lobes.

Inflorescence an indeterminate spike of 3-11-flowered dichasia borne in the axils of alternate primary bracts. Lateral inflorescences sometimes arise in the axils of the 2-4 upper leaves. Primary bracts leaf-like, trifid to pinnatifid, grading into the upper leaves in size and shape, gradually reduced towards apex, glabrous; secondary bracts linear, 0.4-0.6 mm long, 0.1-0.15 mm wide, brown, membranous; tertiary bracts linear-deltoid, minute, brown, membranous.

Flowers bimerous, glabrous, on pedicels 0.4-0.5 mm long. Sepals 2, deltoid, 0.8-1.0 mm long, 0.9-1.0 mm wide, lacking midrib. Petals 2, hooded, non-unguiculate, 1.7-2.5(-2.9) mm long, 0.3-0.5 mm wide (keel to margin), yellow-green to reddish. Stamens 4, filaments (0.3-)0.6-0.8 (-1.2) mm long; anthers narrow-oblong, 1.0-2.0(-3.0) mm long, 0.4-0.5 mm wide, 4-celled, non-apiculate. Styles 2, 1 mm long, stigmas shortly fimbriate. Ovary ovoid, ± compressed in plane of petals, 1.1-1.3 mm long, 0.8-1.0 mm wide. slightly furrowed from base of sepals, 2-locular with 1 pendulous ovule per locule.

Fruits 1-5 per axil, compressed-ovate, 2.8-3.1 mm long, 2.2-2.7 mm wide, margins muricate, undulate, sometimes ± winged. Persistent sepals ovate with prominent midvein. Exocarp very slightly spongy, endocarp and septum woody; 2 locules with a single seed in each.

Distribution. (Map 9)

H. brownii is known from south-western Western Australia, south-eastern South Australia (including Kangaroo Island) and from Victoria and Tasmania. It has also been stated to occur in New South Wales (Schindler, 1905), but no specimens have been seen which support this statement.

Ecology.

This species is usually found in or near ± stagnant fresh water. Collectors' notes include "on edge & in water of a swamp assoc. with

Tuart & Mel. rapheophylla" (Smith UWA490); "with Potamogeton in Typha swamp. Water 14" deep" (Marchant 114); "common on damp mud beside a small fresh-water swamp, in shaded situation" (Aston 1442); "in 30-45 cm water" (Orchard 1999) and "on mud above water level. Semi-erect plants amongst small reeds and grasses, etc., and partially supported by them." (Orchard 2000). Flowers are borne usually from October until February and fruits from October until May.

Specimens examined.

Tasmania: Gunn 883, 1837, Van Ds. Land, K(fl.,fr.) - holotype of *Meionectes brownii;* Hooker s.n., Tasmania, UPS (fr.); Williamson 1712, -.xi.1912, Flinders Is. MEL1003466 (fl.).

Victoria: Audas s.n., -.xii.1912, near Vereker Range, Wilson's Promontory, MEL1003449 (fr.); Audas & St.John s.n., 14.xi.1908, Oberon Bay Swamp, MEL1003440 (fl.,fr.); Aston 1442, 14.xii.1965, ½ mile S.W. of Drik Drik, AD (fl.,fr.); Beauglehole 5861, 13.xi.1963, 2½ miles S.W. of Portland post office, MEL (fl.,fr.); Beauglehole 7086, -.xii.1965, Long Swamp ± 2 miles E of Glenelg [River] mouth, MEL (fl.,fr.); Beauglehole & Finck 21342, 9.ix.1966, Two Mile Bay, Port Campbell National Park, BEAUGLEHOLE (st.); Mueller s.n., Wilson's Promontory, MEL1003438, 1003453, NSW99284 (fr.); Mueller s.n., Port Phillip, MEL1003448 (fr.); Mueller s.n., 30.iv.1853, entrance of the Snowy River, MEL1003447 (fr.); Mueller s.n., 11.v.1853, Wilson's Promontory, MEL1003441, 1003445 (fr.); Mueller s.n., -.ii.1855, mouth of the Snowy River, MEL1003442. NSW99282 (fr.); Orchard 1999, 2000, 11.ii.1969, Bridgewater Lakes ca 35 km west of Portland, AD (fl.,fr.); Orchard 2018, 13.ii.1969, Long Swamp, AD (fl.,fr.); Walters s.n., -.xi.1897, Grampians, NSW99281 (fl.); Williamson s.n., -.i.1896, Winslow, NSW99283 (fl.); Williamson s.n., -.x.1897, Winslow, MEL1003443 (fl.,fr.); Williamson s.n., -.xii.1902, Hawkesdale, BRI079976 (fl.,fr.).

South Australia: Cleland s.n., Morialta, AD968061225 (st.); Cleland s.n., 29.i.1924, upper Hindmarsh River, AD966032563, 968020528 (fl.,fr.); Cleland s.n., 18.ii.1924, Rocky River, K.I., AD968020545 (fl.,fr.); Cleland s.n., 5.iii.1926, Squashy Creek, K.I., AD968020542 (st.); Cleland s.n., 17.i.1931, Back Valley, AD968020548 (fl.,fr.); Cleland s.n., 20.xii.1942, upper Waterfall Gully, AD968020532 (fr.); Cleland s.n., ca 10 km south-east of Cape Banks, AD968020529 (fr.); Eardley s.n., 8.ii.1942, 8-mile Creek swamp, ADW4958 (fr.); Ising s.n., 29.vi.1929, Morialta, AD966032039 (st.); Mueller s.n., Dec. 29, Mt. Lofty Range, MEL1003452, 1003454, 1003455 (fr.); Tate s.n., 16.xi.1882, Cape Northumberland lagoon, AD96810063 (fl.,fr.); Tepper 1145, 24.xi.1885, Belair National Park, AD (fr.); Tepper 1195, 1196, -.ii.1884, Belair National Park, AD (fl.,fr.); C.W. s.n., entrance of the River Murray, MEL1003456 (st.).

Western Australia: Anon s.n., between Perth and York, MEL1003450 (fl.); Anon. s.n., Herdsman's Lake near Perth, UWA491 (fl.,fr.); Allmon s.n., -.iii.1916, Osborne Park, PERTH (fr.); Andrews 45, 17.x.1901, Guildford, PERTH (fl.); Brown s.n., K.G. Sound, MEL1003460 (fl.,fr.); Churchill s.n., 25.xii.1957, Cape Leeuwin, UWA492 (fl.); Churchill s.n., Mid Beach Swamp, UWA493 (fl.); Diels 5494, 12.xi.1801, Guildford, MEL, NSW (fl.) - isotypes of *H. breviloba*; Fitzgerald s.n., -.v.1901, Leederville, NSW99280 (fl.,fr.); George s.n., 5.ii.1965, Cullelal Lake, Wanneroo, PERTH (fl., fr.); Helms s.n., -.xii.1896, Albany, NSW103121 (fl.); Helms s.n., -.xii.1898, Albany, PERTH (st.); Jones s.n., -.xi.1963, Maddington, PERTH (fl.) - pollen sent to Palyn. Lab. Stockholm; Knight s.n., -.x.1959, White Lakes, UWA489 (st.); Koch 2544, 21.i.1921, Big Brook, Pemberton, BRI, MEL (fl.,fr.); Marchant 114, 23.xii.1957, Safety Bay, PERTH (fr.); McComb 215, -.ix.1966, Lock McNess, Yanchep, UWA (st.); Morrison s.n., 29.xi.1899, Cannington, BRI079977 (fl.); Morrison s.n., 19.i.1901, Herdsman's Lake, CANB136619, PERTH (fl.,fr.); Morrison s.n., 8.ii.1902, l.c., AD96344261, BRI079979, CANB136618, PERTH (fr.); Morrison s.n., Subiaco, PERTH (fl.); Morrison s.n., 6.iii.1909, Herdsman's Lake, CANB136620, PERTH (fr.); Mueller s.n., -.xi.1877, upper Swan River, MEL1003451, 1003462 (fl.); Mueller s.n., 10.xii.1877, upper Blackwood River MEL1003461 (fl.); Preiss 2385, 9.ii.1839, Monger's Lake, LE, MEL (fl.,fr.) - isotypes of *Meionectes preissii*; Preiss 2385, 1843, Swan River, G (fl.,fr.) - ?isotype of *M. preissii*; Preiss s.n., Busselton, MEL1003459 (fr.); Royce 3167, 15.x.1949, Ambergate, S. of Busselton, PERTH (fl.); Royce 5834, 24.ii.1959, Jandakot, PERTH (fl., fr.); Smith s.n., -.x.1959, Safety Bay, UWA490 (st.); Smith s.n., -.viii.1966, Augusta, UWA529 (st.); Walcott, s.n., Karri Dale, MEL1003465 (fl.,fr.).

Notes.

1. The Preiss collection in herb. G is tentatively listed as an isotype of *Meionectes preissii* on the basis of the collector's number. The locality given ("Swan River") is a general designation including the type locality ("Monger's Lake"), but the date (1843) does not agree with that on the other type collections (9.ii.1839). It is probable that this later date represents the date of accession (by herb. G) rather than the date of collection.

2. *H. brownii* is probably most closely related to *H. tenuifolia*, which it resembles in habit, leaf shape and habitat preference. It differs mainly in its bimerous flowers and fruits; those of *H. tenuifolia* are trimerous.

B. HALORAGODENDRON Orchard, gen. nov.

Haloragis Forst., Char. Gen. Pl. (1776)61, t. 31. p.p.

Halorrhagis sect. b. *Pleianthus* subsect. ι. *Spongiocarpus* Schindler, Pflrch. 23(1905)59 p.p.

Frutices vel arbores parvae, glabrae, 1-3 m. altae; caules erecti, valde 4-angulati; folia decussata, serrata vel biserrata, petiolata vel subsessilia. Inflorescentia terminales, racemosa, flore apicali et dichasiis compositis in axillis foliorum superorum reductorum pauxillum dispositis. Flores bisexuales, tetrameri; petala navicularia vel planiuscula, non cucullata, eburnea vel sanguinea, 2.5-5.5 mm longa; antherae lineares vel apices versus decresentes, bases versus rotundatae vel sagittatae aliquam, connectiva in apicula plus minusve curvata producta. Ovarium quadri-alata vel quadri-costata, ovula quattuor pendula, locula quattuor completa vel incompleta septis solidis non nisi in apice lateribus basique praesentibus. Fructus indehiscens, 1-seminalus, 4-alatus vel 4-costatus, pericarpium plus minusve spongiosum, endocarpium lignosum pauxillum.

Type species: *Haloragodendron racemosum* (Labill.) Orchard comb. nov. (Basionym: *Haloragis racemosa* Labill. Nov. Holl. Pl. Sp. 1(1805)100, pl. 128.)

Glabrous shrubs or small trees 1-3 m tall, branches spreading or erect, decussately arranged, ± square with 4 prominent vertical ribs, smooth or dotted with raised tubercular oil glands, often reddish; leaves decussate, petiolate or almost sessile, juvenile leaves sometimes pinnatisect or pinnatifid, mature leaves linear or narrow - oblong to lanceolate, serrate to biserrate, midrib prominent below, channelled above, often bearing well developed leafy shoots in the axils, giving the impression of whorled leaves. Leaves variable between species, 1-9 cm long, 0.1-1.5 cm wide, thin or thick in texture, always glabrous.

Inflorescence terminal, primary bracts decussate, only slightly reduced from vegetative leaves, and retaining all their leaf-like characteristics. Axis terminated by a simple or compound dichasium, with simple or compound dichasia of 3-15 flowers in the axils of the upper 4-7 pairs of bracts and lateral inflorescences of similar construction in the axils of leaves immediately below the terminal inflorescence and at irregular intervals down the stem. The lowest pair of bracts in the terminal inflorescence may bear 3-7 flowered auxiliary dichasia in addition to the normal ones. Primary bracts persistent at least in the lower part of the inflorescence, secondary and tertiary bracts thin, membranous, deciduous at or about anthesis. The terminal flower of the inflorescence and of the lateral dichasia develop to maturity as can some of the lateral flowers within the dichasia, but the flowers of the ultimate branches of the compound dichasia usually abort at an early stage. In *H. lucasii* the terminal flower of the inflorescence develops first, followed by the terminal flowers of the lateral dichasia in a basifugal sequence. In other species such as *H. racemosum* and *H. monospermum* all of the functional terminal flowers of the primary dichasia open ± simultaneously or in a slightly basifugal sequence. In any case, within any compound dichasium, the flowering order is in the order of branching.

Flowers showy, ± sessile or borne on pedicels 1-2 mm long. Sepals 4, deltoid, smooth or convex, lacking median basal callus. Petals 4, red or cream, navicular or planar, not hooded ± lanceolate, contorted or imbricate, (2.5-) 5-10 mm long, (0.7-)1.5-2.5 mm wide. Stamens 8, anthers yellow, 4 locular, opening by slits, linear or tapering towards apex, connective produced into a short ± curved apiculum, the base rounded or sagittate, length 2-3 (-7) mm long, on filaments 1-2.5 mm long. Styles 4, stigma yellow or red, capitate, fimbriate. Ovary inferior, glabrous, tapering towards base longitudinally 4-ribbed or-angled, 4-locular, septa solid, 1 ovule per locule.

Fruit obovoid-obpyramidal, shortly pedicellate and pedunculate longitudinally 4-winged or 4-angled, smooth between angles, pericarp ± spongy, endocarp slightly woody. Only 1 ovule per fruit develops and occupies the entire fruit, pushing the septa to one side.

A genus of 5 species, all narrow endemics, 2 confined to southwestern Western Australia, two to eastern New South Wales and one to north-eastern Victoria. One species, *H. lucasii*, is very rare and perhaps extinct.

Key to the species of *Haloragodendron*.

(1) Fruits 4 angled, lacking distinct wings, petals cream, plants smooth, not glandular.

(2) Erect tree or shrub 1-3 m tall, leaves all lanceolate, 6-8 cm long [W. Aust. species]. 1. *H. racemosum*

(2) Rounded shrub ½-1½ m tall, juvenile leaves pinnatisect, adult leaves lanceolate, 1.3-1.9 cm long [N.S.Wales species]. 3. *H. monospermum*

(1) Fruits 4 winged, petals cream or red, plants smooth or glandular.

(3) Petals cream, plant smooth, leaves lanceolate [eastern species].

(4) Petals torsive (not twisted) in bud, anthers linear, not tapering, 2-3 mm long [Vict.-N.S.Wales species].

2. *H. baeuerlenii*

(4) Petals contorted in bud, anthers tapering towards apex, 5-7 mm long [N.S.Wales species]. 4. *H. lucasii*

(3) Petals red, plant glandular, leaves linear to narrow-oblong [W.Aust. species]. 5. *H. glandulosum*

1. *Haloragodendron racemosum* (Labill.) Orchard, comb. nov.

Haloragis racemosa Labill. Nov. Holl. Pl. Sp. 1(1805)100, pl.128! [Typus: "Habitat in Terra Van Leuwin". Lectotypus (Orchard): No.130. Nova Hollandia ora austro-occidentalis. Herb. Webbianum. Ex Herb. Labillardiere, FI (photograph!) Isolectotypi: M. Labillardiere, Nouv. Holl. Sud-ouest, G (fr.)!; "haloragis racemosa. bill. in Holl. Herb. Webbianum. Ex. Herb. Desfontaines.", FI (photograph!)]; Sprengel (ed.), Linn. Syst. Veg. ed. 16. 2(1825)261; Benth., Fl. Aust. 2(1864)480; F.v.M., Frag. 8(1874)162; F.v.M., Census 1(1882)49; F.v.M., Sec. Census 1(1889)85; Schindler, Bot. Jb. 34.Beibl. 77(1904)30,31,35,42; Schindler, Pflrch. 23(1905)59; Britten, J. Bot. 45(1907)137; Gardner, Enum. (1931)99.

Cercodia racemosa (Labill.) DC.,Prod. 3(1828)67.

Haloragis racemosa var. *angustifolia* Schindler, Pflrch. 23(1905)59. [Typus: "West Australien: (R.Brown, F.v.Müller, Maxwell). - Herb. Berlin Deless., Petersb." Lectotypus (Orchard): Maxwell, B (probably destroyed) n.v. Isolectotypus: Maxwell, NSW99297 ex B !] ; Ewart, Fl. Vict. (1931)882; Blackall & Grieve, W. Aust. Wildfls. 3(1965)469.

Small erect tree or shrub 2-3 m tall, glabrous, branching decussate; stems square, prominently 4 ribbed, somewhat reddish. Leaves decussate, petiolate, linear-lanceolate, widest below middle, upper part attenuated into a narrow tapering point, serrate with 40-50 distinct teeth, dark green above, paler below, midrib sunken above, prominent on undersurface, lateral veins obscure, lamina 6-8(-9) cm long, 0.6-0.8(-1.4) cm wide, petiole narrowly winged, merging insensibly with blade, ca 1 cm long.

Inflorescence a terminal raceme. Axis monopodial, terminated by a compound dichasium of 7 flowers. Compound dichasia of 7-15 flowers are borne in the axils of the 5-6 pairs of decussately arranged bracts immediately below the apical dichasium, becoming more complex basipetally. The lowermost pair of bracts may also bear an auxiliary dichasial inflorescence of 3-7 flowers. Lateral inflorescences similar to but less complex than the terminal one are borne in the axils of the 2-3 pairs of leaves immediately below the terminal inflorescence. Within each compound dichasium all except the flowers of the ultimate branches are functional, and within the inflorescence all of the functional flowers develop ± simultaneously.

Primary bracts leaflike, becoming reduced towards the apex of the inflorescence, fleshy and serrated; secondary, tertiary etc. bracts lanceolate, ± membranous and deciduous at an early stage.

Flowers cream-green on thin pedicel 1.0-1.5 mm long. Sepals 4 deltoid-ovate, ± smooth with faint median longitudinal rib, 0.6 mm long, 1.0 mm wide. Petals 4, cream, navicular, torsive (not twisted), 3.0 mm long, 1.2 mm wide. Stamens 8, filaments 0.5-0.7 mm long; anthers yellow, 4 locular, tapering slightly towards apex, 2.0-2.2 mm long, 0.4-0.5 mm wide at base, connective produced into a short ± curved apiculum. Styles 4, clavate, 0.8-1.0 mm long. Ovary obovoid, 4 angled, smooth, 1.2-1.5 mm long, 0.8-0.9 mm wide, 4 locular, with 2 ovules per locule, 1 of which aborts at an early stage.

Fruit obovoid with 4 narrow vertical wings, almost square in transverse section, wings decurrent in pedicel and sepals. Sepals persistent, erect, broad-deltoid, 0.5 mm long, 3.0 mm wide, with an indistinct median longitudinal rib. Pericarp spongy, endocarp very slightly woody. Length

9.0-10.0 mm, width 4.5-5.0 mm, 1 locular by abortion of 3 ovules, 1 seed occupying the whole fruit and pushing the septa and columella to one side. (Figs. 17, 25)

Distribution. (Map 12)

The species is confined to a coastal strip of south-western Western Australia from the vicinity of Esperance Bay to Cape Leeuwin and including the off-shore islands of the Recherche Archipelago.

Ecology.

Haloragodendron racemosum appears to favour sandy granitic soils. Collectors' notes include "in deep depression of granite outcrop" (Aplin 2620), "creek head in Karri forest" (Baird UWA496) and "in deep black sand in gullies" (Royce 6225). Flowers October to December, fruits late October to January or February.

Specimens examined.

Western Australia: Anon. s.n., Middle Island, Recherche Archipelago, MEL39233 (fl.,fr.); Anon. s.n., 1884, Lake Muir, MEL39237 (fl.); Anon. 34, summit of Mt. Lindsay, MEL39240 (fl.); Aplin 2620, 25.x.1963, Mt. Boyatup, PERTH (fl.,fr.) - Voucher for Alkaloid Survey; Baird s.n., 5.i.1933, Nornalup Inlet, UWA495 (fr.); Baird s.n., 6.xii.1947, Walpole, UWA496 (fr.); Brown s.n., 1802-5, Bay I., LE (fr.); Brown s.n., 1802, Bay I., MEL39235 (fr.); Delin(?) 130, Nova Hollandia ora occidentalis, FI ex Herb. Labill. (photo. only)(fr.) - lectotype of *Haloragis racemosa*; Humphreys s.n., -.x.1965, Walpole, W. of Albany, PERTH (fl.,fr.); bill. [Labillardiere] s.n., in holl., FI ex Herb. Desfontaines (st.) - isolectotype of *Haloragis racemosa*; Labillardiere s.n., Nouv. Holl. Sud-ouest, G (fr.) - isolectotype of *Haloragis racemosa*; Maxwell s.n., s. loc., NSW99297 (fr.) - isolectotype of *Haloragis racemosa* var. *angustifolia;* Maxwell s.n., S.W. Australia, MEL39234,39236 (fl.,fr.); Maxwell s.n., on the island in Nornalup Inlet, MEL39239 (fr.); McHardie s.n., 1884, Blackwood River, MEL39238 (fr.); Orchard 1285, 1.x.1968, Boyatup Hill, 110 km east of Esperance, AD (fl.); Richardson s.n., -.xi.1930, Frankland River, Nornalup, PERTH (fr.); Royce 6225, 6.ii.1960, Mondrain Island, Recherche Archipelago, PERTH (fl.,fr.); Webb s.n., 1882, Mt. Lindsay, MEL39241 (fl.); Willis s.n., 7.xi.1950, Figure-of-Eight Island, Recherche Archipelago, MEL39242 (fl.,fr.).

Notes.

1. The choice of a lectotype is necessary as there are two specimens in FI both from Webb's Herbarium (see Stafleu 1967, p.252), and both

bearing labels in Labillardiere's handwriting. The sheet here designated lectotype bears three labels, the largest consisting of notes on the specimens in Labillardiere's handwriting as well as "Dr. Delin(?) No.130. Haloragis racemosa Lab. 128." The second label also in Labillardiere's handwriting consists of the second half of his description in Novae Hollandiae Plantarum Specimen from "... concava, dorso carinata, utrinque acuta, ..." to the end of the legend for the plate. The third label is printed with the words "Herb. Webbianum. Ex Herb. Labillardiere." with the locality "Nova Hollandia ora austro-occidentalis" in handwriting other than Labillardiere's. The material consists of 5 separate specimens, all apparently belonging to the same entity. The second sheet in FI consists of a single specimen and two labels. One bears the words "haloragis racemosa. bill. in Holl." in Labillardiere's handwriting, the other has the printed words "Herb Webbianum. Ex. Herb Desfontaines." as well as the word "Haloragis" in an unknown handwriting.

2. In Labillardiere's description he states "rami oppositi aut alterni" and in the accompanying Tab. 128 the branches of the leafy flowering shoot are shown as all alternate. In the type material, as in all other material examined, the branching at least in the upper part of the plant is decussate (with the exception of occasional pseudo-alternate nodes). Tab. 128 also shows the anthers as dorsifixed and versatile, whereas they should be basifixed.

3. A collection by R.D. Royce (no. 6225) from the Recherche Archipelago differs from the mainland material in having the fruit pericarp not spongy and possessing proportionately broader leaves with much smaller serrations. More material is required from this area to determine whether this specimen represents a distinct taxon or only a teratological

variant.

4. *H. racemosum* is probably closest allied to *H. baeuerlenii* which was united with it by Schindler (1905).

2. *Haloragodendron baeuerlenii* (F.v.M.) Orchard, comb. nov.

Haloragis baeuerlenii F.v.M., Trans. roy. Soc. Vict. 24(1888) 132. [Typus: "Between rocks in ravines on and near the summit of Mount Tingiringi, at an elevation of about 5000 feet; W. Baeuerlen." Lectotypus (Orchard): Baeuerlen 545, -.v.1887, Tingiringi Mountain, MEL39229 (fr.)! Syntypi: Baeuerlen s.n., Tingiringi Mt., MEL39222 (wood sample)!; Baeuerlen s.n., Tingiringi Mountain, MEL39224 (fr.)! Baeuerlen s.n., 1885, Mt. Tingiringi, MEL39225 (fr.)! Baeuerlen s.n., 1887, Mt. Tingiringi, MEL39228 (st.)!, NSW99299 (fl.,fr.)!; Baeuerlen 535, -.v.1887, Tingiringi Mntn, MEL39227 (fr.)!; Baeuerlen 545, -.v.1887, Tingiringi Mntn, MEL39223 (fr.)!];F.v.M., Key Syst. Vict. Pl. 1(1887-8) 261 ('baeuerleni'); F.v.M., Sec. Census 1(1889)85 ('bauerlenii'); Moore,Hdbk. Fl. N.S.Wales (1893)185; Bailey, Qld. Flora 2(1900)553,554 ('bauerlenii'); Schindler, Pflrch. 23(1905)59 pro syn. *H. racemosae* [*H. Haenerlein* F.v.M. ex Schindl.,l.c., nom. nud.; the reference given is incorrect.]; Durand & Jackson, Ind. Kew., Suppl. 1(1906)195 ('baeuerleinii'); Dixon, Pl. N.S.Wales (1906)129; Bailey, Comp. Cat. Qld. Pl. (1913)175.

Haloragis racemosa var. *baeuerlenii* (F.v.M.) Schindler, Pflrch. 23(1905)59; Maiden & Betche, Census N.S.Wales Pl. (1916)159 ('baeuerleni'); Ewart, Fl. Vict. (1931)882.

Shrub or small tree up to 1½ m tall, glabrous, branches spreading, decussately arranged. Stems reddish, prominently 4 winged and angled. Leaves decussate, lanceolate, serrate with 30-40 small simple appressed teeth; midrib sunken above, prominent below, lateral veins obscure; glabrous, dark green above, paler below; 3.0-3.5 cm long, 0.6-0.8 cm wide, widest just below middle, on a petiole 0.5-0.6 mm long.

Inflorescence racemose, terminal on young stems. Axis monopodial, terminated by a compound dichasium of 7 flowers. Simple or compound dichasia of 3-7 flowers are borne in the axils of the 3-5 pairs of primary bracts immediately below the apical dichasium, becoming more complex basipetally. Lateral inflorescences similar to but less complex than the terminal one, are borne in the axils of the pair of leaves immediately below the terminal inflorescence. Within each compound dichasium ("Paracladium") only the flowers of the ultimate branches do not develop. The terminal flower of the whole inflorescence opens first followed by the other functional flowers which develop ± simultaneously. Primary bracts similar in size and shape to the upper leaves.

Flowers showy, on thin pedicels 1.5-1.7 mm long. Dichasia usually on short thick flattened peduncles 0.5-1.0 mm long. Sepals 4, deltoid, erect, 1.0-1.4 mm wide, 1.0-1.2 mm long, slightly convex, lacking basal calluses. Petals 4, navicular, imbricate, almost flat, cream to white, 5.0-5.5 mm long, 1.8-2.0 mm wide. Stamens 8, filament fine, ca 1 mm long; anthers yellow, linear, 4 celled, opening by slits, 2.2-2.6 mm long, 0.3-0.4 mm wide, connective produced into a short curved apiculum. Styles 4, red. Ovary glabrous, 4 winged, 2.0-2.3 mm long, 1.5 mm wide (incl. wings), slightly convex between wings, otherwise smooth, incompletely 4-celled, septa solid.

Fruit obovoid, 4 winged, the wings narrow, longitudinal, antipetalous, ca 0.5 mm wide, profusely veined in a dichotomously branching and anastomosing pattern, lacking a marginal vein, produced for a short distance below the fruit and decurrent in the pedicel. Fruit 5.0-5.5 mm long, 4.0-4.5 mm wide (incl. wings) widest slightly above the middle, sepals persistent, erect, enclosing the styles, broadly deltoid, 2.0 mm wide and 0.5 mm long; pericarp slightly spongy, endocarp slightly woody, 8 ribbed; septa pushed to one side by the single seed. (Fig. 25)

Distribution: (Map 12)

This species is confined to a small area on the New South Wales-Victorian border between Delegate and Wulgulmerang.

Ecology.

H. baeuerlenii is confined to the tops of mountains which end at an altitude of 3000-4000(-5000) ft. (900-1500 m.) in a rocky outcrop. The plants are usually found in crevices on the north-facing side of these outcrops. Flowering occurs from December to January and fruiting from December to June.

Specimens examined.

New South Wales. Anon s.n., Broga (near Bega), MEL1003714 (st.); Baeuerlen s.n., 1887, source of the Genoa, K (fr.); Clifford s.n., -.vi.1888, Delegate, MEL39230 (fr.); Forsyth s.n., -.i.1910, Merambego, Delegate, NSW99298 (fr.).

Victoria. Baeuerlen s.n., Tingiringi Mt., MEL39222 (wood sample) - syntype of *H. baeuerlenii*; Baeuerlen s.n., Tingiringi Mountain, MEL39224 (fr.); Baeuerlen s.n., 1885, Mt. Tingiringi, MEL39225 (fr.); Baeuerlen s.n., 1887, Mt. Tingiringi, MEL39228 (st.), NSW99299 (fl.,fr.); Baeuerlen 535,545, -.v.1887, Tingiringi Mntn, MEL39227,39223 (fr.) - all the above Baeuerlen specimens are syntypes of *H. baeuerlenii*; Baeuerlen 545, -.v.1887, Tingiringi Mountain, MEL39229 (fr.) - lectotype of *H. baeuerlenii*; Baeuerlen s.n., -.i.1889, Tingiringi Mntn, MEL (fl.,fr.); Beauglehole, Rogers & Finck 33376, 7.i.1970, Ballantyne Needles, east of Wulgulmerang-Suggan Buggan road, AD, BEAUGLEHOLE (fr., seedlings); Hunter s.n., -.xii.1939, Ballantyne's Hills, Suggan Buggan, MEL39231 (fr.); Orchard 2647, 5.xii.1970, Mt. Wheeler ca 10 km east of Wulgulmerang, AD (fl., fr.); Orchard 2784, 2785, 7.xii.1970, Ballantyne Hills, Suggan Buggan, AD (fl., fr.).

Notes.

1. Bailey (1900) claimed that *Haloragis baeuerlenii* was recorded for Queensland by Mueller, but cites no reference or specimens. This record is unsupported by other evidence and is extremely suspect.

2. The choice of a lectotype is necessary for *Haloragis baeuerlenii* because of the large number of sheets in MEL representing several different collections. Any one of these could serve as lectotype, but the one chosen has the best material.

3. *H. baeuerlenii* was considered to be a varietas of *H. racemosa* by Schindler (1905). Although these two species are closely related, they differ sufficiently in leaf and fruit characters to be maintained as distinct, and are separated by 1100 miles (ca 1880 km).

3. *Haloragodendron monospermum* (F.v.M.) Orchard, comb. nov.

Haloragis monosperma F.v.M., Proc. Linn. Soc. N.S.Wales 10(1885)197 [Typus: "On heaths at the western side of the ranges near Braidwood, at an elevation of about 3000 feet; W. Bauerlen." Holotypus: W. Baeuerlen 448, Febr. 1885, Braidwood District, 3,200 ft., MEL39170 (fr.)! Isotypus: W. Bauerlen s.n., -.ii.1885, Braidwood, NSW99302 p.p. (fr.)!]; F. Muell., Key Syst. Vict., Pl. 2(1885)22; F. Muell., Trans. roy. Soc. Vict. 24(1888)137; F. Muell., Sec. Census 1(1889)86; Moore, Hdbk. Fl. N.S.Wales (1893)185; Schindler, Bot. Jb. 34. Beibl. 77(1904)30,31,40; Schindler, Pflrch. 23(1905)59; Dixon, Pl.N.S.Wales (1906)129; Maiden & Betche, Census N.S.Wales Pl. (1916)158.

Erect or rounded shrub 1-2 m tall, glabrous, branching decussate, stems 4 ribbed, terminating in inflorescences. Leaves decussate, sessile, juvenile leaves deeply dissected, pinnatisect to pinnatifid, adult leaves narrow lanceolate, widest at middle, apex acute, slightly narrowed towards base, midrib channelled above, ± prominent below, margin finely serrate in upper $\frac{1}{2}$-$\frac{2}{3}$ with 10-15 teeth; 13-19 mm long, 1.0-1.5(-3.0) mm wide. Vegetative leaves often bearing leafy shoots in their axils, giving the impression that the leaves are whorled.

Inflorescence terminal on young stems. Axis monopodial, terminated by simple dichasium or monochasium of 1-3 flowers. Simple or compound dichasia of 3-7 flowers are borne in the axils of the 6-7 pairs of primary bracts immediately below the terminal dichasium, becoming more complex basipetally. Lateral inflorescences similar to but less complex than the terminal one are borne in the axils of the leaves below the terminal inflorescence. Within the dichasia all flowers except those of the ultimate branches are functional, and usually all of the functional flowers form fruits. The order of flowering within the inflorescence is basifugal, the terminal flower opening last; the terminal inflorescence developing before the lateral ones. Primary bracts green, leaf-like, reduced to about half normal leaf size in the upper part of the inflorescence, secondary bracts lanceolate, membranous, ca 0.5 mm long, 0.1 mm wide; tertiary bracts ca 0.2 mm long, 0.05 mm wide; secondary and tertiary bracts deciduous at or before anthesis.

Flowers on pedicels 0.5-0.8 mm long, peduncle very short. Sepals 4, deltoid, smooth, 0.7 mm long, 0.8 mm wide. Petals 4, cream, shallow-navicular, almost flat, slightly keeled, apparently acute at tip in bud, but actually rounded, 4.5-5.0 mm long, 1.4-1.6 mm wide. Stamens 8, filaments 1.0-1.3 mm long; anthers yellow, 4 locular, tapering slightly towards apex, ± sagittate at base, connective produced into small apiculum at apex, 3.1-3.6 mm long, 0.2-0.3 mm wide. Styles 4, yellow, 0.7 mm long including orange capitate stigmas. Ovary obpyramidal, 4 angled, ca 1.2 mm long, 1.0 mm wide.

Fruit sessile, pedicel 0.5 mm long, ± oblong, tapering towards base, 4 sharp slightly verrucose angles opposite the petals, 4 indistinct smooth rounded ribs opposite sepals, otherwise smooth, slightly swollen at apex, 3.5-3.7 mm long (excl. sepals) 1.7-2.0 mm wide. Sepals persistent, erect, broad-deltoid, 1.2 mm wide, 0.6 mm long. Styles persistent, ± 1.1 mm long. Fruit 4 locular, septa solid, pushed to one side by single seed. (Figs. 17, 25)

Ecology.

Grows on granitic soils at elevations of 2000-4000 feet. Those plants from the Corang River were growing on the floodplain of the river bed. Flowers late October to December, fruits December to February or March.

Distribution. (Map 12)

Confined to the mountains near Braidwood, New South Wales, at an elevation of 2000-4000 ft., plus one specimen from near Kybean.

Specimens seen.

New South Wales: Bauerlen s.n., -.ii.1885, Braidwood, NSW99302 p.p. (fr.) - holotype of *Haloragis monosperma*; Bauerlen s.n., -.xi.1886, Braidwood, NSW99302 p.p. (fl.); Bauerlen s.n., -.xii.1886, Charley's Forest, Braidwood District, BRI080071 (fl.); Bauerlen s.n., ante 1887, near Braidwood, G (Herb. DC.) ex MEL (fl.); WB. [Baeuerlen?] s.n., -.xi.1888, Corang River, NSW99304 (fl.); Boorman s.n., -.iii.1909, Currocobilly Mnt. Braidwood, NSW99303 (fr.); Boorman s.n., -.ii.1910, Currockbilly, AD9620066 ex NSW (st.); Cambage 1897, 4.xi.1908, Kybean, near Kydra Trig Station, NSW (st.); Gauba s.n., 10.xi.1957, East of Braidwood, CBG013194 (fl.); Orchard 2389,2390,2391,2392, 29.x.1969, Corang River at crossing of the Nerriga-Braidwood road, AD (fl.); Wrigley s.n., 4.xii.1967, Corang River, Braidwood-Nerriga road, CBG023487, (fl.,fr.).

Notes.

1. Mueller (1885) records this species for eastern Victoria, in the Gippsland area. No collections have been seen to support this statement, but the species is known from New South Wales, adjacent to the Victorian border.

2. The relationships of this species are obscure, but probably lie with *H. baeuerlenii*.

4. *Haloragodendron lucasii* (Maid.et Betche) Orchard, comb. nov.

Halorrhagis lucasii Maiden et Betche, Proc. Linn. Soc. N.S.Wales 34(1909)358 ('lucasi') [Typus: "A.H.S. Lucas, in a wild gully near Gordon, Port Jackson, November, 1908." Holotypus: A.H.S. Lucas, In a wild gully near Gordon, -.x.1908, NSW113167 (fl.,young fr.)! isotypi: A.H.S. Lucas, -.x.1908, Gordon, AD96905159 ex NSW (st.)!, A.H.S. Lucas, -.x.1908, Near Gordon in the Port Jackson district, G(Herb.Pitard-Briau)ex NSW!, MEL1003576 ex NSW (fl.,frt.)!]; Maiden & Betche, Census N.S.Wales Pl. (1916)158; Evans, in Beadle, Evans & Carolin, Hdbk. Vasc. Pl. Syd. (1963)175.

Figs: Maiden & Betche, Proc. Linn. Soc. N.S.Wales 34(1909) Pl.31.

Erect shrub up to 1 m tall, glabrous, stems arranged decussately, 4 winged. Leaves decussate, sessile, oblanceolate, widest about $\frac{2}{3}$ of way to acute apex, midrib channelled above, prominent below, lateral veins not visible, coriaceous, darker green above than below, serrate to biserrate, 10-16 serrations per leaf mainly in the upper $\frac{1}{2}$ to $\frac{2}{3}$, 2.5-3.0(-4.5) cm long, 0.4-0.5 cm wide.

Inflorescence racemose, terminal on young stems. Axis terminated by a simple dichasium, with simple dichasia in the axils of the upper 3-4 pairs of primary bracts. Lateral inflorescences similar to the terminal one but extending over only 1-3 nodes, are borne in the axils of the 3-6 pairs of leaves immediately below the terminal inflorescence. Within each inflorescence, the terminal flower of the terminal dichasium develops first, followed by the terminal flowers of the two lowest dichasia. The terminal flowers of the intermediate dichasia then open in basifugal order. The lateral flowers of each dichasium abort. Primary bracts similar in size and shape to upper leaves. Secondary bracts brown, opaque, lanceolate, entire, ± 2 mm long, 0.4 mm wide, deciduous before anthesis, tertiary bracts formed, extremely minute, deciduous early with the lateral flowers of the dichasium.

Flowers ± sessile on peduncle 0.3 mm long. Sepals 4, broad-deltoid, erect, 1.0 mm long 1.5 mm wide. Petals 4, creamy white, strongly twisted in bud, very shallow navicular (almost planar) in flower, lanceolate, 9.5-12(-14) mm long, 2.0-2.5 mm wide, becoming twisted again before being shed. Stamens 8, filaments 1.5-2.5 mm long; anthers yellow with reddish connective, narrowly sagittate, somewhat compressed, tapering to a blunt point at the apex, (4.0-)5.5-7.0 mm long, 0.6 mm wide at base. Styles 4, conical at first, later capped with a saddle shaped fimbriate stigma. Ovary glabrous, ellipsoid, with four longitudinal antipetalous wings 0.5 mm wide; 4.2 mm long, 2.5 mm wide (incl. wings).

Fruit not seen mature. Borne on pedicel 0.2-0.5 mm long on peduncle 0.5-1.0 mm long. (Figs. 18, 25)

Ecology.

Very little known. Flowers August to November, fruits present in October.

Distribution. (Map 12)

Confined to New South Wales in the vicinity of Ku-Ring-Gai Chase, a reserve near Hornsby in the north-west suburbs of Sydney. Last collected in 1926, the species is very rare or extinct. Searched for in vain, 29th October, 1969.

Specimens seen.

New South Wales: Blakely s.n., -.xi.1915, Turramurra Range, Hornsby, NSW99294 (fl.,young f .); Blakely s.n., -.viii.1916, Kuringai Chase, Hornsby, AD96920067, BRI080045, SYD (fl.,young fr.); Blakely s.n., 15.ix.1918, 2½ miles east of Hornsby, NSW99296 (fl.); Blakely s.n., -.ix.1920, Kuring-gai Chase, 2½ miles E. of Hornsby, NSW99295 (fl., young fr.); Blakely, Lucas & Shiress, 14.viii.1926, About 3 miles due E of Hornsby railway station, AD96921184 (fl.); Lucas, -.x.1908, In a wild gully near Gordon, NSW113167 (holotype of *Haloragis lucasii*), G (Herb. Pitard-Briau) ex NSW, MEL1003576 ex NSW (isotypes; all 3 fl., young fr.), AD96905159 (isotype; st.).

Notes:

1. In Maiden and Betche's original description of *Haloragis lucasi* they give the date of collection of the type specimen as November, 1908. The date on the holotype (NSW) and both isotypes (AD, MEL) is clearly stated as "10.1908".

2. The buds in the type specimens have the petals twisted in a dexter direction (as viewed from outside) while all other collections have them twisted in a sinister direction. In all cases however, the type of imbrication is the same, with the right hand margin of the petal visible, and covering the left hand side of the adjacent petal.
i.e. from above  The significance of this is unknown.

3. The relationships of this species are obscure.

5. *Haloragodendron glandulosum* Orchard, sp. nov.

Frutex parvus glaber, caules 4-alati glandibus multis stipitatis rubris vestiti. Folia linearia ad angusto-oblonga sessilia 0.9-1.4 cm longa 0.2-0.4 cm lata serrata glandibus in marginibus. Flores rubri, petala navicularia, antherae luteae apiculatae 1.5-2.0 mm longae. Fructus rubri-purpurei 4-alati obpyriformes; alae in pedicellum decurrentes ad apices auriculatae. Semen 1, septa ad laterem depulsa.

Typus: Hj. Eichler 21105, 9.ix.1971, Western Australia. South-West Division. Shire of Oldfield. Kundip, ca. 20 km south of Ravensthorpe, along roadside on gravel of Ravensthorpe-Hopetoun road. (Same as 21106, but from different plant). Holotypus: AD97144017 (fl.)! Isotypi: Two, to be distributed.

Small glabrous shrub, 1-1½ m. tall, stems erect, 4 angled with numerous scattered red, stalked glands on wings. Leaves decussate, with usually well developed shoots in the axils, sessile, linear to narrow-oblong, irregularly serrate to biserrate, the tip of each serration bearing a gland as on the stems, lamina thick, midrib channelled above, prominent below, 0.9-1.4 cm long, 0.2-0.4 cm wide.

Inflorescence a terminal raceme. Axis monopodial, terminated by a simple dichasium. Simple or compound dichasia of 3-7 flowers are borne in the axils of the 8-9 pairs of decussately arranged bracts immediately below the terminal dichasium, becoming more complex basipetally. Within each dichasial group, all except the flowers of the ultimate branches are functional (except for the terminal dichasium, where all flowers may abort), and the functional flowers within the inflorescence develop basifugally. Lateral inflorescences are borne in the axils of the leaves immediately below the terminal inflorescence. Primary bracts leaflike, fleshy, serrate, with stalked glands on tips of serrations, reduced to about half leaf size at apex, secondary bracts similar to primary bracts, ca 2 mm long, 1 mm wide, serrate and glandular; tertiary bracts 2-5 serrate, glandular tips, ca 1mm long, 0.5 mm wide; all bracts ± persistent.

Flowers tetramerous, on pedicels 0.2-0.5 mm long. Sepals 4, pink, smooth, deltoid, 0.8-1.2 mm long, 0.7-1.0 mm wide. Petals 4, pink-red, navicular, non-unguiculate, 5.0 mm long, 0.7-1.0 mm wide, (keel to margin). Stamens 8, filaments 0.3-0.5 (-1.0) mm long; anthers yellow, linear, 4-celled, apiculate, connective produced into a curved apiculum, 3.2-4.0 mm long, 0.3-0.4 mm wide, antipetalous anthers 0.5-0.8 mm shorter than antisepalous ones. Styles 4, 0.8-0.9 mm long, stigmas capitate. Ovary pink to red, obpyriform, strongly 4-winged opposite the petals, wings ± lobed at apex, decurrent in pedicel below; ovary 1.5 mm long, 1.0 mm wide, 4-locular with one ovule per locule.

Up to 3 fruits matured per dichasium, usually reddish-purple, obpyriform, 4-winged, the wings decurrent in the pedicel at the base and produced into auricles at the apex, hiding the persistent, deltoid sepals. **Fruit** incompletely 4-locular, septa formed only at top and sides, pericarp ± woody, length (incl. wings) 6.5-7.0 mm, width 4.5-5.0 mm on a pedicel 3.0-4.0 mm long; 1 seed, occupying entire fruit. (Fig. 18; Plates 17, 18)

Ecology.

"In clay soil, with Euc. [Eucalyptus] platypus" (George 1618). Flowers September to November, fruits October to December.

Distribution. (Map 12)

H. glandulosum is relatively widespread in south-western Western Australia from the vicinity of Southern Cross to Ravensthorpe.

Specimens examined.

Western Australia: Aplin 2705, 27.x.1963, nr. Kundip 18 miles N of Hopetoun, PERTH (fr.); Brockway 3, -.x.1946, 30 miles south of Moorine Rock, PERTH (fr.); Davies 103, -.xii.1962, Daniell, PERTH (fl.,fr.) - pollen sent to Palyn. Lab. Stockholm sub nom. *Haloragis aculeolata*; Eichler 21105, 9.ix.1971, Kundip, ca 20 km south of Ravensthorpe, AD (fl.) - type of *H. glandulosum*; Eichler 21106, 9.ix.1971, l.c., different plant, AD (fl.); Gardner s.n., -.xi.1944, Ravensthorpe district, PERTH (old fls., fr.); George 1618, 13.x.1960, 13 miles S of Ravensthorpe, PERTH (fr.); Steedman s.n., -.xii.1929, Forrestania, PERTH (fr.).

Notes.

1. The relationships of this species are obscure, although in flower and fruit characteristics it comes closest to *H. racemosum*. The stalked glands which densely clothe the leaf and bract margins and ribs of the stems are unique in the family, perhaps approached only by the papillose hairs of *Haloragis platycarpa*. The specific epithet refers to this distinctive feature of the plants.

C. <u>*GLISCHROCARYON*</u> Endl., Ann. Wien Mus. 2(1838)209. [Type species: *Glischrocaryon roei* Endl., l. c. 210]; Endl. & Fenzl, Nov. stirp. Dec. 9(1839)78; Meisner, Gen. 1(1941)328, 2(1841)240; Orchard, Taxon 19(1970)823.

Loudonia Lindl., Sketch Veg. Swan R. Col. (1840)42 [Type species: *Loudonia aurea* Lindl. l. c.] (non *Loudonia* Bert. ex Hook., Bot. Misc. 3(1833)193, nom inval. sub Art. 34, 1966 Code). Endl., Gen.(1840)1197; Endl., Enchir. Bot. (1841)640; Walp., Rep. 2(1843)100; Meisner, Gen. 2(1843)356; Nees in Lehm., Pl. Preiss. 1(1844)159 ['Laudonia']; Walp., Ann. 1(1848)293, 4(1858)683, 7(1870)938; Lindley, Veg. Kingd. 3 ed. (1853)723; Loudon, Encycl. Pl. (1855)1354; Benth., Fl. Aust. 2(1864)471; Benth. & Hook., Gen. Pl. 1(1865)674; Hereman (ed.), Paxton's Bot. Dict. (1868)344; Eichl., Bluethendiagr. (1875)463, 464; Baill., Nat. Hist. Pl. 6(1877)479, 500; FvM., Census 1(1882)49, Sec. Census 1(1889)85; FvM., Key Syst. Vict. Pl. 2(1885)22, 1(1887-8)259; Tate, Fl. S. Aust. (1890)100; Moore , Hdbk. Fl. N.S.Wales (1893)184; Petersen, Pflfam. 3(1893)231; Dalla Torre & Harms, Gen. Siph. (1900-1907)361, 625; Diels & Pritzel, Bot. Jb. 35(1904)44; Schindl., Pflrch. 23(1905)17; Dixon, Pl. N.S.Wales (1906)129; Maid. & Betche, Census (1916)158; Black, Fl. S.Aust. (1926)429; Ewart, Fl. Vict. (1930)879; Gardner, Enum. (1931)99; Black, Fl. S.Aust. 2 ed. (1952)640; Gardner, Wildfls. W.Aust. (1959)120; Blackall & Grieve, W.Aust. Wildfls. 3(1965)463-464.

Glabrous, erect, perennial herbs 10-100 cm tall; rootstock woody, roughly corticated, branched at apex, bearing numerous annual stems. Stems smooth, green, pithy, ± unbranched except at base, often ± leafless.

Leaves alternate, often deciduous, terete to narrow lanceolate or linear, acute or minutely mucronate at tip, sessile, margin entire, ± fleshy, veins and midrib obscure, 1-2(-6) cm long, 0.1-0.3(-0.5) cm wide, sometimes bimorphic and then the juvenile forms are shorter and narrower than the adult form.

Inflorescence terminal, cymose, pseudoumbelliform. Floral axis terminated by a compound dichasium of (7-)15-31 flowers with (2-)4-5 alternately arranged dichasia of 7-63 flowers below. All flowers functional or those of the ultimate branching aborted. Peduncles of the lower dichasia long and usually adnate to the lower part of their subtending primary bract. Lateral inflorescences similar to, but usually of a lesser order of branching than the terminal one, borne irregularly in the axils of the upper leaves. Primary bracts leaflike, green, fleshy, narrow lanceolate to oblanceolate, sometimes absent in upper part of inflorescence, 0.5-1.0 cm long, 1-3 mm wide; secondary bracts similar in shape, membranous, often deciduous at or about anthesis, 1-2 mm long, 0.5 mm wide; tertiary, quaternary, etc., bracts less than 1 mm long.

Flowers yellow or cream, 2-(3-) 4-merous, borne on filamentous pedicels 1-3 mm long, on short thick peduncles. Sepals 2 or 4, deltoid, smooth, margin entire or ± erosus, decurrent in wings of the ovary or free, 0.3-0.7(-1.0) mm long, 0.8-1.2 mm wide. Petals 2 or 4, cream or yellow, torsive, navicular or hooded, 2-4 mm long, 0.7-1.0 mm wide (margin to keel). Stamens 4 or 8, filaments white or yellow, 0.5 mm long; anthers yellow, linear-oblong, 4 celled, the connective usually produced into a short apiculum, antisepalous anthers often up to 0.5 mm longer than antipetalous anthers, anther length 1.5-3.0 mm, width 0.3-0.6 mm.

styles 2 or 4, cream-yellow, (0.5-)0.7-1.4 mm long, stigmas capitate, ± shortly fimbriate. Ovary inferior, yellow, obovoid to obpyriform, 2 or 4 winged, the wings decurrent in the pedicel, and confluent with the sepals (except *G. roei*), body of the ovary swollen or not swollen, 1 locule with 4 pendulous ovules (of which only 2 are functional in *G. behrii*) and central columella (no septa), length 0.9-3.5 mm, diameter (incl. wings) 1.5-2.5 mm.

Fruit cream or yellow (sometimes reddish), ovoid to obovoid (flattened in *G. behrii*), 2- or 4-winged or-ribbed, the wings membranous, with radiating dichotomous veins, no marginal vein, (0.5-)1.5-3.5 mm wide, decurrent in sepals (except *G. roei*) and pedicel (the wings in *G. flavescens* and *G. roei* are reduced to ribs 0.5 mm wide), the pericarp between the wings swollen or membranous, the endocarp slightly woody; 1 seed, occupying the entire locule.

Ecology.

The species of *Glischrocaryon* show weedy tendencies, usually growing in disturbed habitats, often on light sandy soils. An exception is *G. flavescens* which is common on rocky hillsides, especially in South Australia. The species range through areas with rainfall of 10"-25"(-40") [25.5-78.5(-101) cm] per annum, and *G. flavescens* and *G. aureum* var. *angustifolium* may tolerate a little less. Flowering usually occurs from late August until November and fruiting from October until February.

<u>Key to the species and varieties of *Glischrocaryon*.</u>

(1) Flowers and fruits 4-merous [S.Aust., W.Aust.]

(2) Petals navicular, tips reflexed in bud, flowers usually cream, plants 75-90 cm tall, stems (3-)5-8 mm diam. [S.Aust., W.Aust.]

1. *G. flavescens*

(2) Petals hooded (± navicular in *G. roei*), tips not reflexed in bud, flowers bright yellow or sometimes reddish, plants 30-40 30-40(-100) cm tall, stems 1-3(-4) mm diam. [S.Aust., W.Aust.]

(3) Ovary not swollen or only concavely swollen between wings in bud, body of fruit ovoid or narrow ovoid, wings always pronounced, (2.0-2.5 mm wide, sometimes swollen at base), sepals enlarged in fruit, sepals 1.5-2.2 mm wide, 0.5-0.7 mm long. [S.Aust., W.Aust.] 2. *G. aureum*

(4) Mature leaves oblanceolate, 3.0-6.0 cm long, 2.0-5.0 mm wide, juvenile leaves flattened, linear-lanceolate, 1.0-2.0 cm long, 0.1-0.15 cm wide. [W.Aust.]

2α. *var. aureum*

(4) Mature leaves linear to linear-lanceolate, 0.8-2.5 (-3.0-4.0) cm long, 0.1-0.15 cm wide, juvenile leaves ± terete, 0.6-0.7 cm long, 0.5 mm wide.[S.Aust.,W.Aust.]

2β. *var. angustifolium*

(3) Ovary convexly swollen between wings in bud, body of fruit globular, wings almost absent (up to 0.5 mm wide), sepals not enlarged in fruit, sepals 0.7-1.2 mm wide, 0.5-0.6 mm long. [W.Aust.] 3. *G. roei*

(1) Flowers and fruits 2-merous. [S.Aust., Vict., N.S.Wales]

4. *G. behrii*

1. *Glischrocaryon flavescens* (Drummond ex Hook.) Orchard, Taxon 19(1970)824.

Loudonia flavescens Drummond ex Hook., Lond. J. Bot. 1(1842)396; [Typus: none cited. Lectotypus (Orchard): J. Dr. 73, *Loudonia flavescens* Drummond. W.A., MEL39531 (fr.)! - see Note 3, Isolectotypus (?): Drummond 73, 1843, Swan River, P (fr.).]; FvM., Linnaea 25(1853)385.

Loudonia citrina FvM., Linnaea 25(1853)385 [Typus: "Ad latus occidentale montium Flinders range secus ripas glareosis, nec non inter rupas apicales montium Elders range et prope Cudnaka." Lectotypus: Mueller s.n., Oct. 51, Auf den steinigen Berggipfeln der Elder-Range und nordwestlich von Cudnaka, dann auch nicht selten im Geroll der Flussbetten an der Westseite des Flinders Gebirgs, MEL39545 (fl.,fr.)! Syntypi: Mueller s.n., Oct. 51, Flinders Range, MEL39632 (fl.)!; Mueller s.n., Flinders Range, MEL39637 (fl.)!; Mueller s.n., Oct. 51, inter rupes apicales montium prope Cudnaka, MEL39558 (fl.)!; Government Botanist, Melbourne s.n., 1851, Elders Range, MEL39556 (fl.,fr.)!]

Glabrous clump-forming perennial herb 75-90 cm tall. Rootstock perennial, woody, simple taproot or shortly branching at apex, 1-2 cm diam., thickly corticated. Stems numerous, stout, annual, erect, (3-)5-8 mm diam., pithy, ± unbranched except in forming axillary inflorescences, smooth, green, often ± leafless, terminating in corymbose inflorescences. Leaves alternate, sessile, linear to narrow-lanceolate, tapering towards apex, slightly concave above, midrib indistinct, sunken above, prominent below, lateral veins not apparent, 2-3(-6) cm long, 1.5-2.5(-3.0) mm wide.

Inflorescence a terminal pseudo-umbelliform compound dichasium. Axis terminated by a compound dichasium of 31 flowers, with 2 alternately arranged compound dichasia of 31 flowers on the axis below. Two alternately arranged lateral inflorescences are borne immediately below the terminal inflorescence. All flowers functional and usually produce seed. Peduncles of lower dichasia long, thickened, adnate to the basal part of the subtending primary bract, resulting in the bract apparently arising some distance along the branch it subtends. Similarly for all bracts except those of the ultimate and penultimate branching. Primary bracts persistent, green to yellow, lanceolate, 5.5-6.0 mm long, 1.2-1.4 wide.

Flowers cream to sulphur yellow, paler than in other species; Sepals 4, deltoid, smooth, 0.6-0.7 mm long, 0.9-1.3 mm wide. Petals 4, navicular, very shortly unguiculate, torsive, prominently keeled, tips ± reflexed in bud, 3.4-3.9(-4.5) mm long, 0.8-1.0 mm wide (keel to margin). Stamens 8, filaments white or yellow, relatively thick, ca 0.5 mm long; anthers yellow, linear, 4-locular, 2.0-2.6(-3.2) mm long, 0.3-0.4(-0.6) mm wide, the antisepalous ones ca 0.5 mm longer than antipetalous ones, connective produced into a short apiculum (sometimes absent in W.A. specimens). Styles 4, cream-yellow, 0.9-1.0 mm long, capped by very shortly fimbriate orange-yellow capitate stigmas. Ovary obovoid (obpyramidal), 4 winged, the wings decurrent in the pedicel and sepals, with numerous radiating veins but no marginal vein; ovary 0.9-1.5 mm long, 2.5 mm wide, 4 ovulate, one locule with central columella.

Fruit cream, ovoid-oblong, 4-winged, pericarp swollen, spongy between wings, wings 0.5 mm wide, ± membranous at margin, swollen at base, decurrent in sepals and pedicel. Styles persistent, erect, 1.0-1.2 mm long, surrounded by tube formed of connate sepal bases. Tips of sepals free, broad deltoid, 0.5-0.8 mm long, 1.2-1.7(-2.0) mm broad. Fruit (excluding sepals and styles) 5.0-6.5 mm long, 3.0-3.5(-4.0) mm broad, on pedicel ca 3.5 mm long. One seed, filling entire locule. (Fig. 19; Plates 19, 20)

Distribution. (Map 11)

South-western Western Australia in the Esperance-Norseman district, and South Australia in Northern Eyre Peninsula and the Flinders Range.

Ecology.

In higher rainfall areas within its range, *G. flavescens* grows on deep sand (e.g. near Esperance) while in lower rainfall areas (e.g. Norseman in Western Australia, and all localities in South Australia) it grows on rocky hillsides. Collectors' notes include "on red soil" (Beard 2093), "on roadside in white sand dune" (Orchard 1227), "perennial herb on rocky hillock" (Burbidge 2720). Flowers (August-)September to December, fruits (October-) November to February.

Specimens examined.

South Australia: Alcock 846, 7.xi.1965, Hd. Charleston, Sec. 17. AD (fl.,fr.); Batt s.n., 1886, Eucla, MEL39588 (fl.,fr.); Brummitt s.n., 11.xii.1892, Robertstown, AD96211067, AD96851094 (fr.); Cleland s.n., 10.xi.1928, Wilpena Pound, AD968051012, AD966032582 (fl.); Cleland s.n., 3.xi.1936, Whyalla, AD968051005 (fr.); Cleland s.n., -.xi.1936, Iron Knob, AD968051015 (fl.); Cleland s.n., 1.ix.1944, Whyalla Knob, AD968051027 (fl.); Copley 1512, 8.x.1967, Thurlga, AD (fl.); Donner 2539, 15.x.1967, 25 miles E. of Chilpuddie, AD (fl.); Donner 3147, 27.x.1968, ca 40 km north-north-east of Minnipa, AD (fl.,fr.); Eichler 20478, 27.x.1968, 32 km north-north-east of Kimba AD (fl.); Fagg 482, 25.xi.1967, 8 km north east of Darke Peak, AD (fr.); Ising s.n., 2.ix.1935, Carapee Hill, AD966031993 (fl.); Ising s.n., 13.ix.1938, Gawler Range, AD96803139 (fl.); Jackson 1479, 27.x.1968, ca 40 km north-north-east of Minnipa, AD (fl.); Koch 182, -.x.1901, Flinders Range, NSW (fl.); Koch 282, -.ix.1902, Flinders Range, P (fl.); Orchard 1799, 27.x.1968, ca 42 km north of Minnipa on road to Yardea, AD (fl.); Orchard 2172, 15.viii.1969, Yandinga Gorge, ca 50 km north of Minnipa, AD (st.); Orchard 2248, 26.ix.1969, Yandinga Gorge, AD (fl.); Orchard 2328, 28.ix.1969, ca 5 km east of intersection of Yardea, Nonning and Kingoonya roads. AD (fl.); Orchard 2596, 7.xi.1970, between Madges Hill and Edeowie Gorge, AD (fl.); Orchard 3215, 7.i.1971, ca 70 km east of Wirrulla, AD (st.); Pulleine s.n., -.v.1931, Nonning, AD968051014 (st.); Richards s.n., -.ix.1886, Middleback Ranges, AD96810020, MEL39597 (fl.); Rogers 1814, 4.xi.1961, Mount Whyalla, AD (fl.,fr.); Rogers 1815, 9.xii.1969, Mount Whyalla, AD (fr.); Rohrlach 5, 15.xii.1958, Pinkawillinie, AD (fr.); Specht & Carrodus 63, 15.xi.1958, 12 miles south west of Nonning Homestead, AD (fl.); Sullivan s.n., Gawler Ranges, MEL 39541, 39553 (fl.,fr.); Tate s.n., Yudnamutana Mine, AD96810005 (fl.); Whibley 1822, 23.viii.1967, ca 55 km north of Cowell, AD (fr.)

Western Australia: Anon. 17, 24.xi.1894, Southern Cross, AD (fr.); Aplin 1471, 22.v.1962, 8 miles north of Watheroo, PERTH (fl.,fr.); voucher for Alkaloid survey sub nom. *L. aurea*; Beard 2093, 28.ix.1962, Binnu, north of Geraldton, PERTH (fl.); Brittan s.n., 12.vii.1951, 104 miles W of Esperance, UWA502 (fl.); Brockway s.n., -.x.1947, Murchison District, PERTH (fl.,fr.), CANB26628 (fl.,fr.), CANB192882 (fl.,fr.); Burbidge 2720, 30.ix.1947, Lake Cowan, 5 miles N.W. of Norseman, CANB (fl.); Crawford 80, 1887, Betw. Vict. Springs and the W. end of the Great Bight, MEL (fr.); Drummond 73, 1843, Swan River, P (fr.)- Isolectotype of *L. flavescens*; Drummond 74, 1843, Swan River, MEL, P (fr.); Eichler 20167, 10.x.1968, Location 1109, Shire of Esperance, AD (fl.); Eichler 20263, 15.x.1968, Location 1158 Shire of Esperance AD (fl.,fr.); Grieve s.n., 14.ii.1959, 10 miles W. of Tammin UWA 512 (fl.,fr.); George s.n., 13.x.1963, 4 miles S of Cundeelee Mission on road to Zanthus, PERTH (fr.); Helms s.n., 2.xi.1891, nr. Fraser Range, MEL39536 (fl.,fr.); Helms s.n., 12.xi.1891, near Gnarlbine, MEL39535 (fl.,fr.); Helms s.n., -.x.1898, Northampton, NSW98840 (fl.); Jutson 165, -.xii.1916, Comet Vale, NSW (fl.); Koch 2953, 9.xi.1923, Merredin, MEL (fr.); Lullfitz 3065, 5.xii.1963, 127 m peg on Wyalkatchem Rd., PERTH (fr.); Lullfitz L3842, 25.xi.1964, Lake Cronin, 3½ miles north of Cross Roads, PERTH (fr.); Maxwell s.n., Phillips River, MEL39643 (fr.); McLean s.n., 6.v.1934, Gutha, UWA511 (fl.); Merrall s.n., 1888, Golden Valley, MEL39677 (fr.-terat.); Merrall s.n., 1889, Lake Brown, MEL39676 (fl.-terat.); Morrison s.n., 30.x.1906, Carnamah, CANB136625 (fl.), PERTH (fl.); Mueller s.n., -.xi.1862, Eyres Range, MEL39640, 39641 (fr.); Mueller s.n., -.x.1877, Shark Bay, MEL39564 (fl.,fr.); Mueller s.n., -.xi.1877, Greenough River, MEL39675 (fl.,fr.); Orchard 1227, 27.x.1968, Location 1105, Shire of Esperance, AD (fl.); Orchard 1515, 13.x.1968, Oldfield River at crossing of the Esperance-Ravensthorpe road, AD (fl.); Orchard 1702, 21.x.1968, northern end of Location 1163, Shire of Oldfield, AD (fl.,fr.); Preiss 2068, 1837-1840, Swan River, G (Herb. Boiss) (fl.,fr.); Pritzel 836, -.x.1901, District Avon: in apertis arenosis, AD, NSW, P (fl.); Sewell s.n., 1889, Mt. Carol, MEL39662 (fr.); Steedman 68, -.xii.1929, Mt. Holland, PERTH (fr.); van Dam 170, 4.vii.1969, Wongan Hills, AD (fl.,fr.); Willis s.n., 12.ix.1947, Mundaring, MEL39574 (fl.).

Notes.

1. When growing on sand in Western Australia, the flowers and fruits of *G. flavescens* are a distinctive pale creamy white and the root-

stock is a simple taproot. When growing on rocky hillsides in Western Australia and South Australia, the flowers and fruits are yellow and the rootstock becomes branched at the apex, the branches creeping on the surface of the soil or rocks for up to 10 cm.

2. Despite the widely disjunct distribution, no differences, other than those influenced by substrate and rainfall mentioned above, can be discerned between the South Australian and Western Australian populations that would warrant their recognition as distinct taxa.

3. *Loudonia flavescens* was described in a letter from Drummond to Hooker which was published by Hooker in the London Journal of Botany. Drummond did not cite any specimens in his letter, and a search by Mr. J. Carrick in 1970 failed to locate any material in K or BM which bore the name *Loudonia flavescens*. Apparently the only extant Drummond collections which are annotated with this name are two in MEL (MEL39531 (Drummond 73) and MEL39532 (Drummond 74)). Of these only the former bears fruit (the other is sterile) and has therefore been chosen as lectotype.

4. In its flower and fruit morphology and relatively robust habit, this species shows some similarity with members of *Haloragodendron*, particularly *H. racemosum*, and may provide a link between the two genera. Within *Glischrocaryon*, *G. flavescens* is probably most closely related to *G. aureum*.

2. *Glischrocaryon aureum* (Lindl.) Orchard, Taxon 19(1970)823.

Loudonia aurea Lindley, Sketch Veg. Swan R. Col. (1840)42. [Typus: none cited. Sheet in CGE consisting of 3 collections with annotations by Lindley. Lectotypus (Orchard): "Mrs. Molloy. Vasse River on the South West coast of New Holland. 1839." CGE (fl.)!] Walp., Rep. 2(1843)100; Nees in Lehm., Pl. Preiss. 1(1844)153; Walp., Ann. 1(1848)293, 4(1858)683; FvM., Linnaea 25(1853)385; Loudon et al. (ed.), Loud. Encycl. Pl. (1855)1354; Benth., Fl. Aust. 2(1864)472; Hereman (ed.), Paxton's Bot. Dict. (1868)344; FvM., Fragm. 8(1874)162, 11(1878)20; Tate, Trans.roy.Soc. S.Aust. 3(1880)64; FvM., Census 1(1882)49; Tepper, Trans roy. Soc. S.Aust. 9(1887)115 ('Loudonio aurea'); Cleland, Trans. roy. Soc. S.Aust. 10(1888)78; FvM., Sec. Census 1(1889)85; Tate, Fl. S.Aust. (1890)100, 233; Petersen, Pflfam. 3(1893)228, 231-2; FvM. & Tate, Trans. roy. Soc. S.Aust. 16(1896)352; Koch, Trans. roy. Soc. S.Aust. 22(1898)111; Moore, J. Linn. Soc. (Bot.) 34(1899)190; Schindl., Bot. Jb. 34.Beibl. 77(1904)8; Schindl., Pflrch. 23(1905)17; Gardner, Wildfls. W. Aust. (1926)120; Black, Fl. S.Aust. (1926)429, 2 ed. (1952)641; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)464.

Figs: Lindley, Sketch Veg. Swan R. Col. (1840)43, fig. 1, 2; Lindley, Veg. Kingd. (1853)fig. CCCCLXXXII; Baill., Nat. Hist. Pl. 6(1880)figs. 462-464; Petersen, Pflfam. 3(1893)fig. 98E, F, 101B; Gardner, Wildfls. W.Aust. (1926)119; Black, Fl. S.Aust. 2 ed. (1962)fig. 870; Blackall & Grieve, 3(1965)pl.20.

Glabrous perennial herb 25-75(-100) cm tall; perennial rootstock woody, branched or unbranched with rough brown bark, up to 1 cm diam. at apex; stems annual, smooth, green to brown, pithy, 1-4 cm diam. at base, sparsely branched. Leaves bimorphic, alternate, sessile, the juvenile leaves narrower than mature leaves. Mature leaves 1-6 cm long, 0.2-1.5 cm wide, midrib indistinct.

Inflorescence an umbelliform series of compound dichasia. Flowering stem terminated by a compound dichasium of 7-31 flowers with 1-5 compound dichasia on the stem immediately below. The flowers of the ultimate dichasial branches may or may not be functional. 1-6 lateral inflorescences are borne in the axils of the upper leaves.

Flowers yellow, 4-merous. Sepals 4, yellow, deltoid, smooth, 0.6-0.9 mm long, 1.0-1.3 mm wide. Petals 4, yellow, hooded, keeled, very shortly unguiculate, 2-4 mm long, 0.8-1.1 mm wide (keel to margin). Stamens 8, filaments 0.2-0.4 mm long; anthers 4-celled, yellow, oblong, connective produced into a short apiculum, 1-3 mm long, 0.4-0.5 mm wide, the antipetalous anthers ca 0.2-0.5 mm shorter than the antisepalous anthers. Styles 4, yellow, 0.8-1.0 mm long, stigmas yellow, capitate, very shortly fimbriate. Ovary yellow, 4-winged, obpyriform, pericarp unswollen, length 2-3 mm, width 1.5-3.0 mm (incl. wings), ovules 4 in a single locule with central placental strand.

Fruit yellow or reddish, ovoid-obovoid, on pedicel up to 4 mm long, 4-winged, (wings 2.0-3.5 mm wide), 7.5-11.5 mm long, 4.5-7.5 mm wide (incl. wings), sepals persistent, erect, forming circum-stylar tube, free part deltoid, 0.5-0.7 mm long, 1.0-2.2 mm wide. Pericarp usually not swollen, or if swollen, then wings still distinct. Single pendulous seed occupies entire locule.

α. var. *aureum*

Glabrous perennial herb, (30-)40-75(-100) cm tall, perennial rootstock woody, with rough, brown cortication, ca 1 cm diam. at top, sparsely branched. Stems annual, smooth, green, pithy, 2-4 mm diam. at base, sparsely branched, leaves bimorphic, alternate. Juvenile leaves flattened, linear-lanceolate, sessile, acute at tip, 1.0-2.0 cm long, 0.1-0.15 cm wide. Adult leaves oblanceolate, sessile, tapering gradually to base, apex acute, midrib indistinct, not raised or channelled, lateral veins very indistinct, ± parallel to midrib, length (1.7-)3.0-6.0 cm, width 0.2-0.5 cm.

Inflorescence a terminal, 15-31 flowered compound dichasium with 1(-2?) compound dichasia borne on the stem immediately below. The flowers of the ultimate branches may be non-functional. Several of the dichasia may be reduced to monochasia, but not in any regular sequence. Lateral inflorescences similar to the terminal inflorescence occur in the axils of the upper 5-6 leaves.

Flowers yellow, 4-merous. Sepals 4, deltoid, smooth, margin ± entire, 0.7-0.9 mm long, 1.0-1.2 mm wide; petals 4, yellow, hooded, very shortly unguiculate, (2.5-)3.0-4.0 mm long, 0.9-1.1 mm wide; stamens 8, filaments yellow, 0.2-0.3 mm long, anthers yellow, 4-celled, oblong, connective produced into a very short apiculum, anther length 2.3-2.5 mm, width 0.35-0.5 mm, the antipetalous anthers 0.2-0.3 mm shorter than antisepalous ones; styles 4, 0.9 mm long. Ovary yellow, 4-winged, obpyriform, pericarp not swollen, on slender pedicel 1.5 mm long, wings membranous, decurrent in pedicel and sepals, length (incl. wings) 2.0-3.0 mm, width 1.6-2.3 mm; ovules 4, in a single locule with central placental strand.

Fruit yellow, sometimes reddish, obovoid, on pedicel *ca* 4 mm long, 4-winged, the wings membranous with radiating dichotomizing veins, no intramarginal vein, 2.0-2.5 mm wide, decurrent in pedicel and sepals. Sepals persistent, decurrent with wings, forming circumstylar tube, free part deltoid, 0.5-0.7(-1.0) mm long, 1.7-2.2 mm wide. Fruit (incl. wings) 7.5-8.5 mm long, 4.5-6.0 mm wide, pericarp usually not swollen, 1 locule, 1 seed.

Distribution. (Map 11)

This taxon is confined to a coastal strip of Western Australia, extending from the Darling Range near Perth to the vicinity of Shark Bay.

Ecology.

G. aureum var. *aureum* ranges over a variety of soils, mainly sandy, with an annual rainfall of between 14" and 40" (ca 35-100 cm). Collectors' notes include "Edge of sand plain" (Ashby 81), "On hillside of shallow soil over sandstone" (Belcher 243), "White sand" (Galbraith WA527), "Granitic soil, with Cas. [Casuarina] huegeliana" (Gardner 2792), "Sand. Low heath with Melaleuca cordata" (Green 593), "Lateritic ridge south of big granite outcrop" (Heinsohn 91) and "Spinifex sandplain (burn)" (Speck 827). Flowers August to October, fruits September to December.

Specimens examined.

Western Australia: Adams s.n., 1889, interior of Western Australia, MEL39592 (fl.,fr.); Adams s.n., 1891, Mangowine, MEL39596 (fl.); Anon. s.n., Kings Pk., UWA524 (fl.); Anon s.n., Oct., Bullsbrook Rd., UWA525 (fl.); Aplin 119, 10.ix.1958, 8-10 miles east of Calingiri along Wongan Hills road, PERTH (fl.); Aplin 165, 10.ix.1958, 8-10 miles east of Calingiri, PERTH (fl.); Aplin 766, -.x.1960, Reserve - 17 miles East of Pingelly, PERTH (fl.,fr.); Ashby 81, 6.ix.1946, Moora, AD, PERTH (fl.); Bailey s.n., Sept., 8m. east Meckering, PERTH (fr.); Bailey 124, Muntadgin,CANB (fr.); Bailey 721, Muntadgin, CANB (fl.,fr.); Baird s.n., Yandanooka, UWA522 (fl.); Belcher & Belcher 243, 8.x.1967, Ringa-Clackline Road about 1 mile south of Ringa, MEL, PERTH (fl.); Cleland s.n., -.ix.1908, Cunderdin, NSW98842 (fl.); Cronin s.n., 1889, sources of Blackwood River, MEL39593, 39664 (fr.); Drummond s.n., 1839, Swan River, CGE (fl.,young fr.) - syntype, & P (fl.) - isosyntype of *L.aurea*; Drummond 409, Swan River, W (fl., young fr.); Eaton s.n., 1888, 1889, sources of the Swan River, MEL39585, 39570 (fl.,fr.); Easton s.n., 1893, Youndegin, MEL39668 (fr.); Filson 8583, 6.ix.1966, North-West Coastal Highway, 7 miles North of the Murchison River Bridge, MEL (fl.,fr.); Fitzgerald s.n., -.x.1900, Darling Range, NSW98844 (fl.,fr.); Forrest s.n., 1881, between Swan River & King Georges Sound, MEL39602 (fl.); Forrest s.n., 1889, near Lake Deborah, MEL39589 (fl.,fr.); Galbraith WA527, 17.viii.1964, Mullewa-Wilroy Road, AD (fl.,fr.); Gardner 2792, 1.x.1931, Moorine Rock, PERTH (fl.); Gray s.n., 1873, Champion Bay, MEL39599 (fl.,fr.); Green 593, 3.xi.1956, 2 miles N. of Yerecoin, PERTH (fr.); Grieve s.n., -.viii.1947, Northampton Dist., UWA526 (fl.); Guerin s.n., 1871, Champions Bay, MEL39549 (fr.); Hamilton s.n., 1902. W.A., NSW98835 (fl.,fr.); Heinsohn 91, 13.xi.1966. Tuttanning Reserve, 17 mi. E of Pingelly, PERTH (fr.); Helms s.n., -.ix.1898, Darling Range, NSW98849 (fl.); Jessup s.n., -.ix.1947, between Geraldton & Northampton, MEL39573 (fl.,fr.); Koch 2953, 9.xi.1923, Merredin, NSW (fl.,fr.); Lea s.n., Swan River, PERTH (fl.); Loneragan 67.028, 8.x.1967, 23 miles SW of Eneabba, Eneabba-Three Springs Rd., UWA (fr.); Maiden s.n., -.ix.1909, Welshpool-Kalamunda, NSW103172 (fl.); Maiden s.n., -.ix.1909, Tammin, AD96921174 ex NSW (fl.); Maiden s.n., -.x.1909, Southern Cross, AD96921188 (fl.); Mangles s.n., Swan River, CGE (fl.) - syntype of *L. aurea*; Merrall s.n., 1888, E. sources of Swan River, MEL39577 (fr.); Molloy s.n., 1839, Vasse River, on the South West coast of New Holland, CGE (fl.) - lectotype of *L. aurea*; Monch s.n., -.xi.1946, South of Geraldton, PERTH (fr.); Morrison s.n., 5.x.1903, Wongan Hills, CANB 136623 (fl.,fr.); Morrison s.n., 5.xii.1903, Swanview, Darling Range, CANB136624 (fr.); Mueller s.n., -.xi.1877, Upper Swan River, MEL39660 (fr.); Preiss 2068, 1843, Swan River, G(herb. DC) MEL39547, 39636, (fl.); Preiss 2068, -.x.1839, Swan River. In limosis ad fluvium Canning (Perth), P (fl.); Preiss 2068, 19.x.1839, In solo limoso pr. urbiculam Guildford & ad fl. Canning (Perth), P (herb. Bunge) (fl.,fr.); Roark s.n., 13.xi.1949, Darlington, AD96905108, UWA (terat. fl.,fr.); Sewell s.n., between the Rivers Murchison and Arwin, MEL39550 (fl.fr.); Sewell s.n., 1886, 1889, Mt. Caroline, MEL39598, 39578 (fl.,fr.); Sewell 5, 1885, Swan River, MEL (fl.); Sonster 552, 13.x.1946, Perth, NSW (fl.); Speck s.n., 6.ix.1949, Murchison River, UWA527 (fr.); Speck s.n., 22.ix.1951, Mimegarra-Mt.Misery, UWA518 (fl.); Speck 827, 15.ix.1957, 30 miles N. of Wiluna, CANB (fl.); Stone 431, -.viii.1947, Muntadgin, CANB (fl.); Vachell s.n., -.xii.1903, Kellerberrin, NSW98837 (fr.); Vauzetti s.n., -.x.1925, Marchagee, PERTH (fr.); Wells, s.n., 50 miles east of York, MEL39670 (fl.,fr.); White 5285, 5.xi.1927, Narrogin, BRI (fr.);

Notes.

1. The choice of a lectotype is necessary as there are 3 distinct

collections on the type sheet in CGE. All three collections belong to the same taxon. The collection by Mrs. Molloy consisting of 2 stems each bearing an inflorescence is here chosen as lectotype as one of the stems closely resembles the illustration accompanying Lindley's description. Stearn (1952) mentions the other 2 collectors (Mangles and Drummond) as providing material for Lindley, but does not mention Molloy. Erickson (1969) states (p.28) that Mrs. Molloy was a collector for Mangles, and that some of her collections were seen by Lindley before publication of his account of the Swan River plants.

2. All three collections in CGE bear small tubercular swellings between the wings of the fruit, differing in this respect from nearly all other collections placed in var. *aureum*. A swollen pericarp is a common occurrence in var. *angustifolium*, suggesting that these three collections may be the result of introgression. One other recent collection (Aplin 119) also has calluses between the wings and smaller flowers than usual. Aplin 165 from the same locality is typical for var. *aureum* in all respects.

3. Nees (1844), in describing *L. aurea* β *angustifolia* cited two Preiss numbers (three localities) under the species description, i.e. by implication, under var. *aurea*. Preiss collections under these numbers (2067 and 2068) exist in P (general collection and herb. Bunge) G (herb. Boiss. and herb. DC.) and MEL. Upon examination of these collections it was found that they were heterogeneous. Their correct determinations are as set out below.

Preiss 2067	G (herb.DC)	G. aureum var. angustifolium
	MEL39633 p.p.	G. aureum var. aureum
	P (herb. Bunge)	G. aureum var. angustifolium
Preiss 2068	P	G. aureum var. aureum
	P (herb. Bunge)	G. aureum var. aureum
	G (herb. DC)	G. aureum var. aureum
	G (herb. Boiss.) p.p.	G. aureum var. angustifolium
	G (herb. Boiss.) p.p.	G. flavescens
	MEL39547) MEL39633 p.p.) MEL39636)	G. aureum var. aureum

4. The relationships of this taxon are, on the one hand, with var. *angustifolium*, and on the other, with *G. flavescens*.

β. var. *angustifolium* (Nees) Orchard, comb. et stat. nov.

Loudonia aurea β *angustifolia* Nees in Lehm., Pl. Preiss. 1(1844) 159. [Typus: "In glareosis sterilibus districtus Hay m. Novembri a. 1840. Herb. Preiss. No. 2079" Holotypus: unknown. Isotypus: "Preiss 2079, 7.xi.1840, In glareosis sterilibus districtus Hay. P (Herb. Bunge)!" (fl.)]

Extremely variable glabrous perennial herb 25-65 cm tall; perennial woody rootstock usually consisting only of a simple taproot, sometimes branched at top, clothed in rough brown bark, up to 1 cm in diam. at top; stems annual, smooth, green-brown, pithy, 1.0-2.0(-3.5) mm diam. at base, sparsely branched, and then mainly near base. Leaves bimorphic, alternate. Juvenile leaves ± terete, channelled above, crowded, sessile, ± mucronate, 6-7 mm long, 0.5 mm wide. Mature leaves flattened, linear to linear-lanceolate, sessile, acute, veins indistinct, (0.8-)1.2-3.0(-4.0) cm long, 1.0-1.5 mm wide.

Inflorescence a terminal compound dichasium. Flowering stem terminated by a 7-20 flowered compound dichasium with 4-5 compound dichasia of 7-27 flowers borne alternately on the stem immediately below. The flowers of the ultimate branches may or may not be functional. Some dichasia reduced to monochasia and compound dichasia often unevenly branched. Auxiliary flowers occur sporadically. One or two lateral inflorescences occur in the axils of the upper leaves. Primary bracts fleshy, leaf-like oblanceolate-obovate, tapering towards base, apex obtuse, adnate at base to subtended peduncle, length of free part 0.8-1.2 cm, width 0.35-0.4 cm. Secondary bracts as for primary bracts, length 0.3-0.6 cm, width 0.1-0.2 cm. Tertiary, etc. bracts membranous, deciduous at or about anthesis, up to 1.5 mm long.

Flowers yellow, 4-merous. Sepals 4, yellow, deltoid, smooth, margin slightly irregular, decurrent in wings of ovary, 0.6-0.8 mm long, 0.9-1.3 mm wide. Petals 4, yellow, hooded (rarely ± navicular), keeled, very shortly unguiculate, 2.0-3.0(-3.5) mm long, 0.8-0.9 mm wide (keel to margin). Stamens 8, yellow, filaments 0.3-0.4 mm long; anthers 4-celled, oblong, ± apiculate, (0.8-)1.3-2.6(-3.2) mm long, 0.4-0.5 mm wide, antipetalous anthers ca 0.5 mm shorter than antisepalous ones. Styles 4, yellow, 0.8-1.0 mm long, stigmas capitate, very shortly fimbriate, yellow. Ovary yellow, obpyriform, 4-winged, the wings decurrent in the sepals and pedicel, ovary (including wings) 1.7-2.8(-4.0) mm long, 1.3-2.0(-3.0) mm wide; 1 locule, 4 pendulous ovules.

Fruit yellow or reddish, ovoid-obovoid, 4-winged, the wings membranous, venation radiating, dichotomous, with no marginal vein. Wings (1.5-)2.0-3.5 mm wide, decurrent in pedicel and sepals, sepals forming a circum-stylar tube, their free tips broad-deltoid, 0.5-0.7 mm long, 1.0-2.0 mm wide. Fruit 7.5-11.5 mm long, 4.5-7.5 mm wide, endocarp slightly woody, exocarp swollen or not swollen, but never reducing the wings to ribs as in *G.roei*. Single seed occupies entire locule. (Fig.19,25)

<u>Distribution</u>. (Map 11)

This taxon is extremely widespread in south-western Western Australia, in the region south of Shark Bay and west of Kalgoorlie. It is also known from northern Eyre Peninsula and Kangaroo Island in South Australia.

<u>Ecology</u>.

G. aureum var. *angustifolium* grows over a very wide range of soils and climatic conditions. Collectors' notes include "Dry gravel" (Andrews s.n.), "Heath with scattered mallees on laterite" (Briggs s.n.), "Spinifex" (Brockway s.n.) "Coastal dunes" (Eichler 20107), "In Jarrah (Eucalyptus marginata) country" (Fairall 345), "In white sandy loam over laterite" (George 6997), "Shallow pale yellow sand over laterite. Assoc. *Banksia attenuata* and *Actinostrobus* (Green 750), "on granite outcrop" (McLean s.n.), "grey sand on roadside" (Rayner s.n.), "spinifex sandplain"(Speck 827), "Rich sandplain soil. Only very low shrubs, few acacia, many creepers." (Went 139). Flowers (July-)August to November (-December), fruits (September-)October to December (-May).

Specimens examined.

South Australia: Cleland s.n., 7.xi.1955, ca 25 km east of Kimba, AD968051016 (fl.,fr.); Cleland s.n., 15.xi.1955, between Kimba and Iron Knob, AD968051018 (fl.,fr.); Ising s.n., 30.xii.1922, MacGillivray, Kangaroo Island, AD96803137 (fr.); Lothian 4251, 11.vi.1968, Hd. of Pinkawillinie, AD (fr.); Orchard 1779, 26.x.1968, ca 32 km north of Minnipa along track to Yardea, AD (fl.,fr.); Orchard 2929, 2934, 29.xii.1970, foot of Iron Duke, AD (fl.,fr.); Orchard 3217, 8.i.1971, Eyre Highway ca 40 km west of Kimba, AD (fr.); Orchard 3218, 8.i.1971, Eyre Highway ca 10 km south-west of Kimba, AD (fr.); Orchard 3223, 8.i.1971, Eyre Highway ca 26 km north-east of Kimba, AD (fl.,fr.); Richards s.n. (p.p.), -.ix.1886, Middle Back Ranges, AD96810020 (fr.); Rogers s.n., 12.xi.1908, Kingscote, Kangaroo Island, NSW98855 (fr.); Rohrlach 325, 17.iv.1959, County Buxton, Pinkawillinie, AD (fl.,fr.); Schomburgk s.n., Central S.Austr., AD96906013 (fr.); Tepper 78, 4.iii.1886, Between head of South West River and Karatta at Circular Lagoon, Kangaroo Island, AD (fl.,fr.).

Western Australia: Alexander 1243, -.x.1915, Waddouring, PERTH (fr.); Andrews s.n., 10.vii.1901, Childow's Well, PERTH (fl.); Aplin 1127, -.x.1961, 5m south of Yanchep, PERTH (fl.) - voucher for Alkaloid Survey sub nom. *L. aurea*; Aplin 1216, 6.xi.1961, Glen Eagle-Jarrahdale Road, PERTH (fl.,fr.) - voucher for Alkaloid Survey sub nom. *L. aurea*; Aplin 1824, 8.ix.1962, Jimberlana Hill, 5 miles NE of Norseman, PERTH (fl.) - voucher for Alkaloid Survey sub. nom. *L. aurea*, pollen sent to Palyn. Lab. Stockholm; Bailey 666, -.ix.1945, Muntadgin, PERTH (fr.), CANB (fl.,fr.); Bailey 721, -.ix.1945, Muntadgin, PERTH (fl.,fr.); Bradshaw & Lipfert 1659, Oct.-Nov. 1920, Stirling Ranges, PERTH (fl.,fr.); Briggs s.n., 30.ix.1960, 57 miles W of Coolgardie, NSW98834 (fl.); Brockway s.n., 14.x.1947, North East of Wiluna, CANB26596 (fl.,fr.);

Brockway 4, -.xii.1943, Between No. 7 Pumping station and Woolgangie, PERTH (fr.); Brooker s.n., 1884, 1885,Israelite Bay, MEL39557, 39595 (fl.,fr.); Burns 1052, 23.x.1966, 80 mi. N. of Geraldton on North West Coastal Highway, PERTH (fr.); Carey s.n., 1877, West end of Great Bight, MEL39600 (fl.); Cashmore 133, 27.ix.1939, Boolardy Station, PERTH (fl.); Clarke s.n., Hampden, MEL39537 (fl.,fr.); Cleland s.n., Perth, NSW98829 (fl.); Cleland s.n., -.x.1907, Geraldton, NSW98841 (fl.); Dempster s.n., 1871, between Esperance Bay and Russell Range, MEL39548 (fl.,fr.); Diels & Pritzel 185, -.xi.1900, Swan District: Subiaco, PERTH (fl.,fr.); Donner 1370, 29.ix.1965, ca 11 km west of Bullabulling, AD (fl.); Donner 2967, 10.x.1968, ca 27 km north of Young River crossing on Ravensthorpe-Esperance road, AD (fl.,fr.); Donner 3046, 16.x.1968, Location 1110, Esperance District, AD, PERTH (fl.,fr.); Eaton s.n., 1892, Youndigna, MEL39576 (fl.); Eichler 20107, 2.x.1968, Duke of Orleans Bay, AD (fl.); Eichler 20241 bis, 15.x.1968, Location 1153, Shire of Esperance, AD (fr.); Eichler 20257, 15.x.1968, Location 1159, Shire of Esperance, AD (fl.,fr.); Eichler 20282, 16.x.1968, Location 1117, Shire of Esperance, AD (fl.,fr.); Eichler 20386, 21.x.1968, Location 1163, Shire of Oldfield, AD (fl.,fr.); Eichler 20405, 21.x.1968, Location 1131, Shire of Oldfield, AD (fl.,fr.); Eichler 20412, 23.x.1968, Near foot of Mt.Ragged, AD (fl.,fr.); Fairall 345, 6.x.1962, 42 mile peg Dale Road, PERTH (fl.); Forrest s.n., 1881, Upper Swan River, MEL 39563 (fr.); Forrest s.n., -.xi.1881, near Stirling Range, MEL39579 (fl.); Forrest s.n., -.iii.1910, Busselton, NSW103171 (fl.,fr.); Forrest s.n., -.viii.1910, Busselton, AD96921171 (fl.); Gascoyne s.n. (p.p.), 2.xi.1891, 85 miles NE from Esperance Bay, NSW98846 (fl.); Geological Survey 170, 1916, East of Laverton, PERTH (fl.); George 6003, 10.xi.1963, 15 miles W of Cundeelee Mission, PERTH (fr.). AD (fr.); George 6997, 29.x.1965, 23 mi. S of Jerramungup, along Devils Creek road, PERTH (fl.,fr.); Gittens 1621, -.viii.1967, Murchison House Stn., PERTH (fl.,fr.); Goadby 274, -.x.1900, Mt. Barker, NSW (fr.); Goadby 275, -.xii.1900, King George's Sound, NSW (fr.); Goadby B2032, -.x.1900. Mt. Barker, PERTH (fl.,fr.); Goadby B2033, -.xii.1900, Kalgan River, King George's Sound, PERTH (fr.); Goodall KL2423, 3.xii.1965, 15 km SE of Cundeelee Mission, UWA (fl.,fr.); Gray s.n., Greenough Flats, MEL39538 (fl.,fr.); Green 750, 3.xi.1956, Piawaning, UWA (fr.); Green 795, 3.xi.1956, 6 miles S of Ballidu, UWA (fl.,fr.); Grieve s.n., 14.ii.1959, Tammin, UWA508 (fr.); Grieve s.n., 26.v.1959, ± 115 mile peg beyond Tammin, UWA509 (fr.); Grover s.n., 1889, north of King George's Sound, MEL39582 (fr.); Helms s.n., 17.ix.1891, Victoria Desert Camp 54, AD96803272 (fl.); NSW98846 (p.p.) (fr.); Helms s.n., 2.xi.1891, Near Fraser Range, NSW28843 (fl.); Helms s.n., 12.xi.1891, Gnarlbine, AD96906011, AD96803279, MEL39534, NSW98826, NSW98828, (fl.,fr.); Helms s.n., -.xii.1898, Mt.Barker, NSW98839 (fl.); Herbert s.n., -.xi.1920, Merredin, PERTH (fr.); Humphries s.n., 29.ix.1950, Bunjil, UWA521 (fl.,fr.); Ising s.n., -.x.1938, Albany, AD96803160 (fr.); Johnson 5095, 23.x.1958, 80 m. W. Giles, CANB, PERTH (fr.); Kelso s.n., -.viii.1902, Raeside Soak, PERTH (fl.); King & Lefroy s.n., 1889, Yilgarn near Mt.Moore, MEL39671 (fr.); Knight s.n., Porongerup, MEL39567 (fl.); Koch 1914, -.x.1940, Lowden, P (fl.,fr.); Kuchel 1667, 11.ix.1964, ca 50 km east of Esperance, AD (fl.); Kuchel 1832, 15.ix.1964, ca 65 km west of Daniell, AD (fl.); Loneragan 8, 20.xii.1961, Mersca Lake near

Wilgarup, UWA (fr.); Lullfitz L2024, 21.xii.1962, 186 mile peg Morawa Rd., PERTH (fl.); Lullfitz L3843, 25.xi.1964, Lake Cronin, PERTH, (fr.); Maiden s.n., -.x.1909, Pindar, AD96921170 (fl.,fr.); Maiden s.n., -.xi.1909, King George's Sound, AD96921167 (fl.,fr.); Maxwell s.n., towards the Great Bight, MEL39542(fl.,fr.); Maxwell s.n., Eyres and Phillips Ranges, MEL39555 (fr.); Maxwell s.n., East River, Stokes Inlet, MEL39569 (fl.); Maxwell s.n., 1875, near Cape Arid, MEL39572 (fr.); McLean s.n., 6.v.1934, Gutha, UWA507, (fl.,fr.); Merrall s.n., 1889, Mt. Moore. MEL39672, 39590 (fl.,fr.); Merrall s.n., 1890, Parkers Range, MEL39575 (fl.); Morrison s.n., 4.xi.1898, Subiaco, P, BRI079878, (fl., fr.); Morrison s.n., 7.xi.1899, Smiths Mill, Darling Ranges, CANB136622, PERTH (fl.,fr.); Morrison s.n., 21.x.1902, Ellens Peak, Stirling Ranges, PERTH (fl.,fr.); Morrison 16040, 12.i.1906, Kamballie, Coolgardie District, PERTH (fl.); Morrison s.n., 17.xi.1909, Claremont, AD96344276, BRI079877, CANB136621, PERTH (fl.,fr.); Morrison & Serventy s.n., 20.ix.1948, Murchison River, PERTH (fr.); Mueller s.n., -.x.1867, north of Stirling Range, MEL39568 (fl.); Newbey 1486, 27.ix.1964, 1 mile East of Lake Grace, PERTH (fl.,fr.); Oldfield s.n., Kalgan River, MEL39551 (fl.); Orchard 1067, 18.ix.1968, near Howick Hill, AD (fl.); Orchard 1120, 21.ix.1968, Location 251, near Howick Hill, AD (fl.,fr.); Orchard 1173, 1174, 25.ix.1968, Location 900, Shire of Oldfield, AD (fl.); Orchard 1221, 1222, 1224, 27.ix.1968, Location 1105, Shire of Esperance, AD (fl.); Orchard 1359, 4.x.1968, Wittenoom Hills, Shire of Neridup, AD (fl.,fr.); Orchard 1399, 8.x.1968, Lort River, near crossing of the Esperance-Ravensthorpe road, AD (fl.); Orchard 1521, 13.x.1968, Oldfield River at crossing of the Esperance-Ravensthorpe road, AD (fl.,fr.); Orchard 1576, 1577, 16.x.1968, Location 1110, Shire of Esperance, AD (fl.,fr.); Orchard 1703, 21.x.1968, Location 1163, Shire of Oldfield, AD, PERTH (fl.,fr.); Petticrew s.n., -.viii.1915, Wickepin, PERTH (fr.); Preiss 2067, 8.ix.1839, In calculosis ad latus orientale montis Bakewell (York), P (herb. Bunge) (st.); Preiss 2067, 1843, in Col. Swan River, G (herb. DC) (fl.); Preiss 2068 p.p., 1837-1840, Swan River, G (herb. Boiss.) (fl.,fr.); Preiss 2079, 7.xi.1840, In glareosis sterilibus districtus Hay, P (herb. Bunge) (fl.) - isotype of *L. aurea* β *angustifolia*; Pritzel 8, -.xi.1900, District Swan, AD, NSW, P (fl.,fr.); Pulleine s.n., -.xii.1917, Balingup, AD96921186, NSW103169 (fr.); Rayner s.n., 23.vi.1957, Hines Hill, UWA503 (fr.); Roark s.n., 1.xii.1949, Darlington, UWA515, UWA519 (fr.); Roach s.n., -.x.1968, Pithara, AD96844244 (fr.); Royce 2262, 15.x.1947, Boyanup, PERTH (fl.); Royce 2990, 29.x.1948, Dorradup, on Nannup-Karridale road, PERTH (fl.,fr.); Salasoo 312, 22.x.1949, Northam-Perth Highway, 4-6 miles from Northam, NSW98847 (fl.); Sayer & Carlson s.n., bet. Hampton Plain and York, MEL39591 (fr.); Sewell s.n., 1889, Mt.Caroline near Mt. Stirling, MEL39667 (fl.); Sewell s.n., 1890, Spring Valley, MEL39669 (fl.,fr.); Speck s.n., 23.ix.1951, Kings-Three Springs, UWA516 (fr.); Speck 827, 15.ix.1957, 30 miles north of Wiluna, PERTH (fl.); Speck 912, 25.ix.1953, 46-63 ml. tanks, UWA (fl.); Steedman s.n., -.xii.1929, Lake Hope, PERTH (fr.); Stewart s.n., N.E. Wiluna, PERTH (fl.,fr.); Tate s.n., Sandhills south of George Gill Range, AD96810039 (fr.); Taylor s.n., 1887, near the Thomas River, MEL39603 (fl.,fr.); Victor s.n., -.x.1898, Murchison District, PERTH (fl.,fr.); Warburton s.n., 1870, Upper Hay River, MEL39544 (fl.); Webb s.n., 1884, Bremer

River, MEL39601 (fl.); Webb s.n., 1888, King Georges Sound, MEL39587 (fl.); Webb 76, 1880, King Geórges Sound, MEL (fr.); Went 139, 9.ix.1962, halfway between Geraldton and Mullewa, PERTH (fl.)

Notes.

1. *G. aureum* var. *angustifolium* is intermediate in many characters between *G. aureum* var. *aureum* and *G. roei*. In addition its range emcompasses that of the other two taxa and spreads beyond. These facts, as well as its wide variability and weedy habit, suggest that *G. aureum* var. *angustifolium* may have arisen by hybridization of *G. roei* and *G. aureum* var. *aureum*.

2. Some collections from Kangaroo Island have trimerous flowers and fruits, while others have tetramerous or bimerous (=*G. behrii*) flowers and fruits. It seems likely that the trimerous plants are the product of introgression between *G. aureum* var. *angustifolium* and *G. behrii*. This phenomenon apparently does not occur on northern Eyre Peninsula, where the two species also grow side by side.

3. *Glischrocaryon roei* Endl., Ann Wien. Mus. 2(1838)209. [Typus: "Crescit in Novae Hollandiae austro-occidentalis interioribus (Roe)." Holotypus: "Roe, N.H.A.O.M." W! (fr.).]; Endl. & Fenzl, Nov. Stirp. Dec.9 (1839)78; Orchard, Taxon 19(1970)823.

Loudonia roei (Endl.) Schldl., Linnaea 20(1847)648; Walp., Ann. 1 (1848)293; Benth., Fl., Aust. 2(1864) 472; FvM., Fragm. 8(1874)162; FvM., Census 1(1882)49; FvM., Sec. Census 1(1889)85; Schindl., Bot. Jb. 34. Beibl. 77(1904)7 ('L. Rhoei'); Schindl., Pflrch. 23(1905)18; Black, Fl. S.Aust. (1926)429, 2 ed. (1952)641; Gardner, Enum. (1931)99; Gardner, Wildfls.W.Aust. (1959)120; Eichler, Suppl. Black's Fl. S.Aust. (1965)245; Blackall & Grieve, W.Aust. Wildfls. 3(1965)464.

Figs. Blackall & Grieve, W.Aust. Wildfls. 3(1965)464.

Perennial herb 30-40 cm tall, glabrous; taproot perennial, ± shortly branched at top, clothed in brown corky bark; stems erect, annual, smooth, green, slender, 1-2 mm diam., well developed pith, branching mainly at base. Apparently no distinct juvenile leaves. Mature leaves alternate, sessile, ± fleshy, linear, acute at apex, slightly concave on upper surface, veins not apparent, length 1.0 cm, width 0.5 mm

Inflorescence a series of terminal compound dichasia. Flowering stem terminated by 4-8 flowers either in a compound dichasium or the final branches monochasial, all the flowers functional, or those of the the final branches abortive. About 3 compound dichasia or monochasia of 2-6 flowers are borne alternately on the stem immediately below the terminal inflorescence. The whole inflorescence is compact and capitate with no lateral inflorescences from lower on the stem as in other species.

Primary bracts ± fleshy, leaf-like, oblanceolate, tapering towards base, apex acute, adnate at base to the subtended peduncle, free part 5-7 mm long, 1-2 mm wide. Secondary bracts membranous, lanceolate-oblanceolate, acute, 2-3 mm long, 1 mm wide. Tertiary, etc., bracts membranous, extremely small, deciduous at or about anthesis.

Flowers yellow, 4-merous. Sepals 4, deltoid, smooth, margins entire, 0.3-0.6 mm long, 0.8-1.0 mm wide. Petals 4, yellow, navicular, keeled, 2.2-2.4 mm long, 0.7-0.9 mm wide (margin to keel). Stamens 8, yellow, filaments 0.4 mm long; anthers 4 locular, oblong, ± non-apiculate, 1.7-2.0 mm long, 0.4-0.6 mm wide, antipetalous anthers ca 0.4 mm shorter than antisepalous anthers. Styles 4, yellow, 1.2-1.4 mm long, ovoid-capitate yellow stigmas. Ovary swollen, obovoid to obpyriform, 4 angled or ribbed, ribs 0.15 mm wide; ovary length 2.0 mm, width 1.5 mm, 1 locule with 4 pendulous ovules.

Fruit yellow, ovoid, 4 longitudinal ribs or narrow wings up to 0.5 mm wide, sepals persistent 0.5-0.6 mm long 0.7-1.2 mm wide, ± not decurrent in wings, ± not forming circumstylar tube, fruit 6.0-7.5 mm long 4.5-5.0 mm diameter, exocarp swollen, fibrous, endocarp slightly woody; single seed occupies entire locule. (Fig. 25)

Distribution. (Map 11)

Confined to a narrow coastal strip of south-western Western Australia between Stokes Inlet (75 km west of Esperance) and Albany.

Ecology.

In the Esperance district, *G. roei* grows on light sandy soils, usually in disturbed habitats, especially along roadsides (Orchard, various collections). Beard (2275) records it growing "on rocky slopes". Flowers

October, fruits October to November.

Specimens examined.

Western Australia: Anon s.n., Fitzgerald River, MEL39659 (fr.); Beard 2275, 2.xi.1962, Mount Desmond (Ravensthorpe), PERTH (fr.); Drummond 190 (5th coll.), Swan River to Cape Riche, CGE (fr.); Eichler 20241, 15.x.1968, Location 1153, Shire of Esperance, AD (fr.); Eichler 20256, 15.x.1968, Location 1159, Shire of Esperance, AD (fl.,fr.); Eichler 20284, 16.x.1968, Location 1117, Shire of Esperance, AD (fl.,fr.); Maiden s.n., -.xi.1909, Kalgan Plains, NSW98831 (fr.); Maxwell s.n., S.W. Australia, MEL39539 (fl.,fr.); Orchard 1520. 13.x.1968, Oldfield River at crossing of the Esperance-Ravensthorpe road, AD (fr.); Orchard 1526, 14.x.1968, Location 1100-1151, Shire of Esperance, AD (fl.,fr.); Orchard 1630, 18.x.1968, Location 37-38, Shire of Esperance, AD (fl.,fr.); Orchard 1701, 1704, 1721, 21.x.1968, Location 1163, Shire of Esperance, AD, PERTH (fl.,fr.); Roe s.n., N.H.A.O.M., W (fr.) - holotype of *Glischrocaryon roei*; Webb s.n., 1885, Salt River, MEL39581 (fl.).

Notes.

1. *G. roei* most closely resembles *G. aureum* var. *angustifolium*, and is possibly one parent of that (postulated) hybrid taxon (see under discussion of generic relationships).

4. *Glischrocaryon behrii* (Schldl.) Orchard, Taxon 19(1970)823.

Loudonia behrii Schldl., Linnaea 20(1847)648 [Typus: "Auf unfruchtbarem Sandboden gesellschaftlich. November. Die Blumen von reinem leuchtenden Gelb." Holotypus: Anon 166, Nov. Sandplain b.Tonanda, MEL39635 ex herb. Sonder (fl.,fr.)! - see Note 3. Isotypus: Behr 166. Sud Australie, 1848. G.(herb. Boissier)! (fl.)]; FvM., Linnaea 25(1853)385; Benth., Fl. Aust. 2(1864)472; FvM., Fragm. 8(1874)162; Tate, Trans. roy. Soc. S.Aust. 3(1880)64; Tepper, Trans. roy. Soc. S.Aust. 3(1880)176; FvM., Census 1(1882)49; Tate, Trans. roy. Soc. S.Aust. 4(1882)106, 6(1883)138, 156; FvM, Key Syst. Vict. Pl. 2(1885)22, 1(1887-8)259; FvM., Sec. Census 1(1889)85; Tate, Trans. roy. Soc. S.Aust. 12(1889)65, 95; Tate, Fl. S.Aust. (1890)100, 233; Moore, Hdbk. Fl. N.S.Wales (1893)184; Petersen, Pflfam. 3(1893)232; Schindler, Bot. Jb. 34·Beibl. 77(1904)5; Schindler, Pflrch. 23(1905)19; Dixon, Pl. N.S.Wales (1906)129; Maid. & Betche, Census N.S.Wales Pl. (1916)158; Black, Fl. S.Aust. 3(1926)429; Ewart, Fl. Vict. (1930)879; Black, Fl. S.Aust. ed. 2. 3(1952)641.

Figs: Petersen, Pflfam. 3(1893) fig 101C; Schindler, Pflrch. 23(1905) fig. 4C, C^1; Black, Fl. S.Aust. 2 ed. (1952) fig. 869.

Small erect perennial herb, glabrous, 30-50 cm tall, rootstock woody, perennial, with a well-developed taproot, stems erect, annual, numerous, arising from very short lateral branches of rootstock. Stems glabrous, smooth, sparsely branched except at base and within the inflorescence, often ± leafless.

Leaves alternate, often deciduous at an early stage, variable, terete to linear or narrow-lanceolate, fleshy, minutely mucronate, sessile, margin entire, veins and midrib not apparent, (0.5-)1.5-2.5 cm long, 0.1-0.2(-0.3) cm wide.

Inflorescence terminal, pseudo-umbelliform. Floral axis terminated by a compound dichasium of 15-31 flowers, with 4-5 alternately arranged dichasia of 7-63 flowers below. All flowers except those of the ultimate branches are functional. The peduncles of the lower compound dichasia tend to be relatively long and adnate to the basal part of the subtending primary bract, resulting in the bract apparently being borne some distance along the branch it subtends. This also applies to bracts of higher orders. Lateral inflorescences similar to, but usually of a lesser degree of branching than the terminal one,borne irregularly in the axils of some of the upper leaves. Primary bracts leaflike, green, fleshy, sometimes absent in upper part of inflorescence, free part 0.7-0.9 cm long, 0.1-0.2 cm wide, narrow-lanceolate; secondary bracts similar, 0.1-0.2 cm long, 0.05 cm wide, often deciduous at about anthesis; tertiary bracts and those of higher order less than 1 mm long.

Flowers yellow, 2-merous, rarely 3-merous, borne on filamentous pedicels 0.1-0.3 cm long, on short thick peduncles ca 0.05 cm long. Sepals 2, deltoid, yellow, smooth, 0.7-1.0 mm long, 1.0-1.2 mm wide, decurrent in wings of ovary; petals 2, yellow, ± hooded, unguiculate, (2.6-)3.5-4.0 mm long, 0.8-1.0 mm wide (keel to margin); stamens 4, filaments yellow, 0.5 mm long, anthers yellow, linear-oblong, 4-locular, 1.5-2.7 mm long, 0.5-0.6 mm wide, antisepalous stamens slightly larger than antipetalous ones, connective usually produced into a very short apiculum at top of anther; styles 2, antipetalous, cylindrical, 0.5-0.7 mm long, with capitate stigmas; ovary inferior, yellow, compressed obpyriform due to 2 longitudinal antipetalous wings, wings decurrent with sepals and pedicel, alternating with antisepalous longitudinal saccate swellings. Ovary unilocular with a median vascular cord, 3.0-3.5 mm long, 2.0-2.5 mm wide; ovules 4, pendulous, of which only 2 are functional.

Fruit yellow, occasionally reddish, 2-winged, obovate. Wings with radiating dichotomous veins, no marginal vein, fused with sepals at apex to form circum-stylar cavity, decurrent in pedicel at base. Saccate longitudinal callus opposite sepals. Fruit 8.5-10.0 mm long, 7.5-9.6 mm wide, free portion of sepals broad deltoid, 0.7-1.3 mm long, 2.5-2.8 mm wide. Pedicels 2-5 mm long, Seed 1, occupying entire locule. (Figs. 20, 25)

Ecology.

G. behrii grows in mallee communities, usually on ± deep sand and often in disturbed ground. Collectors' notes include "open disturbed roadside" (Anway 474), "grey white sand, sand-dune. *Eucalyptus incrassata* association" (Barker 644), "roadside mallee scrub, red clay soil" (Dredge 2A), "a common perennial of white sand dunes" (Kraehenbuehl 2050), "yellow sand dune" (Orchard 1808), "heathy scrub on lateritic sand ridge" (Schodde 538), "burnt ground, gregarious, 8-12 in tufts" (Tate AD96810048), "sandy burnt scrub" (Tepper 1815), "deep sand, low fertility Mallee scrub" (Moore 4635). Flowers late August to October, fruits October to February.

Distribution. (Map 11)

This species is confined to western Victoria, south-eastern South Australia as far north as Adelaide and including the "Murray Mallee", Yorke and Eyre Peninsulas, and Kangaroo Island. This species was recorded also for south-western New South Wales by Moore (1893) and Dixon (1906), but no specimens are available to support this assertion.

Common names: "Golden Pennants" (Anway 474).

Specimens examined.

South Australia:
Alcock s.n., -.x.1963, Hundred of Mortlock, AD (fr.); Alcock C36A, 30.x.1964, Hundred of Cummins, AD (fl.,fr.), pollen sent to Palyn. Lab. Stockholm; Alcock C97, 20.xii.1964, Hundred of Wanilla, AD (fr.); Alcock 1549, 29.x.1967, ca 3 km west of Mt. Verran, AD (fl.,fr.); Alcock 2183, 6.x.1968, Hincks National Park, AD (fl.); Alcock 2487, 13.x.1968, Hincks National Park, AD (fl.); Amtsberg 44, 20.xi.1966, near Minlaton, AD (fr.); Anway 474, 7.x.1965, 47 miles east of Kyancutta, AD, MEL, NSW, PERTH (fl.,fr.); Anon, s.n., Port Lincoln, AD96906016 (fl.,fr.); A.Ashby 753, 31.x.1940, Coonalpyn, AD (fr.); E.Ashby 851, -.x.1905, Middle River, Kangaroo Island, NSW (fl.); E. & K. Ashby s.n., 30.x.1940, 14.xi.1940, between Tailem Bend and Bordertown, AD96803153 (fr.); Barker 644, 14.x.1968, Hundred of Ramsay, AD (fl.); Behr s.n., 1849, in locis sterilibus fruticetis obtectis. Nov. Holl. austr., MEL39652 (fl.); Behr 166, 1848, Sud Australie, G (herb. Boissier) (fl.) - isotype of *Loudonia behrii*; Beythein s.n., 1890, Moonta, MEL39646 (fr.); Browne 20, 110, Port Lincoln, MEL39649 (fl.,fr.); Clarke & Ising s.n., 10.x.1936, Kangaroo Flat, AD966031994 (fl.,fr.); Cleland s.n., 16.x.1920, Monarto South, AD96805997 (fl.); Cleland s.n., 8.xi.1924, Kinchina, AD966032595 (fr.); Cleland s.n., 16.xi.1924, Rocky River,Kangaroo Island, AD968051020 (fr.); Cleland s.n., 27.i.1933, Mt. Scrub, Waitpinga, AD968051023 (fr.); Cleland s.n., 25.i.1940, Cape Borda Road, Kangaroo Island, AD968051026 (fr.); Cleland s.n., 25.xi.1945, Breakneck River, Kangaroo Island AD968051024 (fr.); Cleland s.n., 5.ii.1946, Breakneck River, AD968051021 (fr.); Cleland s.n., 6.ii.1946, west of Breakneck River, AD968051019 (fr.); Crocker s.n., 23.x.1943, W. of Murray Bridge, CANB11789 (fl.); Czornij 79, 27.x.1966, 5 km south of Ashbourne, AD (fl.,fr.); Donner 179, 24.viii.1961 Shipley Hill, AD (fl.); Dredge 2A, 15.xi.1968, 21 miles NW of Coulta, AD (fr.); Eichler 15086, 4.x.1958, Chauncey's Line - Monarto South, AD (fl.,fr.); Eichler 18462, 21.xii.1965, ca 3 km east of Sou'West River, AD (fr.); Eichler 19318, 6.x.1967, ca 8 km north-east of Bascombe Well Homestead, AD (fl.); Fagg 492, 26.xi.1967, ca 12 km south of Kimba, AD (fr.); Gill 162, 30.ix.1890, Yorke's Peninsula, MEL (fl.); Grivell 26, 8.vi.1969, ca 5 km south of Monarto South, AD (fr.); Hunt 205, 14.x.1961, between Western Flat and Bordertown, AD (fl.); Hunt 2140, 19.ix.1964, ca 40 km south-west of Keith, AD (fl.); Hunt 3067, 10.x.1969, Santa Cruz Scrub, Waitpinga, AD (fl.,fr.); Ising s.n., 13.x.1916, Bordertown, AD966032046 (fl.,fr.); Ising s.n., -.x.1929, Monarto South, AD966031952 (fl.,fr.); Ising s.n., -.x.1929, Sandalwood, AD966031961 (fl.); Ising s.n., 16.x.1930, Kinchina, AD966031915 (fr.); Ising s.n., -.x.1932, Yeelanna, AD96803125 (fr.); Ising s.n., -.x.1932, Wynarka School, AD966031810 (fl.); Ising s.n., 29.viii.1935, Arno Bay, AD966031722 (fl.); Ising s.n., 30.viii.1935, Rudall, AD966032025 (fl.,fr.); Ising s.n., 7.xi.1937, Cookes Plains, AD966032305 (fr.); Jackson 297, 28.xii.1959, Rocky River,

AD (fr.); Jackson 318, 6.x.1963, Muston turnoff on Kingscote-Penneshaw road, AD (fl.); Kraehenbuehl 1062, 13.x.1963, western part of Archibald Makin Reserve, AD (fl.); Kraehenbuehl 2050, 8.x.1966, Hambidge National Park, AD (fl.); Kuchel 1300, 22.x.1963, Hundred of Blesing, AD (fr.); Kuchel 1412, 23.x.1963, Hundred of Tooligie, AD (fr.); Lothian 982, 9.x.1961, 10 miles north of Stansbury, AD (fl.); Menzel s.n., -.x.1896, Goolwa , NSW98858 (fl.,fr.); Mueller s.n., -.x.1851, Pine forest Gawler town, MEL39631 p.p. (fl.); Mueller s.n., -.xi.1851, Mount Barker, MEL39631 p.p. (fr.); Orchard 1805, 3.xi.1968, ca 5½ km south of Monarto South, AD (fr.); Orchard 1808, 3.xi.1968, ca 9 km south east of Finnis, AD (fr.); Orchard 2148, 15.viii.1969, 13 km west of Kimba, AD (fl.); Orchard 2342, 28.ix.1969, Eyre Highway ca 30 km west of Kimba, AD (fl.,fr.); Orchard 2586, 11.x.1970, ca 10 km south-east of Minlaton, AD (fl.); Orchard 2635, 4.xii.1970, Dukes Highway ca 32 km north-west of Bordertown, AD (fr.); Orchard 2996, 30.xii.1970, ca 13 km west of Ungarra, AD (fr.); Orchard 3219, 8.i.1971, Eyre Highway ca 10 km south-west of Kimba, AD (fr.); Osborn s.n., 28.xi.1923, Flinders Chase, AD96810053 (fl.,fr.); Pearson s.n., -.xi.1930, between Kingscote & American River, AD96803132 (fr.); Phillips s.n., 22.ix.1965, 4 miles N. of Mt. Hope homestead, AD96919334 (fl.); Robjohns s.n., 24.x.1967, Point Bolingbroke, AD96848094 (fl.); Rogers s.n., -.ix.1908, Middle River-Western River, NSW98854 (fl.); Rothe & Ising s.n. 24.x.1919, Monarto South, AD96803130 (fr.); Schodde 538, 20.xii.1957, ca 12 km east of Cape Borda, AD, CANB (fr.); Schwartz s.n., 1890, Lower Murray Scrub, MEL39580 (fl.); Sharrad s.n., 23.x.1959, 1 mile south of Hall, AD96405270 (fl.,fr.); Sharrad 92, 21.ix.1959, Malinong, AD (fl.); Sharrad 360, 3.xi.1959, 3 miles west of Malinong, AD (fl.); D.Smith 83, -.xi.1955, 5 miles west of Yeelanna, MEL (fl.); T.Smith 795, 31.x.1967, ca 6 km south of Monarto South, AD (fl.,fr.); Specht s.n., -.xi.1953, ca 16 km north-north-east of Keith, AD96514078 (fl.,fr.); Specht 2294, 13.x.1960, Flora & Fauna Reserve, Hundred of Billiatt, AD (fl.,fr.); Specht 2361, 14.x.1960, Flora & Fauna Reserve, Hundred of Peebinga, AD (fl.,fr.); Specht 2435, 8.xi.1960, Flora & Fauna Reserve, Hundred of Hambidge, AD (fr.); Specht 2612, 2613, 11.xi.1960, Flora & Fauna Reserve, Hundred of Hincks, AD (fr.); Tate s.n., Finnis Station, AD96810004 (fr.); Tate s.n., American River, AD96810016 (fr.); Tate s.n., 29.ix.1880, Muloowortie Road, AD 96810064 (fl.,fr.); Tate s.n., 2.x.1880, east of Wellington, AD96810031 (fl.); Tate s.n., 4.iii.1886, between Hundred of Cygnet &Karatta, AD96810048 (fr.); Tepper s.n., 27.x.1887, Nuriootpa, AD96811091 (fl.,fr.); Tepper s.n., 31.x.1889, Murray Bridge, AD96811092 (fr.); Tepper 87, 88, 10 & 17.xi.1886, Karatta, MEL (fr.); Tepper 404,1884, Hundred of Freeling, AD (fr.); Tepper 1815, 8.xi.1886, Karatta to Birchman's Lagoon, AD (fr.); Tillbrook 1057, 13.x.1919, Naturi, AD (fl.,fr.); Warren 6, 17.v.1969, Meribah-Peebinga road, AD (fr.); Wheeler 1138, 13.x.1968, Hincks National Park, AD (fl.,fr.); Whibley 21, 15.xi.1956, Nangkita road near Mount Compass, AD (fl.,fr.); Wilson 383, 11.x.1958, Boston Point, AD (fl.,fr.); Wilson 726, 5.xi.1958, Kelly Hill, AD (fl.); Wilson 1005, 2.xii.1958, Chauncey's Line, AD (fr.); Wilson 1424, 22.xi.1959, Ashville, AD (fr.); Wilson 2086, 29.viii.1961, ca 65 km north of Bordertown, AD (fl.); Womersley s.n., 3.i.1944, east of Flinders Chase, AD96810019 (fr.)

Victoria: Ackland 86, 1.x.1963, 30.6 miles N. of Yanac, BRI, MEL, UPS, (fl.,fr.); Aston 159, 3.xi.1958, about 1 mile S.W. of Lake Hattah, MEL (fl.,fr.); Aston 428, 20.x.1959, 15 miles N.N.E. of Bendigo, MEL (fl., fr.); Aston 981, 28.ix.1963, about 20 miles S. of Nhill, MEL (fl.); Bissett s.n., 1870, Eaglehawk, MEL39620, 39628 (fl.,); Constable 5226, 23.x.1964, 18 miles north-north-east of Bendigo, NSW (fl.,fr.); D'Alton s.n., Nhill, MEL39625 (fl.); D'Alton 13, Mount Arapiles, MEL39621 (fr.); D'Alton 26, 1903, Dimboola, NSW (fl.); Davis s.n., 1888, 1890, Wimmera, MEL39630, 39624 (fl.,fr.); Duncan 6139, anno 1862, Victoria, P (fr.); Eckert s.n., 1891, Wimmera, MEL39626 (fl.,fr.); French s.n., -.ix.1887, N.W. of Lake Albacutya, MEL39618 (fl.); Holland 3076 (W15), -.x.1965, Wyperfeld National Park, CANB (fl.); Moore 4635, 19.x.1966, between Tempy and Ouyen, CANB (fl.,fr.); Morris 1564, 15.x.1926, Mittyack, NSW (fr.); Morris 1564, 15.x.1926, Mittijack, BRI (st.); Mueller s.n., Victoria, LE (fr.); Mueller s.n., Murray River, MEL 39654 (fl.,fr.); Mueller s.n., Australia felix, P (fr.); Muir 909, 20.x.1959, about 6 miles north of Bagshot, MEL (fl.); Musgrave 6, -.x.1948, 9 miles S.of Kiata, NSW (fr.); Reader 11, 29.x.1892, near Dimboola, MEL (fr.); Seeback s.n., 3.x.1965, Hattah Lakes National Park, MEL39605 (fl.); Thacker s.n., -.x.1897, Wimmera, NSW98859 (fr.); Walters s.n., -.xi.1887, Wimmera, MEL39623 (fr.); Walters s.n., -.x.1891, Wimmera district, BRI079881 (st.).

Notes.

1. Two collections of Alcock (2183 & 2487) both from Hincks National Park have distinctly larger leaves and flowers than usual. Another collection made at the same time and in the same locality (Wheeler 1138) is within the normal size range. The differences are probably caused by exceptional local conditions and are not considered significant.

2. The apiculum of the anthers is usually moderately well developed in western specimens, but often poorly developed or absent in eastern plants. The change appears to be clinal.

3. The specimen nominated as holotype (MEL39635) is from Sonder's herbarium and bears a label "166. Loudonia behrii Schldl." on which is stamped "scripsit Schlechtendal". As no other specimen which could be the holotype is known to the present author, this sheet, annotated by Schlechtendal, seems the most likely candidate.

4. This species closely matches *G. aureum* var. *angustifolium*

in leaf and general fruit morphology, and in overall habit. The ranges of the two taxa overlap on Eyre Peninsula and Kangaroo Island. In the latter place, plants with trimerous flowers and fruits are relatively frequently encountered, suggesting possible hybridization between the two species.

<u>*Loudonia* species exclusa</u>.

Loudonia cordigera (Endl.)[Lindl. Sketch Veg. Swan R. Col. (1840)42, comb. not made]; Hereman, Paxton's Bot. Dict. (1868)344. = *Gonocarpus cordiger* Endl.

Loudonia scoparia (Fenzl) [Lindl., Sketch Veg. Swan R. Col. (1840)42, comb. not made]; Hereman, Paxton's Bot. Dict. (1868)344 = *Haloragis scoparia* Fenzl.

Loudonia excelsa Kunth, Enum. Pl. 3(1841)250 [nom. inval.] = *Chamaerops martiana* Wall.

D. *MEZIELLA* Schindler, Pflrch. 23(1905)60 [Type species: *M. trifida* (Nees) Schindler, l.c., p.61] Gardner, Enum. (1931)99; Blackall & Grieve, W. Aust. Wildfls. 3(1965)463, 472.

Glabrous creeping perennial herbs, stems rooting at nodes, leaves alternate, trifid, lobes ± terete, with a short tooth in the angles between them.

Inflorescence an indeterminate spike of single flowers in the axils of alternate, leaflike, primary bracts. Flowers 4-merous on short pedicels. Sepals 4, narrow-deltoid, midrib weak or lacking. Petals 4, navicular or ± planar, not hooded. Stamens 4, antisepalous, filaments short, anthers broad linear. Styles 4, stigmas capitate. Ovary obconical, 4-ribbed, 4-locular, 4 ovules. Fruit unknown.

A genus of one species, *M. trifida*, which is known only from the type collection.

1. *Meziella trifida* (Nees) Schindler, Pflrch 23(1905)61; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)472.

Gonocarpus ['*Goniocarpus*'] *trifidus* Nees, in Lehm., Pl. Preiss. 1(1844)159 [Typus: "In turfosis humidis ad lacum haud procul ab oppidulo Albany (Plantagenet) m. Octobri 1840. Herb. Preiss. No. 2401" Holotypus: Preiss 2401, 11.x.1840, In turfosis humidis ad lacum haud procul ab oppidulo Albany (Plantagenet), LE (fl.) ["herb. Nees ab Esenbök"]! Isotypus: L. Preiss s.n., 11.x.1940, In turfosis humidis ad lacum haud longe ab oppidulo "Albany" (Plantagenet), MEL1003795 (st.)!] Gray, Bot. U.S. Expl. Exped. 1(1854)628.

Haloragis trifida (Nees) Walp., Rep. 5(1846)672; F.v.M., Trans. roy. Soc. Vict. 24(1888)137.

Figs: Schindler, Pflrch. 23(1905) fig. 18; Blackall & Grieve, W.Aust. Wildfls. 3(1965)463, 472.

Glabrous herb, up to 3 cm tall, stems creeping, arcuate ascending or decumbent; leaves alternate, crowded, pseudo-verticillate, trifid, 1.0 cm long, 2.0-5.0 mm wide, sessile, lobes erect, terete, ± 3 mm long, 0.2 mm wide, entire, apex acute, with a tiny tooth in angle between lobes, all veins obscure.

Inflorescence an indeterminate (?) spike of single flowers in the axils of leaflike primary bracts. Lateral inflorescences apparently absent. Primary bracts leaflike, trifid, indistinguishable from upper leaves in size and shape. Secondary bracts ('bracteoles') narrow-ovate, 1.4 mm long, acuminate, entire.

Flowers 4-merous, on pedicels 0.2 mm long. Sepals 4, narrow-deltoid, 1.3-2.0 mm long, 0.15 mm wide, thickly subsetose at apex, weakly midribbed with a median basal callus. Petals 4, cream, navicular to planar, not hooded, apex acute and tricuspidate, non-unguiculate, 0.8-1.7 mm long, 0.1-0.3 mm wide. Stamens 4, antisepalous, filaments 0.2 mm long; anthers oblong, 1.0 mm long, 0.25 mm wide. Styles 4, oblong, convergent, 0.2 mm long, stigmas capitate. Ovary obovoid, 0.3 mm long, 0.4-0.5 mm wide, 4-ribbed opposite petals, 4-locular with 4 ovules.

Fruits not available.

Distribution. (Map 12)

This species is known only from near Albany in south-western Western Australia.

Ecology.

M. trifida apparently favours the swampy margins of lakes. Flowering occurs in October.

Specimens examined:

Western Australia: Preiss 2401, 11.x.1840, near Albany, LE, MEL (fl.) - type of *G. trifidus*.

Notes.

1. Although the citation of the locality is slightly different in the LE and MEL specimens ("haud procul" ... and "haud longe" ... respectively) there is little doubt that they belong to the same collection.

2. The species is known only from the type collection and this is extremely fragmentary, consisting only of short pieces of stem, leaves, and one incomplete spike of young buds. For this reason, the above description is based largely on that of Schindler (1905), who apparently saw much better material. More collections, particularly fruiting specimens, are urgently needed, but it is possible (or even probable) that the species is extinct.

E. <u>*GONOCARPUS*</u> Thunberg, Nov. Gen. 3(1783)55 et Fl. Jap. (1784)5 [Type species: *G. micranthus* Thunb., l.c., p.69](non *Gonocarpus* Ham., Prod. Pl. Ind. Occ. 39(1825)n.v. = Combretum L. fide Airy-Shaw (1966)); Labill., Pl. Nov. Holl. 1(1804)39, t.53.

Gonatocarpus Schreber (ed.), Gen. Pl. 1(1789)86 n.v., nom. illeg.; Willd., Spec. Pl. 1(1797)690.

Linociria Necker, Elem. Bot. 3(1790)366, nom. illeg.

Goniocarpus Koenig, Ann. Bot. 1(1805)546, nom. illeg.; DC., Prod. 3(1828)66; Cunn., Ann. Nat. Hist. 3(1839)30; Nees in Lehm, Pl. Preiss. 1(1844)158, 2(1848)225.

Annual or perennial herbs or small shrubs, up to 4 m tall (usually 10-30 cm), rootstock a simple taproot, stems ascending or erect, smooth or 4-5-ribbed, herbaceous or woody, often rooting at nodes in lower parts, glabrous, scabrous, or pilose with various types of simple hairs.

Leaves sessile or petiolate, exstipulate, alternate, opposite, or rarely, in whorls of 3(-5), terete, linear, lanceolate or ovate, margin entire or serrate, midrib sunken above, prominent below, glabrous or scabrous, with hairs as for the stems.

Inflorescence an indeterminate spike of single flowers borne in the axils of alternate, opposite or whorled primary bracts. Lateral inflorescences may arise in the axils of the upper leaves. Primary bracts leaflike, grading into upper leaves at base of inflorescence, becoming ± rapidly reduced in size and serrations towards apex. Secondary bracts ("bracteoles") borne on pedicels of flowers, linear, lanceolate or ovate, brown, membranous, much smaller than primary bracts.

Flowers (3-)4-merous on short pedicels. Sepals (3-)4, deltoid, lanceolate or cordate, often with pronounced midrib and prominent median basal callus, glabrous or scabrous. Petals same in number as sepals, hooded, ± unguiculate, keeled, glabrous or scabrous on keel. Stamens twice the number of sepals, filaments short; anthers oblong, 4-locular, non-apiculate, antisepalous anthers slightly longer than antipetalous ones. Styles same in number as sepals, clavate, stigmas capitate. Ovary ovoid to hemispherical, smooth or ribbed opposite sepals and/or petals, ± tuberculate, glabrous or scabrous, incompletely (3-)4 locular, with 1(-2) pendulous ovules per locule (if 2, then 1 aborts at an early stage).

Fruits similar in size and shape to ovary, never winged, glabrous or scabrous; sepals persistent, erect, deltoid, lanceolate or cordate, usually with midrib and median basal callus; pericarp ± membranous, septa ± absent, 1 seed, occupying entire fruit.

Distribution.

Gonocarpus is widespread in Australia and New Zealand and can be found in most parts of these countries. About four species occur in New Guinea and two or three in Indonesia(?), Borneo, the Philippines, Japan, Formosa, Taiwan, and the coastal regions of mainland South-East Asia. *G. micranthus* ssp. *micranthus* is found almost throughout the range of the genus (absent only in central and western Australia).

Ecology.

The species of this genus occupy a wide range of habitats, ranging from rain-forest to dry rocky hillsides, although most species grow in relatively damp localities, often in sclerophyll forest. There are apparently no aquatic species, nor any desert ephemerals in this genus.

Some alpine species are normally covered with snow for part of the year. Flowering and fruiting normally occur during mid to late summer. Pollination is probably anemophilous in most species. Most species are potentially perennial, dying back to the rootstock and lower branches after fruiting, and shooting again during the following winter/spring. Some species probably reproduce vegetatively from the creeping or procumbent stems which root at the nodes.

Notes.

1. Thunberg spelt the name of the genus 'Gonocarpus'. The names *Gonatocarpus* Schreber and *Goniocarpus* Koenig were proposed as variants to prevent confusion between *Gonocarpus* and *Conocarpus* L. (Combretaceae). As all the names for the genus in Haloragaceae were based on the same type species (*G. micranthus*), all except *Gonocarpus* are illegitimate.

2. *Gonocarpus* was included in *Haloragis* by Robert Brown (1814) when he recognized the family Haloragaceae as distinct from Onagraceae. He was followed by all subsequent authors with the exception of A.-P. deCandolle (1828). The genus is reinstated in this treatment on the basis of differences from *Haloragis* in characters of the inflorescence, septa, pericarp and development of the fruit.

3. There has not been time in the present study to examine all species of this genus (ca 20-25 species) in detail, although the types of most of them have been seen. An attempt has been made to include, among the few treated fully, species representative of the diversity within the genus. A key to these selected species is not provided as it would be without significance; these species are not a complete representation from any biogeographical area, or of any natural group within the genus.

1. *Gonocarpus micranthus* Thunberg, Nov. Gen. 3(1783)69 n.v. et Fl. Jap. (1784)69 [Typus: "Crescit iuxta Nagasaki, copiose." Isotypus: Dr. Thunberg s.n., Japan, S (fr.)!] Koenig, Ann. Bot. 1(1805)546; DC., Prod 3(1828)66.

Haloragis tenella Brongn. in Duperrey, Voy. Coq. (Bot.) (1827-34) t.68 [Typus: l.c., t.68!]; Hook. f., Fl. N.Zeal. 1(1852)63, Suppl. (1855)328.

Goniocarpus microcarpus Thibaud ex DC., Prod. 3(1828)66 [Typus: "in Australasia" n.v.].

Haloragis micrantha (Thunb.) R.Br. ex Sieb. & Zucc., Fl. Jap. 1(1835)25 [R.Br. in Flind. Voy. 2(1814)550, comb. implied but not made]; A. Gray, Bot. U.S. Expl. Exped. 1(1854)626; Hook. f., Fl. Tasm. 1(1856) 120, 121; Sonder, Linnaea 28(1856)230; Benth., Fl. Aust. 2(1864)481, 482, 484; F.v.M., Fragm. 8(1874)162, 10(1876)54; Hook. f., Fl. Brit. Ind. 2(1878)430; Baillon, Nat. Hist. Pl. 6(1880)491; Tate, Trans. roy. Soc. S.Aust. 3(1880)64; F.v.M., Census 1(1882)49; Bailey, Syn. Qld. Fl. (1883)157; Tate, Trans. roy. Soc. S.Aust. 6(1883)96; Colenso, Trans. N.Zeal. Inst. 18(1885-6)260; F.v.M., Key Syst. Vict. Pl. 2(1885)22, 1(1887-8)263; F.v.M., Trans. roy. Soc. Vict. 24(1888)134; Tate, Trans. roy. Soc. S.Aust. 12(1889)86; F.v.M., Sec. Census 1(1889)86; Featon, Art Alb. N.Z. Fl. 1(1889)149; Tate, Fl. S.Aust. (1890)101, 234; Moore, Hdbk. Fl. N.S.Wales (1893)186; Petersen, Pflfam. III.7(1893)230, 233; Kirk, Stud. Fl. N.Zeal. (1899)149; Bailey, Qld. Fl. 2(1900)556; Rodway, Tas. Fl. (1903)49; Diels & Pritzel, Bot. Jb. 35(1904)447; Schindler, Bot. Jb. 34, Beibl. 77(1904)30,42; Schindler, Pflrch. 23(1905)42; Dixon, Pl. N.S.Wales (1906)130; Maiden & Betche, Proc. Linn. Soc.

N.S.Wales 31(1906)396, 398; Merrill, Philip. J. Sci. 1 Suppl. (1906)217; Merrill, Philip. J. Sci. (Bot.) 2(1907)289; Cheeseman, Trans. N.Zeal. Inst. 42(1909)203; Cockayne, Rep. Bot. Surv. Stewart Is. (1909)57; Bailey, Comp. Cat. Qld. Pl. (1913)174; Guillaumin, Bull. Soc. Bot. France 61(1914)9, 10; Maiden & Betche, Census N.S.Wales Pl. (1916)158; Gibbs, Phytogeog. & Fl. Arfak Mts. (1917)159; Went, Nova Guinea 14(1924) 107; Cheeseman, Man. N.Zeal. Fl. 2 ed. (1925)623; Black, Fl. S.Aust. (1926)430; Mansfeld, Bot. Jb. 61(1927)26; Domin, Bibl. Bot. 89(1929)1034; Ewart, Fl. Vict. (1931)880; van Steenis, Bull. Jard. Bot. Buitenz. III. 13(1934)218; Hosakawa, Trans. Nat. Hist. Soc. Formosa 30(1940)335; Black, Fl. S.Aust. 2 ed. (1952)642; Curtis, Stud. Fl. Tas. 1(1956)187; Allan, Fl. N.Zeal. 1(1961)244; van Steenis, Endeavour 21(1962)187; Evans, in Beadle, Evans & Carolin, Hdbk Vas. Pl. Syd. Dist. (1963)175; Eichler, Suppl. Black's Fl. S.Aust. (1965)245; Ohwi, Fl. Jap. (1965)660.

Goniocarpus citriodorus A. Cunn., Ann. Nat. Hist. 3(1839)30 [Typus: "New Zealand (Northern Island). In bogs, on the banks of the Keri Keri river, Bay of Islands. - 1834, Rich. Cunningham." Holotypus: R. Cunningham 530, 1834, Bogs about the Keri Keri, K (fr.)!]; Featon, Art Alb. N.Zeal. Fl. 1(1889)149 ['Goniocarpus citriodours'].

Haloragis citriodora (A. Cunn.) Walp., Rep. 2(1843)99.

Haloragis minima Colenso, Trans. N.Zeal. Inst. 18(1885-86)259 [Typus: "Hab. Tarawera, high lands between Napier and Taupo; December,1884; Mr. H. Hill." Holotypus et isotypus: W, A (fide Allan, 1961), n.v.].

Prostrate or ascending creeping or erect herbs, glabrous or rarely very slightly scabrous on stems and petioles with scattered, appressed, simple, unicellular hairs 0.1-0.2 mm long. Stems smooth (not ribbed or winged), rooting at the lower nodes, ± intricately branched, with 1-3 lateral branches arising from the axil of a single leaf. Leaves decussate, shortly (0.6-2.0 mm) petiolate, orbicular to ovate, sometimes almost cordate or lanceolate, 0.4-1.3 cm long, 0.3-1.1 cm wide, rounded or cordate at base, acute to obtuse at the apex, margins thickened, serrulate with (4-)8-20(-30) small crenate teeth, midrib ± prominent below, smooth above, lateral veins indistinct.

Inflorescence an indeterminate spike of single flowers borne in the axils of alternate primary bracts. Lateral inflorescences are borne in the axils of the upper leaves, and the lateral inflorescences may themselves bear branchlets, and so on, up to the 4th order of branching. Primary bracts lanceolate, 0.5-0.8(-1.0) mm long, 0.1-0.2 mm wide, membranous, entire; secondary bracts (bracteoles) ± orbicular, 0.1-0.2 mm long, 0.1-0.2 mm wide, membranous, serrulate or entire. All bracts deciduous, at or about anthesis.

Flowers pendant, on pedicels 0.1-0.3 mm long. Sepals 4, green, deltoid, 0.4-0.5 mm long, 0.3-0.4 mm wide, with median basal callus. Petals 4, reddish, hooded, keeled, 0.8-1.3(-1.5) mm long, 0.2-0.4 mm wide, glabrous. Stamens 8, filaments 0.1-0.3 mm long; anthers yellow or red, oblong, (0.5-)0.7-0.9 mm long, 0.1-0.2 mm wide, 4-celled, nonapiculate. Styles 4, stigmas red to yellow, fimbriate. Ovary obovoid, 0.6-0.9 mm long, 0.5-0.7 mm wide, tapering gradually towards base, shortly contracted at apex, shiny red to grey with 8 prominent longitudinal ribs, glabrous, incompletely 4-locular, with 4 pendulous ovules.

Fruit reddish to grey, obovoid, 0.7-0.9 mm long, 0.6-0.7(-0.8) mm wide, 8-ribbed, glabrous, or rarely with short, curved unicellular hairs arising from tubercles on the ribs; sepals persistent, erect, deltoid, 0.4-0.6(-0.7) mm long, 0.3-0.4(-0.5) mm wide, with a median basal callus; 1 seed, occupying entire fruit.

G. micranthus consists of two subspecies, which can be distinguished as follows.

1. Inflorescence narrow, unbranched, or branching only to the 2nd order; all inflorescence branches ± erect. Plants usually prostrate, 5-10 cm tall. Leaves (3.0-)4.0-7.0 mm long, (3.0-)4.0-6.0 mm wide.

i. ssp. *micranthus*

1. Inflorescence diffuse, branching to the 3rd and 4th order; the final inflorescence branches ± horizontal. Plants erect, 25-60 cm tall. Leaves (8.0-)10.0-13.0 mm long, (7.0-)8.0-12.0 mm wide.

ii. ssp. *ramosissimus*

i. ssp. *micranthus*

Prostrate or ascending creeping herb, stems rooting at nodes; in open situations the stems become stoloniferous and give rise to cushion plants 5-10 cm tall; in dense undergrowth the stems are supported by surrounding plants and may reach 30 cm tall. Leaves (lanceolate-) ovate-cordate, (3.0)4.0-7.0 mm long, (3.0-)4.0-6.0 mm wide. Inflorescence narrow, unbranched (i.e. no lateral inflorescences) or branched only to the 2nd order, and then all branches are ± erect. Flowers and fruits as for species. (Fig. 24)

Distribution. (Map 13, 14)

This is the most widespread of the two subspecies, extending from south-eastern Australia to New Zealand, New Guinea, Borneo, Philippines and south-eastern Asia, including Japan, Formosa, Taiwan, China, Indo-China and northern India.

Ecology.

G. micranthus ssp. *micranthus* favours wet or boggy places, either in open or grassy situations. It has been found at altitudes ranging from sea-level to about 3000m (10,000 ft.), and often occurs in alpine meadows where it is covered with snow for several months of the year. Collectors' notes include "hilly granite country near small running creek" (Burbidge & Gray 4451); "alpine bog land" (Schodde 3221); "in sphagnum bogs & on wet surfaces along streams etc." (Costin 0021); "in damp soil among sandstone rocks" (Rodway 2579); "in sandy soil in heath-land" (Muir 3332); "common in small flat masses on burnt grasslands" (Brass 4645) and "growing on mud and floating debris at water level" (Orchard 2030). Within Australia and New Zealand, flowering occurs from about December to February and fruiting from December to March. In New Guinea, Borneo, Philippines and Japan flowering and fruiting times are earlier.

Specimens examined.

Japan: Burmann s.n., Japan (?), G(herb. Deless.) (fl.,fr.); Lugd Batav. s.n., Japonia, W (fl.); Lugd. Batav. 51, Japonia, W (fl.); Tagawa 3840, 19.vii.1951, Takara-ga-ike, Kyoto, U (fl.,fr.); Thunberg s.n., E.Japonia, BRI066083 (photo. - Kew neg. 7122) - isotype of *G. micranthus;* Thunberg s.n., Japan, S (fr.) - isotype of *G. micranthus*.

Formosa: Linley Gressitt 429, Taiheizan, U (fr.).

East Pakistan: Hook. f. & Thomson s.n., Khasia, CGE (fl.).

Philippines: Merrill s.n., -.iv.1910, Canlaon Volcano, Negros, BRI1080068 (fl.); Merrill 861, -.v.1911, Benguet subprovince, Luzon, U (fl.,fr.); Santos s.n., -.iv-vi.1918, Pauai, Luzon, BRI080069 (fl.).

Borneo: Jacobs 5741, 15.x.1958, Mount Kinabalu, CANB66999 (fl.).

New Guinea: Brass 4645, -.vi-ix.1933, Murray Pass, Wharton Range, BRI (fl.); Brass 9194, -.viii.1938, Lake Habbema, BRI (fl.); Brass 22248, 19.v.1953, Maneau Peak, Mt.Dayman, CANB (fl.,fr.); Henty & Carlquist NGF16623, 10.ii.1963, Mount Poira, BRI (fl.,fr.); Kalkman 4831, 9.vii.1966, Mt. Kerewa, CANB (fl.,fr.).

New Zealand: Anon. s.n., New Zealand, AD96906025 (fl.,fr.); Barker 355, 4.i.1938, Tekapo River Township, CHR21009 (fl.,fr.); Colenso s.n., Nov. Zeland, U (st.); R.Cunningham 530, 1834, Bogs about the Keri Keri, K (fr.) - holotype of *G. citriodorus*; Davey s.n., -.xii.1943, Paekakariki, CHR37228 (fl.,fr.); Druce s.n., -.i.1960, betw. Egmont & Ponaki Ra., CHR86699 (fl.); Hamlin s.n., 18.i.1950, near Pureora, Maraeroa Plains, CHR68631 (fr.); Hay s.n., 1.i.1952, Paramahoe, Takaka, CHR73661 (fl., fr.); Healy s.n., -.i.1940, Ikaramio, Kaituna Valley, CHR35542 (fl.,fr.); Kirk 64, Nelson, AD (fl.,fr.); Locan s.n., 2.ii.1969, Invercargill, CHR186100 (fr.); MacMillan 68/10, 6.i.1968, Irishman Creek 4 m. S.E. of Marsden, CHR (fl.); Mason 7466, 4.xii.1959, between Piako River and Patetonga, CHR (fl.,fr.); Mason 7744, 11.xii.1959, 6 miles N of Katikati, CHR (fl.,fr.); Mason 8122, 3.i.1961, Ferguson Creek, Hunter Valley, Otago, CHR (fl.); Mason & Moar 1043, 18.ii.1952, Clinton-Mataura road, CHR (fr.); Mason & Moar 5383, 18.ii.1958, Lake Kini, Bruce Bay, CHR (fl.,fr.); Mason & Moar 6416, 26.xi.1958, 1 m. from Netherby, CHR (fl., fr.); Mason & Moar 6481, 27.xi.1958, Lake at western edge of Rukuhia Swamp, CHR (fl.,fr.); Moore s.n., 27.xii.1953, Puketi road (Okaihau-Kapo) CHR83626 (fl.,fr.); Melville 6034, 14.i.1962, Cobb River, below Mt. Peel, Nelson, CHR (fl.,fr.); Simpson 4928, 25.i.1966, Butler River, Nelson Lakes National Park, CHR (fl.,fr.); Thomson s.n., -.xii.1879, near Dunedin, BRI080066 (fl.,fr.); Tryon s.n., Tarawera Swamp, Hawkes Bay, BRI080054 (fl.); Tryon s.n., Wairarapa, Masterton, BRI080067 (fr.).

Tasmania: Anon. s.n., Tasman., MEL1003776 (fl.); Archer 5, Tasmania, NSW (fl.); Black 308, 30.xii.1921, S. Bruny, AD (fl.,fr.); Bufton 2, 1893, Port Arthur, MEL (fl.,fr.); Burbidge 3155, 15.i.1949, Two miles from Hastings Caves Reserve, CANB (fr.); Carolin 1662, 2.ii.1960, Tim Shea, Florentine Valley, SYD (fr.); Curtis s.n., 19.i.1911, summit Mount Wellington, CHR180363 (fr.); Curtis s.n., 16.ii.1948, Somerset, CHR180362 (st.); Davis s.n., 17.i.1937, Hente Siding, near Strahan, NSW99127 (fl.); Eichler 16631, 15.i.1960, Cynthia Bay, Lake St.Clair, AD (fl.,fr.); Gulliver s.n., Lake St.Clair, MEL1003619 (fr.); Gulliver s.n., 1873, Tasm. MEL1003612 (fr.); Gunn s.n., Tasmania, MEL1003764 p.p.; Gunn 884, 12.xii.1837, To Forest C.Hd, NSW (fl.,fr.); Gunn 884, 31.i.1840, Mt.Wellington, NSW (fr.); Gunn 884, 3.xii.1841, Pt. Effingham, NSW (fl., fr.); Hook. f. s.n., Tasmania, UPS (fl.); Jacobs 178, 1960, Bicheno, MEL (fl.,fr.); Lucas s.n., -.xii.1923, Bellerive, NSW99138 (fl.,fr.); Lucas s.n., -.xii.1924, Waratah, NSW99128 (fl.); Moore 11, 1892, Mt. Zeehan, MEL (fl.); Mueller s.n., -.i.1849, Mersey River, MEL1003621 (fl.); Mueller s.n., -.i.1869, Mount Field East, MEL1003618 (fl.); Mueller 424, 8.i.-, Mersey R, MEL (fl.); Mueller 887, Brisbane Bay, Macquarie Harbour, MEL (fl.); Phillips s.n., 21.xi.1965, 24 miles from Queenstown, CBG033908 (fl.); Phillips & Carroll 62307, 19.i.1962, Hartz Mountain National Park, CBG (fr.); Rodway s.n., -.xii.1915, Cradle Mtn., NSW99126 (fl.); Rodway 2702, -.xii.1892, Strahan, NSW (fl.); Rupp 45,

-.i.1922, Mt.Barron, NSW (fr.); Whaite 2214, 19.i.1961, road to Hastings Caves, NSW (fr.).

Victoria: Allender s.n., 16.i.1961, Echo Flat, Lake Mountain, MEL1003582 (fr.); Allitt s.n., Portland, MEL1003623 (fl.,fr.); Beauglehole 15337, 22.i.1966, Mt. Baw Baw, BEAUGLEHOLE (fr.); Beauglehole 15413, 25.i.1966, Bogong High Plains, BEAUGLEHOLE (fr.); Beauglehole 15596, 26.i.1966, Bogong High Plains, BEAUGLEHOLE (fl.,fr.); Beauglehole 16363, 9.xii.1967, Wannon River, Grampians, BEAUGLEHOLE (fr.); Beauglehole 17016, -.xii.1946, Portland, BEAUGLEHOLE (fl.); Beauglehole 30552, 19.ii.1969, N. of Wannon River Bridge, Grampians, BEAUGLEHOLE (fl.); Beauglehole 30847, 2.vii.1969, N. of Sugarloaf Hill, Grampians, BEAUGLEHOLE (fl.); Beauglehole 31219, 13.x.1969, ± 13½ miles direct S.W. of Mallacoota P.O., BEAUGLEHOLE (st.); Beauglehole 31282, 26.x.1969, Marlo Aerodrome, AD, BEAUGLEHOLE (fl.); Beauglehole 31290, 27.x.1969, 1 mile E. of Marlo, BEAUGLEHOLE (fl.); Beauglehole 31677, 13.xi.1969, ± 20½ miles direct S.W. of Mallacoota P.O., BEAUGLEHOLE (st.); Beauglehole 31707, 14.xi.1969, ± 7 miles direct N.W. of Mallacoota P.O., BEAUGLEHOLE (fl.,fr.); Beauglehole 32213, 8.xii.1969, ± 2½ miles W. of Genoa P.O., BEAUGLEHOLE (fl.); Beauglehole 32628, 20.xii.1969, East Wingan Road, East Gippsland, BEAUGLEHOLE (fr.); Beauglehole & Finck 31975, 22.xi.1969, Cicada Trail, East Gippsland, BEAUGLEHOLE (fl.); Beauglehole & Finck 32128, 5.xii.1969, ± 4 miles direct N.W. of Mallacoota P.O., BEAUGLEHOLE (fl.); Beauglehole & Finck 32951, 29.xii.1969, E. of Top Lake, Mallacoota Inlet, AD, BEAUGLEHOLE (fl.,fr.); Beauglehole, Rogers & Finck 33318, 7.i.1970, Benambra-Wulgulmerang road, BEAUGLEHOLE (fl.,fr.); Beauglehole & Willis 31518, 4.xi.1969, ± 3½ miles direct E.N.E. of Mallacoota P.O., BEAUGLEHOLE (fl.); Beauglehole & Willis 31563, 6.xi.1969, ± 6 miles direct E.N.E. of Mallacoota P.O., BEAUGLEHOLE (st.); Beauglehole & Willis 31593, 8.xi.1969, ± 6 miles direct N.E. of Mallacoota P.O., BEAUGLEHOLE (fl.); Belcher 729, 7.xi.1967, about 1½ miles N. of Mt.Kincaid, PERTH (fl.); Brown s.n., Port Albert, MEL1003628 (fl.); D'Alton 1, the Grampians, MEL (fl.,fr.); Eichler 14675, 2.ii.1958, Fall's Creek, Bogong High Plains, AD (fr.); French s.n., -.i.1889, Bendac, MEL1003654 (fl.,fr.); Gates 21, 1891, Ovens River, MEL (fl.,fr.); Hart s.n., Croydon, MEL1003578 (fl.); Hart s.n., 30.xii.1938, Dingley, between Dandenong and Cheltenham, MEL1003579 (fl.,fr.); Lehmann & French s.n., -.xii.1892, Mt.Mueller, MEL1003658 (fl.); Lucas s.n., 1883, Myrtleford, MEL1003633 (fl.); Meebold 2438, -.i.1929, Wilson's Promontory, AD (st.); Merrah s.n., -.v.1887, Head of Bendoc River, MEL1003638 (fr.); Morrison s.n., 10.i.1892, Frankston, CANB127117 (fr.); Morrison 2076, 7.i.1892, Oakleigh, AD, CANB, MEL, NSW, PERTH (fl.); Morrison 2077, 17.xii.1892, Oakleigh, AD, CANB, MEL, NSW (fl.); Mueller s.n., Port Phillip, MEL1003785, 1003795 (fl.,fr.); Mueller s.n., -.i.1850, Dandenong Ranges, MEL1003624 (fl.,fr.); Mueller s.n., 26.ii.1850, Mount Buller, MEL1003627 (st.); Mueller s.n., 19.iv.1853, Mount Ararat, MEL1003763 p.p.; Mueller s.n., -.v.1853, Alberton, MEL1003629 (st.); Mueller s.n., -.xii.1856, South Port, MEL1003615, 1003616 (fl.); Mueller s.n., -.xii.1862, Mount Useful, MEL1003626 p.p., 1003639 (fl.); Mueller s.n., -.xii.1879, Curdies River, MEL1003632 (fl.); Muir 722, 21.i.1959, Falls Creek, Bogong High Plains, MEL (fl.,fr.); Muir 1944, 26.xi.1960, 2 miles east of Cann River, Princes Highway, MEL (fl.); Muir 3110, 3.i.1964, about 2 miles south-west of Mt.Wellington, MEL (fl.); Muir 3332, 17.ii.1964, 12 miles east-north-east of Stratford, MEL (fl.,fr.); Muir 3759, 14.i.1965, 7 miles north-west of Mt.Wellington, MEL (fl.,fr.); Muir 3830, 26.i.1966, 1 mile north of Mt.Wellington, MEL (fl.,fr.); Orchard 1883, 7.ii.1969, ca 32 km north-east of Hamilton, AD (fr.); Orchard 1905, 8.ii.1969, ca 55 km north-east of Hamilton, AD (fl.); Orchard 2003, 2004, 13.ii.1969, ca 24 km west of Heywood, AD (fl.,fr.); Orchard 2015, 13.ii.1969, ca 30 km west of Heywood, AD (fl.,fr.); Reader s.n., 3.xii.1905, County of Follett, MEL1003644 (fl.); Robbins 17027, 1937, Boggy Creek, East Gippsland, BEAUGLEHOLE (fl.); Robbins 17093, 9.i.1951, Mt.Buffalo, BEAUGLEHOLE (fr.); Robbins 17094, 1940, Lower Euroben Creek, BEAUGLEHOLE (fr.); Tadgell 14, -.xii.1914, Mt.Hotham, MEL (fr.); Tadgell 17, -.xii.1914, Mt. St.Bernard, MEL (fl.); Walter s.n., -.xi.1897, Dandenong ranges, MEL1003640 (fl.,fr.); Williamson s.n., -.xii.1902, Hawkesdale, BRI080052 (fr.); Williamson, s.n., -.ii.1903, Hawkesdale, NSW99129 (fr.).

New South Wales: Anon., 324, Dec., Timbarra, MEL1003602 (fl.); Baeuerlen 56, -.iii.1885, Genoa district, MEL (fl.,fr.); Baeuerlen 194, -.xi.1884, Braidwood district, MEL (fl.); Beadle s.n., 7.ii.1952, Kosciusko, NE, SYD (fl.,fr.); Boorman s.n., -.xi.1914, Clyde, Paramatta R., AD, BRI, NSW, SYD (fl.,fr.); Burbidge 6358, between Blackfellow's Gap & Upper Cotter, CANB (fr.); Burbidge & Gray 4451, 17.i.1958, Bendora to Mt. Franklin, CANB (fr.); Burgess s.n., 24.ix.1962, Wentworth Falls, CBG006243 (fl.); Caley s.n., Nouvelle Hollande, G (fl.); Cambage 3154, 4.xii.1911, Mt.Werong, NSW (fl.); Cambage 3297, 14.i.1912, Upper Cotter, Queanbeyan, NSW (fr.); Cambage 4118, 7.xi.1914, Old Racecourse, Ulladulla, NSW (fl.,fr.); Carolin s.n., 30.xi.1963, Mellag Swamp, SYD (fl.); Carolin 905, 22.iii.1959, Mt.Maxwell, SYD (fr.); Carroll s.n., 17.i.1966, Happy Jack's Plains, CBG017597 (fl.,fr.); Cheel s.n.,-.ii.1912, Colo, NSW 99164 (fl.); Constable s.n., 14.xii.1948, Wolgan East, NSW28226 (fl.); Constable s.n., 12.xii.1960, 2 miles W. of Penrith, NSW55717 (fl.,fr.); Constable 7327, 22.ii.1967, Sans Souci, NSW (fl.,fr.); Costin 0021, -.i.1958, Mt. Stillwell, CANB (fl.,fr.); Eichler 13458, 24.i.1957, ca 9 km E.N.E. of Mt. Kosciusko, AD (st.); Eichler 13479, 25.i.1957, ca 8 km E.N.E. of Mt. Kosciusko AD (fl.); Evans s.n., -.i.1932, Blackheath Water reserve, SYD (fl.); Evans 2570, -.x.1924, LaPerouse, Botany Bay, SYD (fl.); Forsyth s.n., -.xii.1901, Kiandra, NSW98923 (fl.); Fraser & Vickery s.n., 7.i.1934, Barrington Tops, NSW98926 (fl.,fr.); Gauba s.n., 6.vii.1950, Badja Mountain, CBG015105 (fl.); Heron s.n., -.v.1899, Conjola, NSW99154 (fl.,fr.); Johnson s.n., 1.xii.1954, Barrington Tops, NSW98927 (fl.); Johnson 920, 18.i.1947, Jibbon Hill, NSW (fl.,fr.); Johnson & Constable s.n., 25.i.1957, Digger's Creek, Kosciusko, NSW18817 (fr.); Lumley 5, 22.iv.1941, Wardell, Richmond River, NSW (fr.); Maiden s.n., -.xi.1896, Port Jackson district, AD96905139 (fr.); Maiden s.n., -.i.1898, Mt.Kosciusko, NSW98919 (fr.); Maiden & Forsyth s.n., -.i.1899, Pretty Point, Mt.Kosciusko, NSW98920 (fr.); Martin s.n., 19.i.1957, Boggy Plain, Kosciusko, SYD (fr.); McBarron 1336, 2.i.1948, Tumbarumba, SYD (fl.,fr.); McBarron 7478, 5.ii.1963, Linden, NSW (st.); McKee 10149, 27.ii.1963, Mt.Gingera, NSW (fr.); McKee 11656, 6.x.1964, Duranbah, CANB (fl.); Moore 2268, 4.ii.1953, Mt.Gingera, CANB (fr.); Moore 3343, 3348, 26.i.1961, near Cabramurra, CANB (st.); Mueller s.n., Paramatta, MEL1003595, 1003605 (fl.); Orchard 2395, 29.x.1969, top of

Bulli Pass, ca 5 km west of Wollongong, AD (fl.); Phillips-Carroll s.n., 9.i.1963, Happy Jack's, CBG015624 (fl.,fr.); Rodd s.n., 15.xi.1964, Kanangra Tops, NSW98934 (fl.); Rodway s.n., 26.xii.1925, Bowen Island, Jervis Bay, NSW99151 (fl.,fr.); Rodway s.n., 19.x.1941, 6 miles S.W. of Nowra, NSW99149 (fl.,fr.); Rodway 224, 30.xi.1930, Fitzroy Falls, NSW (fl.); Rodway 2579, 27.ix.1937, 3 miles S.W. of Nowra, NSW (fl.); Rumsey s.n., -.x.1895, Barber's Creek, NSW98932 (fl.); Salasoo 884, 20.x.1951, E. of Wahroonga, NSW (fl.); Salasoo 922, 2.ii.1952, Roseville Chase, NSW (fl.); Schodde 1280, 8.ii.1961, Bendora, Brindabella Range, AD, CANB (fr.); Schodde 3221, 3.ii.1963, ca 40 miles north of Singleton, CANB (fr.); Simmonds s.n., -.iv.1897, Richmond River, BRI080060 (st.); Tenison-Woods s.n., 30.xii.1882, Wentworth Falls, BRI080056 (fl.); Thompson 87, 17.i.1958, ca 15 miles S. of Kiandra, NSW (fl.,fr.); Walker ANU190, 11.ii.1962, Kosciusko, CANB (fl.,fr.); Walker ANU988, -.xii.1962, Currango, CANB, NSW (fl.); Whaite 816, 24.xii.1950, Carrington Falls, Robertson, NSW (fl.); Whaite 1103, 30.xii.1951, Glen Raphael, NSW (fl.); Whaite 2976, 24.x.1965, 10 miles south of Sassafras, NSW (fl.); Williams s.n., 16.xii.1967, 45 miles E. of Armidale, NE (fl.).

Queensland: Bufton 65, 1893, Bathurst Harbour, MEL (fl.,fr.); Mueller s.n., Moreton Bay, MEL1003590 (fl.).

South Australia: Anon. s.n., St.Vincents Gulf, MEL1003775 (st.); Cleland s.n., 20.i.1926, Cleland's Gully, Mt.Compass, AD96803135 (fl.,fr.); Cleland s.n., 5.iii.1926, ca. 45 km east of Cape Borda, AD96803142 (fr.); Cleland s.n., 5.i.1928, Back Valley, AD96803128 (fr.); Cleland s.n., 17.v.1928, Back Valley, AD96926113 (st.); Cleland s.n., -.x.1929, Flinders Chase, AD96803108 (fl.); Cleland s.n., 12.xii.1938, south of Second Valley Forest Reserve, AD96803117 (fl.); Cleland s.n., 26.xii.1942, Upper Waterfall Gully, AD96803133 (fr.); Cleland s.n., 20.i.1962, Eric Bonython Reserve, Waitpinga, AD966080099 (fr.); Hunt 2599, 7.xii.1965, Penola Pine Forest Reserve, AD (fl.); Hunt 3169, 17.i.1970, Nangkita, AD (fl.,fr.); Ising s.n., 30.xii.1918, Mt.Lofty, AD966032045 (fl.,fr.); Ising s.n., 13.ii.1927, Mt.Lofty, AD966031950 (fl.,fr.); Kuchel 2249, 24.ii.1965, Mt.Lofty Botanic Garden, AD (fr.) - pollen sent to Palyn. Lab. Stockholm; Mueller s.n., Mount Lofty Range, MEL1003609, 1003611, 1003763 p.p. (fl.); Orchard 1869, 6.i.1969, Upper Waterfall Gully, AD (fr.); Orchard 2030, 14.ii.1969, ca 2 km east of Mount Burr, AD (fl.); Tate s.n., 18.x.1879, Smithfield, AD96817165 p.p., (fl.); Tate s.n., 28.x.1882, Mt.Lofty, AD96817165 p.p. (fl.); Tate s.n., -.xii.1883, Mt. McIntyre, AD96926117 (fl.); Tate s.n., -.x.1929, Uraidla, AD96926114 (st.); Tepper s.n., 1881, Clarendon, AD96811108, MEL1003610 (fl.); Tepper s.n., 6.i.1882, Square Waterhole, AD96811100 (fl.); Tepper 410, South Australia, AD (fl.); Wheeler 297, 7.xii.1966, Mount Lofty Botanic Garden, AD (fl.,fr.); Wilson 437, 16.i.1966, ca 4 km south-west of Lake Leake, AD, CANB (fl.,fr.).

ii. ssp. *ramosissimus* Orchard, subsp. nov.

Herba erecta (20-)30-40(-75) cm alta; folia ovata ad cordata 1.0-1.3 cm longa, 0.8-1.1 cm lata, ± sessilia serrata dentibus 15-25 crenulatis. Inflorescentia diffusa, ramosa quater, ramuli ultimi ± horizontales.

Holotypus: A.E. Orchard 2383, 27.x.1969, New South Wales. Evans Head, on coast ca 135 km north of Coff's Harbour. Growing on black sand on sandy heath, AD97016109 (fl.,fr.)! Isotypi: Still to be distributed.

Erect herb, stems rooting at nodes in lower part only (20-)30-40 (-75) cm tall; leaves ovate to cordate, 1.0-1.3 cm long, 0.8-1.1 cm wide, ± sessile, serrate with 15-25 small crenate teeth. Inflorescence diffuse, branching to the 4th order, final branchlets ± horizontal. Flowers and fruits as for species, but ribs of fruit often tuberculate, the tubercles sometimes bearing a short, curved unicellular hair. (Fig. 24; Plate 21)

Distribution. (Map 14)

This subspecies is confined to the coastal regions of northern New South Wales and southern Queensland.

Ecology.

G. micranthus ssp. *ramosissimus* is usually found on flat swampy heaths in sandy soils ("wallum"). Collectors' notes include "sandy swampy soil (Wallum Country)" (Kajewski 19); "in open Eucalypt forest on shallow sandy soil" (Johnson 1101A); "Soil: yellow podsolic from granite. Eucalypt forest" (Boyd AD95809056); "damp, heavy soil in Melaleuca scrub" (Burgess CBG015871); and "swamp behind sanddunes of beach" (Rodway 148). Flowering normally occurs between October and March and fruiting from November to May.

Specimens examined.

New South Wales: Anon.s.n., Clarence River, MEL1003604 (fl.); Anon.s.n., Port Jackson, AD96906001 p.p.; Beckler s.n., Clarence River, MEL1003597 (fl.); Beckler s.n., Ben Lomond, MEL1003592 (fl.); Beckler s.n., R.Hastings, MEL1003594 (fr.); Betche s.n., -.xii.1886, near Sydney, NSW99160 (fl.); Blakely s.n., 30.iii.1918, Carr's Paddock, Carlton, NSW113147 (fr.); Blakely & Shiress s.n., 20.iv.1935, Gosford, NSW99155 (fr.); Boorman s.n., -.xii.1909, Dorrigo, NSW99147 (fl.); Boorman s.n., -.i.1911, Torrington, NSW98929 (fl.); Boyd s.n., 24.i.1955, Snowy Range, New England, AD95809056 (fl.) - pollen sent to Palyn. Lab. Stockholm; Brown 4426, Port Jackson, K (fl.); Brown s.n., Port Jackson, MEL1003608 (fl.); Burgess s.n., 23.ii.1963, Limeburner's Creek near Booral, CBG015871 (fl.); Burgess s.n., 1.xi.1966, Coff's Harbour, CBG018739 (fl.); Caley s.n., N'elle Hollande, G (fl.); Cleland s.n., Neutral Bay, AD96905116 (fl.,fr.); Cleland s.n., 24.iv.1912, Grafton, AD96905160 (fr.); Cleland s.n., 30.ix.1912, Byron Bay, AD96905115 (fl.,fr.); Constable s.n., 22.i.1956, Wingello State Forest, NSW35339 (fl.); Constable s.n., 25.iii.1962, Tent Hill-Torrington road, NSW66214 (fl.,fr.); Constable 7375, 20.vi.1967, Bona Park, Sans Souci, NSW (fr.); Crawford 526, -.iii.1885, Moona, Walcha, MEL (fl.,fr.); Dwyer 1082, -.iii.1920, Belmont, NSW (fr.); Evans s.n., 20.ii.1926, Narrabeen, SYD (fl.,fr.); C.J.F. s.n., New England, MEL1003601 (fl.); Field s.n., N.S.W. BRI080047 (fl.); Fletcher s.n., 30.iv.1887, Botany Bay, NSW99157 (fr.); Fletcher s.n., 3.iii.1888, Alexandria Swamps, NSW99159 (fl.,fr.); Gauba s.n., 7.iii.1952, Jervis Bay, CBG015104 (fl.,fr.); Hickey s.n., -.iii.1885, Maryland, MEL1003593 (fl.); Hynes s.n., -.i.1903, Randwick Rifle Range, NSW99158 (fl.); Jessup & Gray 345, 8.xii.1953, Gilgai, New England, CANB (fl.); King s.n., New Holland, G (herb. Deless.) (fl.,fr.); Lithgow 141, 11.iv.1965, Nelson Bay, NSW (fr.); Mair & Constable s.n., 8.xi.1950, Waterfall, NSW16107, (fl.); Martenz Q110, 23.v.1968, Port Macquarie, CANB (fr.); McBarron 8783, 27.i.1964, Picton Lakes, Thirlmere, NSW (fl.,fr.); Mueller s.n., Ben Lomond, MEL1003607 (fl.); Noonan s.n., -.iii.1949, Glen Innes, NSW98930 (fl.,fr.); Orchard 2383, 27.x.1969, Evans Head, AD (fl.,fr.) - holotype of *G. micranthus* ssp. *ramosissimus*; Orchard 2386, 28.x.1969, ca 6 km south of Coff's Harbour, AD (st.); Rodway 148, 25.x.1930, Huskisson, NSW (fl.); Salasoo 1043, 4.i.1953, Narabeen, NSW (fl.); Thomas s.n., -.xii.1912, Inverell, NSW99105 (fl.); White s.n., New South Wales, G (herb. Deless.) (fl.,fr.); White-Haney s.n., 24.ii.1930, Glen Elgin, CANB7214 (fl.).

Queensland: Bailey s.n., -.iv.1879, Brisbane River, BRI080061 (st.); Bailey s.n., -.iii.1889, Sunnybank, Brisbane, BRI080050 (fl.); Bailey s.n., 20.ii.1891, Stanthorpe, BRI080051 (fl.); Baxter & Lebler 1126, 3.x.1968, about 2 miles S. of Tewantin on Eumundi road, BRI (fl.,fr.); Bick s.n., -.ii.1915, Chermside, NSW99131 (fl.); Dietrich s.n., 1863-1865, Brisbane River, BRI080055 (fl.); Epps s.n., -.xii.1919, Fraser Island, BRI080063 (fl.); Hartmann 13, 1873, Severn, MEL (fr.); Hubbard 4631, 17-18.x.1930, Fraser Island, BRI (fl.); Johnson 1101A, 22.ix.1959, Blackdown Tableland, BRI (fl.,fr.); Kajewski 19, 18.i.1928, mainland opposite southern end of Fraser Island, BRI (fl.,fr.); Smith 353, 15.ii.1938, Sunnybank. BRI (fl.); Smith 688, 29.xii.1939, about 17 miles S.W. of Bundaberg, BRI (fl.); Smith 776, 29.i.1940, Racecourse Creek, N.E. of Wallangarra, BRI (fl.); Ward s.n., 11.ii.1959, Redlands Experiment Station, Moreton district, BRI015672, CANB79393 (fl.,fr.); Whaite 3038, 6.i.1966, ½ mile south of Point Cartwright turnoff, NSW (fl.); White s.n., 13.iv.1907, Nudgee, Brisbane, BRI080049 (st.); White s.n., -.xii.1913, Nerang, BRI080046 (fl.); White s.n., 17.iii.1916, Wellington Point, BRI080053 (fl.,fr.).

Notes.

1. None of the collection of *Haloragis minima* was available during the present study, but this species was considered synonymous with *Gonocarpus ('Haloragis') micranthus* by Kirk (1899), Cheeseman (1925) and Allan (1961). As far as can be judged from the description given by Colenso (1885-6), there is no reason to doubt the above placement.

2. As the number of extra-Australian collections of ssp. *micranthus* available was inadequate to determine the full distribution accurately, this is summarized from literature reports, particularly those of Hooker. f. (1878), Schindler (1905) and Guillaumin (1914).

3. Several species described since Schindler's revision may be only minor variants of this species, but no material was available for comparison in this study. *Haloragis paucidentata* Hosokawa (1940) and *H. walkeri* Ohwi (1958) are particularly of note in this respect.

4. The two subspecies can usually be readily distinguished by the broad, diffuse inflorescence, larger leaves and erect habit of ssp. *ramosissimus*, although some specimens, particularly if sterile, are difficult to place. Ssp. *ramosissimus* is confined to New South Wales and Queensland, although three collections by A. Morrison in 1892 (BRI003488, 078858 and AD95808017) bear labels with the locality "Oakley, Victoria" mentioned. No other collections of this ssp. are known from Victoria, and these records are therefore here considered as

of doubtful origin.

5. The epithet "*ramosissimus*" refers to the inflorescence.

6. *G. micranthus* is probably a fairly advanced species as compared with other species of *Gonocarpus*, and seems to have few close allies. *G. (Haloragis) philippinesis* is probably derived from *G. micranthus* and *G. tetragynus* shows some similarity to these two species.

2. *Gonocarpus confertifolius* (F.v.M.) Orchard, comb. nov.

Haloragis confertifolia F.v.Mueller, Fragm. 10(1876)53 [Typus: "Prope fontes Victoria-Spring et Ularing; Young." Lectotypus (Orchard): Young s.n., Q. Victoria Springs, MEL1003468 (fl.)!, excluding the specimen on the extreme right hand side of the sheet. Iso-lectotypus: Herb. F.v.Mueller s.n., Victoria Springs, K (fl.); Syntypus: Young s.n., 10-15 Oct. 1875, Near Ularing, MEL1003467 (fl.)!] F.v.M., Census 1(1882)49; F.v.M., Trans. roy. Soc. Vict. 24(1888)135; F.v.M., Sec. Census 1(1889)85; Schindler, Bot. Jb. 34, Beibl. 77(1904)30, 31, 35, 38, 40; Diels & Pritzel, Bot. Jb. 35(1904)447; Schindler, Pflrch, 23(1905) 26; Gardner, Enum. (1931)99; Blackall & Grieve, W.A. Wildfls. 3(1965)465. Figs: Schindler, Pflrch. 23(1905) fig 6A; Blackall & Grieve, W.A. Wildfls 3(1965)465.

Annual or perennial herb, 7-30 cm tall, stems erect, ascending or decumbent, smooth or irregularly wrinkled, not longitudinally winged or ribbed, young stems densely spreading pilose with 1-3 celled simple transparent hairs 0.1-0.5 mm long, the older stems becoming ± glabrous.

Leaves decussate in lower parts of stem, spiral above or spirally arranged throughout, fleshy, sessile, rhomboidal to ovate to narrow-ovate, 2.5-8.0 mm long, 1.6-3.0 mm wide, entire or with 1-4 serrations near acute apex, margin ± thickened, especially towards apex, midrib and other venation obscure, both faces covered with appressed or spreading hairs as for the stems.

Inflorescence an indeterminate spike of single flowers borne in the axils of alternate primary bracts. Lateral inflorescences may arise in the axils of the upper leaves. Primary bracts leaflike, ovate to lanceolate, 2.0-3.5 mm long, 1.2-2.0 mm wide, entire, pilose on both surfaces. Secondary bracts brown membranous, linear, 0.5-0.8 mm long 0.1-0.3 mm wide, glabrous except for fringe of 1-celled hairs 0.4-0.5 mm long on margins, deciduous at or about anthesis.

Flower solitary in axils of primary bracts, subtended by 2 secondary bracts. Sepals 4, narrow-lanceolate, 1.3-1.5 mm long, 0.4-0.5 mm wide, with a basal median callus, glabrous except for a fringe of transparent 3-celled hairs 0.7-1.0 mm long on margins. Petals 4, hooded, reddish brown with a cream or greenish margin, 1.8-1.9 mm long, 0.5-0.6 mm wide (keel to margin), with 2-3 rows of 1-2 celled hairs 0.1-0.3 mm long on the keel. Stamens 8, filaments 0.1-0.2 mm long; anthers reddish, oblong, 1.5-1.6 mm long, 0.4 mm wide, nonapiculate. Styles 4, 0.4 mm long, stigmas globose, golden fimbriate, the fimbriae ca. 0.2 mm long. Ovary dull or shiny brown, ovoid, 1.0-1.2 mm long, 0.7-0.8 mm wide, contracted into a short neck towards the top, 8-ribbed longitudinally with 3-4 verrucose calluses between the ribs, glabrous or covered with short scabrous hairs ca. 0.01 mm long, incompletely 4-locular, septa spongy, columella present, ovules 4, pendulous.

Fruit size, sculpturing and indumentum as for the ovary, sepals persistent, spreading, seed solitary.

This species consists of 2 varieties which can be distinguished as follows:

1. Leaves 5.0-8.0 mm long, 2.0-3.0 mm wide; fruit glabrous.

α. var. *confertifolius*

1. Leaves 2.5-3.8 mm long, 1.6-2.5 mm wide; fruit scabrous.

β. var. *helmsii*

α. var. *confertifolius*

Stems erect, 30 cm tall, smooth, or older ones very slightly wrinkled, brown, young stems densely spreading pilose becoming ± glabrous at base of the plant. Leaves all widely spaced, spirally arranged, or subopposite in lower parts, rhomboidal to broad lanceolate, 5.0-8.0 mm long, 2.0-3.0 mm wide, entire or with 1-2 small serrations near apex, midrib slightly prominent below, indistinct above, densely spreading pilose on both surfaces. Primary bracts leaflike, lanceolate, 2.0-3.0 (-3.5) mm long, 1.2-1.5 mm wide, entire, densely spreading pilose on both surfaces. Secondary bracts brown, membranous, linear, 0.5-0.8 mm long, 0.1-0.3 mm wide, excluding the fringe of marginal hairs. Sepals fringed with hairs, petals with hairs on keel, ovary glabrous. Fruits glabrous, brown, ± shiny.

Ecology.

Very little known. Flowers October, fruits May.

Distribution. (Map 10)

Southern Western Australia, on the plains east of Kalgoorlie.

Specimens examined.

Western Australia: Herb. F.v.Mueller s.n., Victoria Springs, K (fl.) - isolectotype of *H. confertifolius;* Wilson, with 5786, 14.v.1967, 70 km N of Zanthus, PERTH (fr.); Young s.n., 10-15.x.1875, Near Ularing, MEL 1003467 (fl.) - syntype of *H. confertifolius;* Young s.n., Q.Victoria Springs, MEL1003468 (fl.) p.p. - lectotype of *H. confertifolius*.

β. var. *helmsii* Orchard, var. nov.

Folia ovata ad angustovata, 2.5-3.8 mm longa, 1.6-2.5 mm lata, basi caulis aggregata decussata; in inflorescentia spiralia. Ovarium et fructus minute scaber.

Typus: R. Helms s.n., 23.xi.1891, Nr. Southern Cross, Yilgarn W.A. Sand. (Elder Exploring Expedition). Holotypus: AD96810032 (fl.,fr.)! Isotypi: K (fl.,fr.)!, MEL1003470 (fl.)!, NSW98955, 9830 (fl.,fr.)!

Stems decumbent or ascending, 7-27 cm tall, smooth or irregularly wrinkled, densely spreading pilose, at least in the upper parts. Leaves crowded and decussate in the lower (sterile) parts, becoming spiral towards the inflorescence, ovate to narrow ovate, 2.5-3.8 mm long, 1.6-2.5 mm wide, entire or 2-4-toothed towards the apex, densely ± appressed pilose on both faces, midrib indistinguishable. Primary bracts leaflike, ± same shape and size as leaves, becoming smaller only in upper part of inflorescence, sparsely scabrous on both faces with a fringe of longer hairs on the margin. Secondary bracts brown, membranous linear, glabrous except for a fringe of 1-celled transparent hairs 0.4-0.5 mm long. Sepals fringed with hairs, petals with hairs on keel, ovary dull brown, scabrous with hairs ca. 0.01 mm long. Fruit scabrous, dull brown. (Plate 22)

Ecology.

Collectors' notes (Helms, Gardner) suggest that var. *helmsii* favours red sandy soil. Flowering specimens have been collected from August to November, and fruiting specimens in November.

Distribution. (Map 10)

Southern Western Australia, west and south of Kalgoorlie.

Specimens examined.

Western Australia: Elder Expedition s.n., 1891, without locality, MEL 1003469 (st.); Gardner s.n., 17.viii.1931, west of Sandstone, PERTH (fl.) - pollen sent to Palyn. Lab. Stockholm; Gardner s.n., -.iv.1943, Burracoppin, PERTH (st.); Helms s.n., 23.xi.1891, Nr. Southern Cross, Yilgarn, AD96810032 (fl.,fr.) - holotype *G. confertifolius* var. *helmsii*, K (fl.,fr.), NSW 9830, 98955 (fl.,fr.), MEL1003470 (fl.) - isotypi *G. confertifolius* var. *helmsii*; Merrall s.n., 1890, Southern Cross, MEL1003471 (st.); Orchard 1260, 30.ix.1968, ca. 34 km north of Widgiemooltha, AD (fl.).

Notes.

1. The choice of a lectotype for the name of the species is necessary as Mueller cited two distinct collections by Young in the original description. The collection from (Queen) Victoria Springs is chosen as the lectotype as duplicates of this collection are held in two herbaria (K, MEL), whereas the Ularing collection exists in MEL only.

2. The two varieties recognized here are distinguished principally on habit, size and arrangement of the leaves, and the presence or absence of scabrous hairs on the ovary and fruit. They also appear to be distinct in geographical distribution, var. *helmsii* apparently occuring to the west of var. *confertifolius* (see Map 10). If this is true then the two taxa may deserve the rank of subspecies, but too few collections exist at present to decide this with certainty.

3. <u>*Gonocarpus cordiger*</u> (Fenzl) Endl. ex Nees in Lehm.,Pl. Preiss. 2(1848)225, 226 ['Goniocarpus'].

Haloragis cordigera Fenzl in Endl. et al., Enum. Pl. Hueg. (1837)45 [Typus: "Swan River. (Hugel)". n.v.] Walp., Rep 2(1843)99; Hooker, Ic. Pl. 6(1843)pl.548; Endl. ex Nees in Lehm., Pl. Preiss. 2(1848)226 ['Haloragis cordata'] pro basionym *Gonocarpus cordiger;* Benth., Fl. Aust. 2(1864)476; F.v.M., Census 1(1882)49, Sec. Census 1(1889)85; F.v.M., Trans roy. Soc. Vict. 24(1888)133; Diels & Pritzel, Bot. Jb. 35(1904)447; Schindler, Pflrch. 23(1905)37; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)466.

<u>Figs</u>: Hooker, Ic. Pl. 6(1843)pl.548; Schindler Pflrch. 23(1905)fig. 10A-C; Blackall & Grieve, W.Aust. Wildfls. 3(1965)466.

Perennial herb or small sub-shrub 30-45 cm tall, stems decumbent or ascending, ± 4-ribbed longitudinally, sparsely pilose with spreading, transparent, 2-celled hairs 0.8-1.0 mm long.

Leaves all alternate, sessile, linear to terete,1.5-3.5 cm long, 0.8-1.0 mm wide, entire, margins revolute, apex acute, sparsely pilose with hairs as for stems.

Inflorescence an indeterminate spike of flowers borne singly in the axils of alternate primary bracts. Lateral spikes are borne in the axils of the upper leaves. Primary bracts leaflike, 0.2-0.7 mm long, becoming smaller in upper part of spike, ± glabrous, occasionally with 1-2 hairs on margins; secondary bracts brown, membranous, ovate, 0.4-0.6 mm long, 0.3-0.4 mm wide, margin irregular.

Flowers 4-merous, on a pedicel 1 mm long. Sepals 4, yellow-green, cordate, 1.3-1.4 mm long, 1.1-1.2 mm wide, attached only in centre base, auricles extending $\frac{1}{2}$ - $\frac{2}{3}$ of ovary length, margins minutely crenate or serrulate, glabrous. Petals 4, yellow-green, hooded, becoming reflexed between the sepals after anthesis, (2.0-)2.4-2.5 mm long, 0.6-0.7(-1.0) mm wide (keel to margin), glabrous except for 1-2 rows of 2-3 celled hairs 0.3-0.4 mm long on the keel. Stamens 8, filaments 0.2 mm long; anthers yellow-orange, linear-oblong, 1.9-2.1 mm long, 0.3 mm wide, nonapiculate. Styles 4, yellow, stigmas red, oblong, closely pressed together in bud, becoming orange, fimbriate and globular in flower. Ovary slate-grey to red, obconical, 1.0-1.3 mm long, 0.8-1.0 mm diam., 8-ribbed longitudinally, irregularly verrucose with a 2-3 celled hair 0.3-0.4 mm long atop each wart, incompletely 4-locular, septa spongy, columella present, 4 pendulous ovules of which only 2 are functional, and only 1 develops to seed. Mature fruit not seen, immature fruit as for ovary.

Distribution. (Map 14)

G. cordiger is confined to the Darling Ranges near Perth, in Western Australia, most collections coming from within 100 km of that city. Isolated collections have also been made from near Moora (Royce 4926) and Narrogin (Steward 264).

Ecology.

Very little information exists concerning the habitat in which this species grows. Pritzel 145 records it as growing "in silvis subumbrosis" and most of the collection locations occur between the altitudes of 300-600m (1000-2000 ft). Flowering takes place from (August-)October to December(-February) and fruiting from December onwards.

Specimens examined.

Western Australia: Anon. 186, x et xi.19.., Avon District, PERTH (fl.); Andrews XLV, 23.xi.1901, near Guildford, PERTH (fl.); Drummond 83, 4th coll., 1848, W. Australia, NSW (fl.); Drummond 83, W.A., MEL1003473 (st.); W.V.F. s.n., -.xii.1902, Midland Junction, NSW98965 (fl.); Gardner s.n., -.xii.1920, Armadale, PERTH (fl.); Gardner 7486, 19.x.1944, North of Greenhills, PERTH (fl.); Hamilton s.n., 1902, W.A., NSW98967 (fl.); Koch 1675, -.xi.1906, Darling Range, AD, NSW p.p. (fl.); Koch 1675, -.iix.1906, Wooroloo, MEL (fl.); Morrison s.n., 18.xi.1899, Smith's Mill, Darling Range, CANB136630 (fl.); Morrison s.n., 19.i.1899, Kelmscott, Canning River, CANB136633 (fl.); Morrison s.n., 22.xii.1900, Smith's Mill, Darling Range, BRI079990, CANB136631 (fl.); Mueller s.n., Serpentine River, MEL1003478 (fl.); Mueller s.n., -.xi.1877, south of Swan River, MEL1003480 (fl.); Mueller s.n., -.xi.1877, towards Yorke, MEL 1003476 (fl.); Mueller s.n., -.xi.1877, Swan River, Darling Range, MEL1003477, 1003479 (fl.); Preiss 1223, -.i.1840, Swan River, MEL1003475, 1003774 (fl.); Pritzel 145, -.xii.1900, montium Darling Range, AD, NSW, PERTH (fl.); Royce 2535, 13.i.1948, Leamurdie, eastern suburb of Perth, PERTH (fl.); Royce 4926, 3.xi.1954, 20 m. W of Moora, PERTH (fl.); Sewell s.n., 1884, Upper Swan River, MEL1003472 (fl.); Speck s.n., Armidale, UWA487 (fl.); Steward 264, -.ii.1913, Narrogin, NSW (fl.); Tepper 66, -.x-xi.1892, Beverley, MEL1003700 (fl.).

Notes.

1. Occasional plants have been collected which have glabrous stems and leaves and almost glabrous ovary and petals (e.g. Gardner 7486 (PERTH), Koch 1675 (AD)).

2. The flowers are usually single in the axil of the primary bracts, as is normal in *Gonocarpus*, but a collection by Hamilton (NSW98967) has some flowers in groups of 2-3 in the axil of a primary bract, ± arranged in a mono- or dichasium. In these instances, tertiary bracts, similar to, but smaller than the secondary bracts, are present.

4. *Gonocarpus elatus* (A. Cunn. ex Fenzl) Orchard, comb. nov.

Haloragis elata A. Cunn. ex Fenzl, Enum. Pl. Hueg. (1837)45 [Typus: "In sterilius interioribus New South Wales. (Cunningh.)" Holotypus: Anon. s.n., 1825, barren interior N.S.Wales, W (fl.)!]Walp., Rep. 2(1843)99; Schldl., Linnaea 20(1847)648; A. Gray, Bot. U.S. Expl. Exped. 1(1854)626; Benth., Fl. Aust. 2(1864)477; F.v.M., Fragm. 8(1874) 162; Tate, Trans. roy. Soc. S.Aust. 3(1880)64; F.v.M., Census 1(1882)49; F.v.M., Key Syst. Vict. Pl. 2(1885)22, 1(1887-8)262; F.v.M., Trans. roy. Soc. Vict. 24(1888)134; Cleland, Trans. roy. Soc. S.Aust. 10(1888)78; F.v.M., Sec. Census 1(1889)85; Tate, Fl. S.Aust. (1890)101, 234; Moore, Hdbk. Fl. N.S.Wales (1893)185; Petersen, Pflfam. III.7(1893)233; Bailey, Qld. Fl. 2(1900)554, Schindler, Bot. Jb. 34, Beibl. 77(1904)35; Schindler, Pflrch.23(1905)27; Dixon, Pl. N.S.Wales (1906)130; Bailey, Comp. Cat. Qld. Pl. (1913)174; Maid. & Betche, Census N.S.Wales Pl. (1916)158; Black, Trans. roy. Soc. S.Aust. 41(1917)49, 43(1919)39; Black, Fl. S.Aust. (1926)430; Ewart, Fl. Vict. (1931)880; Black, Fl. S.Aust. 2 ed. (1952)642; Eichler, Suppl. Black's Fl. S.Aust. (1965)245.

Figs: Petersen, Pflfam. III. 7(1893) fig. 102F; Schindler, Pflrch. 23(1905)fig. 7; Black, Fl. S.Aust. 2 ed. (1952)fig. 872.

Erect or ascending perennial herb or subshrub, 18-35(-60) cm tall, stems slightly 4-5-ribbed, densely spreading pilose with soft, transparent, 3-celled hairs 0.4-1.0 mm long.

Leaves sessile, all alternate or lowest 1-2 pairs subopposite, linear-lanceolate to ovate, (1.0-)1.8-3.0(-5.2) cm long, (1.0-)2.0-5.0 (-8.0) mm wide, ± entire or toothed in upper half only, margins revolute, midrib prominent below, channelled above, ± densely pilose on both surfaces with hairs, 0.3-0.8 mm long, as for stems.

Inflorescence an indeterminate spike of single flowers in the axils of primary bracts, with lateral spikes in the axils of the upper leaves, all characteristically drooping in their upper halves. Primary bracts leaflike, equal to or smaller than the flowers in length, 2.0-3.0 mm long, 0.5-0.7 mm wide, pilose with hairs as for stems and leaves. Secondary bracts brown, membranous, lanceolate, 0.8-1.0(-1.5) mm long, 0.3-0.4 mm wide, pilose with 1-3-celled transparent hairs 0.2-0.3 mm long on margins and abaxial face, glabrous on adaxial face.

Flowers 4-merous, on a pedicel 0.3-0.4 mm long, solitary in the axil of primary bracts, subtended by two secondary bracts. Sepals 4, green, deltoid, 0.6-0.8 mm long, 0.4-0.5 mm wide, with a median basal hemispherical callus, margins thickened, glabrous. Petals 4, reddish-brown with yellow-green margins, ± hooded, 2.1-2.7 mm long, 0.6-0.7 mm wide (keel to margin), glabrous except for 3-4 rows of spreading transparent 3-celled hairs 0.3-0.5 mm long on the keel. Stamens 8, filaments 0.2-0.3 mm long; anthers linear-oblong, 2.0-2.3 mm long, 0.3 mm wide, yellow to reddish. Styles 4, 0.4 mm long, stigmas yellowish, shortly fimbriate. Ovary globose to ovoid, 0.9-1.2 mm long, 0.8-1.0 mm wide, ± 8-ribbed longitudinally, with 3-4 transverse rows of tubercules or sometimes irregularly tuberculate or almost smooth, white to slate grey or brown, ± densely pilose with semi-appressed 3-celled hairs 0.1-0.2 mm long or occasionally almost glabrous, incompletely 4-celled, septa spongy, columella present, ovules 4.

Fruit variable, globose to ovoid, (0.9-)1.2-1.5 mm long, 0.7-1.1 mm wide, ± distinctly 8-ribbed, verrucose as for ovary or almost smooth, appressed pilose, sometimes becoming almost glabrous at maturity; sepals persistent, enclosing the styles, (0.6-)0.8-1.0 mm long, 0.4-0.5 mm wide; 1 seed, filling whole fruit. (Fig. 26)

Distribution. (Map 10)

G. elatus occurs in the Gawler, Flinders and Mt. Lofty Ranges in South Australia, the Grampians, Gippsland and central mountainous region of Victoria, in central and northern New South Wales, with an isolated pocket near Broken Hill, and in two isolated localities in Queensland.

Ecology.

This species favours exposed positions in full sun, usually among rocks and boulders in hilly or mountainous country. This is frequently stated in collectors' notes. Its distribution closely follows the limits of the 14-30 inches (35-75 cm)/annum rainfall area in temperate south-eastern Australia. Burke (NSW98987) stated "spring time bees worked the blossoms very freely for pollen" and Butler (NSW98973) recorded that "sheep will eat it in a dry time but not when there is other feed about". Flowering occurs from October to December, occasionally as early as April or May or as late as January, and fruits are present from (October-) November to March.

Specimens examined.

South Australia: Alcock 847, 7.xi.1965, Section 17, Hd. of Charleston, AD (fl.,fr.); Beck s.n., 1427, -.x.1924, Wilpena Pound, AD (fl.); Behr 164, Barossa Range, MEL (fl.); Black 12, -.xi.1903, Port Lincoln, NSW (fl.); Blandowsky s.n., 1850, Carromandel Valley, MEL1003510, 1003511, 1003521 (fr.); Blandowsky 39, 1850, Carromandel Valley, MEL (fl.,fr.); Brummitt s.n., 3.x.1893, Blackwood, AD96211066 (fl.); Cleland s.n., Warren Reservoir, AD96808373 (fl.); Cleland s.n., -.xi.1920, Waterfall Gully, AD96808401 (fl.); Cleland s.n., 23.ix.1922, Kinchina, AD96808368 (fl.); Cleland s.n., 8.xi.1924, Kinchina, AD96808384 (fr.); Cleland s.n., 20.x.1927, Mt. Remarkable, AD96808356 (fl.); Cleland s.n., 10.xi.1928, Wilpena Pound, AD96808353 (fl.,fr.); Cleland s.n., 15.xi.1928, Wilpena

Pound, AD96803111 (fl.); Cleland s.n., 2.i.1933, Waterfall Gully, AD96803154 (fr.); Cleland s.n., -.xi.1936, Iron Knob, AD96808352 (fl.,fr.); Cleland, s.n., 8.xi.1936, Mt. Remarkable, AD96808388 (fl.); Cleland s.n., 16.xi.1938, Hallett, AD96808389 (fl.); Cleland s.n., 16.xii.1939, National Park, Belair, AD96808405 (fl.); Cleland s.n., 22.xi.1942, Waterfall Gully, AD96808386 (fl.,fr.); Cleland s.n., 28.xi.1942, Morialta, AD966032581 (fr.); Cleland s.n., 28.xii.1943, 30.xii.1944, National Park Belair, AD96808370 (fr.); Cleland s.n., 28.xi.1958, Ferguson Park, Stonyfell, AD96808385 (fl.); Cooper s.n., 20.xi.1957, Alligator Gorge, AD96404245 (fl.); Cooper s.n., 24.ix.1964, ca 1.6-6.0 km east of Melton Siding AD96509267 (fl.); Copley 792, 20.x.1966, Barunga Range, AD (fl.); Czornij 243, 21.xi.1968, Black Hill, AD (fl.,fr.); Donner 1238, 1.xii.1964, Mt. Barker Summit, AD (fl.); Eichler 12077, 7.xii.1955, Hill near Black Springs, AD (fr.); Eichler 12745, 19.ix.1956, Gammon Ranges, AD (fl.); Eichler 14584, 31.xii.1957, Waterfall Gully, AD (fr.); Green 695, 8.x.1950, Morialta Reserve, AD (fl.); Hall s.n., 8.xi.1964, ca. 1.6 km below Gorge Creek deposits, AD96501335, (fl.,fr.); Hilton s.n., 18.iii.1954, Kanmantoo, ADW18601 (fr.); Hogan s.n., Waterfall Gully, AD968061223 (fl.); Ising s.n., 17.xi.1917, Burnside, AD96830389 (fl.); Ising s.n., 21.x.1924, Mount Maria, AD96830367, 96830388 (fl.,fr.); Ising, s.n., 23.x.1928, Alligator Creek, AD96830360 (fl.); Ising s.n., 25.x.1928, Mt.Remarkable, AD966032006 (fl.); Ising s.n., 16.x.1930, 24.x.1930, Kinchina, AD96830365, 966031974 (fl.); Ising s.n., 12.xi.1932, Waterfall Gully, AD96803136, 966032009 (fl.); Ising s.n., 1.ix.1935, Wudinna Hill, AD96833191 (fl.); Ising s.n., 2.ix.1935, Waddikee Rock, AD96830384 (fl.); Ising s.n., 30.xii.1935, Nairne, AD966031949 (fr.); Ising s.n., 8.x.1937, Warpoo near Lyndoch, AD966031981 (fl.); Ising s.n., 13.ix.1938, Gawler Range, AD96909047, 96803127 (fl.); Ising s.n., 20.ix.1939, Mt.Wudinna, AD96803101 (fl.); Ising s.n., 2.x.1939, Chilpuddie Rocks, AD96830374 (fl.); Ising 540, -.x.1918, Mt. Patawurta, Moolooloo Stn., AD (fl.); Ising 634, 1.x.1918, Owieanagan, Moolooloo Stn., AD (fl.); Koch 587, -.x.1901, Flinders Range, NSW (fl.,fr.); Kraehenbuehl 748, 13.x.1962, Mt. Serle, AD (fl.) - pollen sent to Palyn. Lab. Stockholm; Kraehenbuehl 808, 22.x.1962, Blue Gum scrub south of Highbury Hotel, AD (fl.); Kraehenbuehl 1173, 27.x.1963, Tothill Range, AD (fl.); Kraehenbuehl 1527, 27.xi.1965, about 1 km south of Freeling, AD (fl.); Kraehenbuehl 2197, 29.x.1967, Central Tothill Range, AD (fl.); Lothian 3695, 17.xi.1966, Sandy Creek Wild Life Reserve, AD (fl.); Lothian 5046, 1.x.1969, Radium Creek on Arkaroola Station AD (fl.); Mueller s.n., -.x.1857, Cudnaka, near Lake Torrens, MEL1003520, NSW99001 (fl.); Mueller s.n., -.xi.1848, montium Lofty range, MEL1003769, 1003788; Mueller s.n., -.x.1848, inter montana Barkerianum & fluvium Murray, MEL1003507 (fl.); Mueller s.n., Barossa range, MEL1003506 (fl.); Orchard 1813, 1815, 21.xi.1968, Black Hill, AD (fl.); Orchard 1823, 21.xi.1968, ca. 1½ km from Cherryville turnoff on Montacute road, AD (fl.); Parsons 151, 9.x.1962, Section 31, Hd. of Barossa, AD (fl.); Phillips s.n., 22.viii.1964, St. Mary's Peak, Wilpena, CBG010750 (fr.); Salasoo 1713, 1.i.1959, between Gawler and Williamstown, NSW (fr.); Specht & Carrodus 67, 15.xi.1958, 12 miles SW Nonning Homestead, AD (fr.); Sullivan s.n., Gawler Ranges, MEL1003518 (fl.); Symon 972, 17.xi.1960, creek at Wilpena, ADW (fl.,fr.); Tate s.n., 9.xi.1879, Torrens Gorge, AD96810062 (fl.); Tate s.n., 10.i.1880, Belair, AD96810046 (fr.); Tate s.n., 9.xi.1881, Coromandel, AD96810014 (fl.); Tepper 21, Callington, MEL (fr.); Tepper 48, 24.xi.1887, Monarto, AD (fr.); Tepper 48, 25.xi.1887, Murray Bridge, MEL (fr.); Whibley 379, 15.x.1958, Minnipa Hill, AD (fl.); Wilson 523, 16.x.1958, Gawler Ranges, Yandinga Falls, AD (fl.).

Victoria: Anon, s.n., Dry barren ranges on the Avon (River), MEL1003488 (fl.); Beauglehole 17015, -.x.1948, Mt. Arapiles, BEAUGLEHOLE (fl.); Beauglehole 29602, 19.xi.1968, Mt. Arapiles, BEAUGLEHOLE: Beauglehole 29784, 23.xi.1968, Mt. Arapiles, BEAUGLEHOLE (fl.); Beauglehole 29999, 10.xii.1968, Mt. Bepcha, BEAUGLEHOLE (fl.); Beauglehole 30322, 19.i.1969, Grampians, Mt. Rosea Track ± 1m. east of Moora Track, BEAUGLEHOLE (fr.); Beauglehole & Corricks 17841, Mt.Zero-Stapylton area, BEAUGLEHOLE (fl.); Beauglehole et al. 33242, 6.i.1970, Suggan Buggan, AD, BEAUGLEHOLE (fl.,fr.); Beauglehole et al. 33387, 7.i.1970, Ballantyne Needles, E. of Wulgulmerang, BEAUGLEHOLE (fl.,fr.); Canning s.n., 27.x.1967, 4 ml. from Springhurst, CBG024524 (fl.); Davis s.n., 1890, Wimmera, MEL1003482, 1003483 (fl.); Gauba, s.n., 30.xi.1945, Tatura, AD96911102 (fl.,fr.); Matthew s.n., Grampians, AD96906036 (fl.); Matthew s.n., Stawell, AD96905143, NSW99002 (fr.); Moore M205, 17.ii.1946, Wangaratta-Thoona, CANB54669 (st.); Mueller s.n., Australia felix, MEL1003786 (fl.); Orchard 1918, 9.ii.1969, Grampians, Mt. Rosea Track, AD (fr.); Orchard 1945, 1948, 1950, 1953, 10.ii.1969, Golton Creek, AD (fr.); Orchard 1956, 10.ii.1969, Mt. Zero, AD (fl.,fr.); Reader s.n., 19.xi.1892, Shire of Dimboola, MEL1003490 (fl.); Reader s.n., 3.xi.1895, Mt. Arapiles, MEL1003489 (fl.,fr.); Reader 6, 3.xi.1895, Mt. Arapiles, MEL (fl.,fr.); Reader 9, 1892, Wimmera, MEL (fl.); Robbins ACB17037, 29.ix.1947, Wedderburn, BEAUGLEHOLE (fl.); Robbins ACB17109, ca. 1940, Bendigo, BEAUGLEHOLE (fl.); St.John s.n., 7.xii.1912, Lerderderg River, Bacchus Marsh District, MEL1003481 (fl.,fr.); Sullivan 2, -.xi.1882, Black Range near Stawell, MEL (fl.,fr.); Walters s.n., -.xi.1899, Grampians, NSW113160 (fl.); Watts 1291, -.x.1918, nr. Wedderburn, MEL (fl.); Williamson s.n., -.xii.1900, Mt. ARapile, NSW99000 (fr.).

New South Wales: Anon. s.n., 1825, barren interior N.S.Wales,W (fl.) - holotype of *H. elata;* Abrahams 324, -.ix.1910, Wittagoona, NSW (fl.); Andrews s.n., -.ix.1918, Broken Hill, NSW98998 (fl.); Baker 10, 6.x.1917, Kildary, NSW (fl.); Baeuerlen s.n., -.xii.1902, Wellington, NSW98976 (fl.,fr.); Beadle s.n., -.viii.1941, Tottenham, SYD (fl.); Beadle s.n., 6.xii.1950, Co. Bourke, SYD (fr.); Betche s.n., -.x.1883, Harvey Range near Dubbo, NSW98975 (fl.); Betche s.n., 6.x.1886, Girilambone, NSW98989 (fl.); Betche 8, -.v.1910, Barren rocks near Dubbo, MEL (fl.); Blakely 77, -.x.1906, Bowan Park near Cudal, NSW (fl.); Boorman s.n., -.xi.1905, Harvey Ranges, Peak Hill, NSW99093 (fl.,fr.); Boorman s.n., -.xi.1906, Bogan Gate, AD96920059 (fr.); Boorman s.n., -.xi.1906, Manildra, NSW98985 (fl.); Boorman s.n., -.xi.1906, Rockley, NSW99094 (fr.); Boorman s.n., -.xi.1906, Molong, AD96905135, SYD (fl.); Boorman s.n., -.i.1917, Girilambone, NSW103133 (fr.); Boorman s.n., -.iii.1917, Chandlers Peak, Guyra, AD96920071 (fr.); Boorman s.n., 21.xi.1917, Temora, NSW98981 (fl.); Boorman s.n., 8.i.1918, Wyalong, NSW98979 (fl.,fr.); Burke s.n., -.x.1950, Hinya, NSW98987 (fl.); Burkitt s.n., 1877, Between the Darling and Lachlan (Rivers), MEL1003502 (fr.); Butler s.n., -.xi.1950, Gilgandra, NSW98973 (fl.); Cambage s.n., 30.x.1909, Dunwell

Scone, CANB7207 (fl.,fr.); Cambage 1074, 13.x.1904, Dubbo, NSW (fl.); Cambage 2465, 7.xi.1909, Barber's Pinnacle, Boggabri, NSW (fr.); Cambage 2532, 30.x.1909, Mt.Wingen, NSW98984, SYD (fl.,fr.); Cambage 2584, 30.x.1909, Dunwell Scone, NSW98978, SYD (fl.); Cambage 4194, 30.ix.1916, Ardlethan, NSW103132 (fl.); Cleland s.n., -.iii.1915, Dubbo, NSW103139 (fr.); Cunningham 46, -.x.1825, Wellington Valley, BRI017691 (fl.,fr.); Constable s.n., 27.x.1959, Bosche's Creek, ca. 16 miles north of Orange, AD96043031, NSW48931 (fl.); Constable 5163, 21.x.1964, The Rock, NSW (fl.); Constable 7261, 7.xii.1966, Cocoparra Range, 4 miles by road south-west of Rankin's Springs, NSW (fl.); Curtin 295, 25.xi.1953, Murda State Forest (ca. 8m. N.E. of Condobolin), NSW (fl.); Dwyer 757, -.x.1915, Temora, NSW (fl.); Dwyer 948, -.xi.1916, Temora, NSW (fl.); Fletcher s.n., -.x.1889, Wagga, NSW98982, 98992, 98993, 103138 (fl.); Forsyth s.n., -.x.1907, Warrumbungle Ranges, NSW113159 (fl.); Fraser & Vickery s.n., 13.i.1935, Burrinjuck SYD (fr.); Garland 47, 1887, Bet. Murrumbidgee & Lachlan River, MEL (fl.); Gauba s.n., 19.xi.1949, Gavan Gap, AD96911099 (fl.); Gauba s.n., 29.xii.1949, Mount Majura CBG013195 (fl.,fr.); Gray 5933, 11.iv.1966, Mt.Ainslie, CANB (fl.); Harding s.n., -.ix,1931, Broken Hill Racecourse, ADW16993 (fl.); Madsen s.n., -.xi.1949, Baldry District, NSW98983 (fl.); Maiden s.n., -.x.1896, Wagga Wagga, NSW103282 (fl.); McBarron 2698, 28.xi.1948, Monument Hill, Albury, NSW (fl.); McBarron 2998, 22.i.1949, Nail Can Hill, Albury, NSW, SYD (fr.); McKee 413, 10.i.1953, 15 m. E. Rylestone, SYD (fr.); Moore 38, 6.x.1886, Girilligambone, MEL (fl.); Moore M754, 9.x.1947, Dubbo-Tomingley, CANB (fl.); Moore M801, 12.x.1947, Wellington, CANB (fl.); Morris 485, -.xi.1920, Broken Hill, NSW (fl.); Morris 615, 3.vii.1921, Broken Hill, NSW (fl.); Morris 699-615, 4.ix.1921, Mt.Robe, NSW (fl.); Morton s.n., Between the Upper Bogan & Lachlan, MEL 1003503, NSW98994, (fl.,fr.); Passlow s.n., 27.v.1967, Ariah Park, NSW98968 (st.); Rodway s.n., -.xi.1927, Burrier, Shoalhaven River, NSW98970 (fl.); Sainty 247, 4.x.1966, Wumbulgal near Griffith, NSW (fl.); Shoebridge s.n., 2.xii.1961, 20 miles south of Orange, CBG015575 (fl.,fr.); Thackeray s.n., 22.viii.1956, Gundagai district, NSW98977 (st.); Thom 2, 1887, Wagga Wagga, MEL (fl.); Tindale s.n., 29.x.1963, Marsden, AD96401024 (fl.); Tucker 213, 1879, Lachlan River, MEL (fl.,fr.); Wales s.n., -.xi.1949, Gungal, NSW98060 (fr.); Woolls s.n., Castlereagh, MEL1003495 (st.); Woolls s.n., Mudgee, MEL1003512 (fl.).

Queensland: Johnson & Constable s.n., 10.xi.1954, 1 mile E. of Yelarbon, NSW30383 (fl.); O'Shanesy s.n., Table Mountain, MEL1003500 (st.); O'Shanesy Ser. 7, No. 98, 12.xii.1867, in sheltered places among rocks near Table Mt., MEL (st.).

Notes.

1. *G. elatus* is a very variable species, extremely sensitive to its environment, especially in the size and shape of its leaves. In full sun the leaves are leathery, short and narrow (as small as 0.7-1.5 cm long and 0.2 cm wide in Constable s.n. and Kraehenbuehl 748) with entire, strongly

revolute margins, whereas in shade the leaves are soft, with margins not revolute and serrate in the upper part, and up to 5 cm long and 0.8 cm wide. However, in contrast to the changes in leaf shape, the inflorescence always assumes its characteristic drooping appearance.

2. Three collections exist of completely glabrous forms of *G.elatus*, found in widely separated localities. In the case of the Beauglehole collection at least, the glabrous plants were growing in a population of normal pilose plants. For these reasons they do not seem to warrant formal taxonomic status. The collections are: Beauglehole 29785, 23.xi.1968, Mt. Arapiles, Victoria, BEAUGLEHOLE (fl.); Richards s.n., -.ix.1886, locality unknown, MEL1003754 (fl.); Tepper 1443, 1890, Middle Back (Range),Port Augusta, South Australia, MEL (fl.).

3. Some collections of *G. elatus* show characters suggestive of introgression with species such as *G. teucrioides* and *G. tetragynus*. Apparently only one mass collection exists of specimens from a hybrid swarm between *G. elatus* and another species. This is the series Orchard 1942 to 1955 collected at Golton Creek in the Grampians on 10.ii.1969 and housed in AD. Of these collections, numbers 1945, 1948, 1949, 1950 and 1953 show affinity with *G. elatus*, numbers 1943, 1952 and 1955 show affinity with *G. teucrioides* and the rest form a more or less continuous series between the two apparent parent species.

5. *Gonocarpus hexandrus* (F.v.M.)Orchard, comb. nov.

Haloragis hexandra F.v. Mueller, Fragm. 3(1862)31 [Typus: "In locis uliginosis ad sinum Wilson's Inlet Novae Hollandiae austro-occidentalis. Oldfield". Holotypus: Oldfield 758, Wilson's Inlet, W.Aust. Bogs. Pt. diffuse, leaves fleshy. MEL1003573 (fl.,fr.)! Isotypus: Oldfield 758, Wilson's Inlet.Bogs.Plt. tufted, branches diffuse, Lvs. fleshy. MEL1003569 (fls.-terat.)!]; Benth., Fl. Aust. 2(1864) 478-9; F.v.M., Census 1(1882)49; F.v.M., Trans. roy. Soc. Vict. 24(1888) 134; F.v.M., Sec. Census 1(1889)85; Schindler, Bot. Jb. 34., Beibl. 77(1904)5; Schindler, Pflrch. 23(1905)53-54; Gardner, Enum. (1931)99; Blackall & Grieve, W.Aust. Wildfls. 3(1965)47.

Figs: Schindler, Pflrch. 23(1905) fig 16E; Blackall & Grieve, W.Aust. Wildfls. 3(1965)47 (var. *integrifolia*).

Prostrate, ascending or erect perennial herbs or small shrubs 25-100(-200) cm tall, much branched, the stems 4-ribbed, glabrous or sparsely pilose. Leaves opposite at base of plant becoming alternate in the upper parts, (broad-)lanceolate to oblanceolate,± sessile, entire or serrate, glabrous or pilose, size variable.

Inflorescence an indeterminate spike of (1-)3-5(-7) flowered dichasia, borne in the axils of alternately arranged primary bracts. Lateral inflorescences similar to the terminal one, may be borne in the axils of the upper 6-12 leaves. Primary bracts green, leaflike, lanceolate, 2.5-8 mm long, 0.5-2.0 mm wide; sessile, usually ± entire, glabrous or pilose; secondary bracts brown, membranous, lanceolate, 0.3-0.7 mm long, 0.1 mm wide, ± entire; tertiary bracts minute.

Flowers trimerous, on pedicels 1-5 mm long, peduncles up to 1 mm long. Sepals 3, green, deltoid, 0.3-0.6 mm long, 0.4-0.7 mm wide, entire, lacking midribs, glabrous. Petals 3, green to cream, hooded, tip hooked, non-unguiculate, 1.7-2.5 mm long, 0.3-0.6 mm wide (keel to margin), glabrous or sparsely pilose along keel. Stamens 6, filaments 0.1-0.5 mm long; anthers cream to red, oblong, (1.0-)1.5-1.7(-2.1) mm long, 0.2-0.4 mm wide, 4-locular, non-apiculate, all equal. Styles 3, 0.1-0.5 mm long, stigmas fimbriate, cream or red. Ovary green, ovoid, (0.3-)0.4-0.7 mm long, 0.5-0.7 mm wide, 3-ribbed opposite petals, 3 grooves opposite sepals, incompletely 3-locular, septa present only in lower part, with 1 ovule per locule, central columella present.

Fruit trigonous, 1.0-1.7 mm long, 0.6-1.0 mm wide, 3-ribbed opposite the petals, grooved opposite the sepals, ± irregularly rugose between, 1-locular at apex, ± 3-locular at base, septa membranous; sepals persistent, enclosing styles, deltoid, 0.6-0.7 mm long, 0.6-0.8 mm wide; 1 seed occupying entire fruit.

This species consists of three subspecies which can be distinguished as follows:

1. Leaves 1.5-2.0 cm long, (0.25-)0.4-0.6 cm wide; plant erect, 15 cm tall. i. ssp. *hexandrus*
1. Leaves 3.0-5.0 cm long, 0.7-1.7 cm wide; plant weak stemmed, twining, up to 2 m tall.
   2. Leaves strongly serrate towards apex, teeth 1-3 mm long. ii.ssp. *serratus*
   2. Leaves weakly serrate towards apex, teeth 0.5 mm long. iii. ssp. *integrifolius*

i. subsp. *hexandrus*

Perennial herb 15 cm tall; rootstock perennial, much branched; stems annual, numerous, arising ± unbranched from rootstock, ± 4-angled, green or reddish, glabrous. Leaves decussate in lower parts, becoming alternate higher up, lanceolate to oblanceolate, obovate or obcuneate, 1.5-2.0 cm long, (0.25-)0.4-0.6 cm wide, entire, fleshy, apex acute, tapering gradually towards base, ± sessile, midrib indistinct, slightly prominent on lower surface, glabrous.

Inflorescence an unbranched indeterminate spike, with dichasia of 1-3 flowers in the axils of alternately arranged primary bracts. Primary bracts leaflike, green, fleshy, lanceolate, 2.5-8.0 mm long, 0.8-2.0 mm wide, entire, no veins apparent; secondary bracts membranous, deltoid to lanceolate, 0.3-0.5 mm long, 0.1 mm wide; tertiary bracts extremely minute or absent.

Flowers 3-merous. Sepals 3, green, deltoid, 0.3-0.4 mm long, 0.5-0.6 mm wide lacking midrib. Petals 3, yellow-green, hooded, tip hooked, 1.8-2.2 mm long, 0.5-0.6 mm wide (keel to margin). Stamens 6, filaments 0.1 mm long; anthers yellow, oblong, 1.5-1.7 mm long, 0.3-0.4 mm wide, nonapiculate, all equal size, 4-locular. Styles 3, bent towards centre, 0.1-0.2 mm long, stigmas red, cylindrical. Ovary ovoid, 0.3-0.4(-0.7) mm long, 0.4-0.5(-0.7) mm wide, 3-ribbed opposite the petals, 3-furrowed opposite the sepals, incompletely 3-locular, septa present in lower half of ovary only; ovules 3, pendulous.

Fruit trigonous, 1.1 mm long, 1.0 mm wide, 3-ribbed opposite the petals, 3-furrowed opposite the sepals; sepals persistent, erect, deltoid, 0.6 mm long, 0.8 mm wide, enclosing the styles; ± 1-locular (membranous septa in base), seeds not seen.

Distribution. (Map 10)

This subspecies is known only from the vicinity of Wilson's Inlet, about 30 km west of Albany in south-west Western Australia.

Ecology.

The plant is apparently confined to wet, boggy areas. Collectors' notes include "Bogs" (Oldfield 758) and "in wet vallies and on rivulets" (Mueller MEL1003563, 1003574). Flowers and fruits at least in December.

Specimens examined.

Western Australia: Mueller s.n., Wilson's Inlet, MEL1003562 (fl.,fr., some terat.); Mueller s.n., 22.xii.1877, between K.G.S. [King Georges Sound] and Wilson's Inlet, MEL1003563, 1003574 (fl.,fr.); Oldfield s.n., Wilson's Inlet, MEL1003572 (fl.); Oldfield 758, Wilson's Inlet, MEL1003569 (fl.,terat.), MEL1003573 (fl.,fr.) - isotype and holotype of *H.hexandra*.

Notes.

1. This subspecies has apparently not been collected since 1877, as there are no later collections in the major Australian herbaria.

ii. subsp. *serratus* (Schindler) Orchard, comb. et stat. nov.

Haloragis hexandra var. α. *serrata* Schindler, Pflrch. 23(1905)54 [Typus: "Nord-Australien: Port Walcott (Diels n. 7832). - Herb. Berlin" (destroyed). Lectotypus (Orchard): P. Walcott s.n., Dec. 67, Hab.Valley in the Karri Country, Loc. Karri Dale, MEL1003564 (fl.)! Syntypi: P. Walcott, s.n., Jan. 1868, Height 12 to 36 inches, Hab. Springs & brooks, Loc.Warren River, MEL1003568 (fl.)!; P. Walcott s.n., W.A., MEL1003571 (fl.)!].

Perennial herb, stems weakly ascending, ± twining, 25-35 cm long (up to 2m. - Koch 2259), ± 4-ribbed, sparsely pilose, the hairs soft, simple, 5-6 celled, transparent except for red-purplish pigment on transverse walls. Leaves opposite in lower part, alternate above, not fleshy, broad lanceolate-oblanceolate, 3.0-3.5(-5.0) cm long, 0.7-1.2(-1.7)cm wide, ± sessile, tapering gradually to base, apex acute, ca. 6 teeth 1-3 mm long in upper half, midrib slightly channelled on upper surface, prominent below, lateral veins indistinct, diverging at an angle of 15°-20° to midrib, hairs as for the stems sparsely scattered along margins and on lower surface of midrib.

Inflorescence an indeterminate spike of (1-)3-5 flowered dichasia borne in the axils of primary bracts; all flowers developing to anthesis. Lateral inflorescences are borne in the axils of several (6-12) of the upper leaves. Primary bracts green, leaflike, lanceolate, 3-8 mm long, 0.5-2.0 mm wide, ± entire (occasionally 1-2 serrations in upper part), sessile, apex acute, midrib distinct, pilose on margins with hairs as for stems. Secondary bracts brown, membranous, lanceolate, 0.5-0.7 mm long, 0.1-0.2 mm wide, entire or 1-2 serrate. Tertiary bracts membranous, deltoid-lanceolate, 0.1-0.2 mm long.

Flowers 3-merous, on pedicels 1-3 mm long, peduncles 1 mm long. Sepals 3, deltoid, 0.6 mm long, 0.5-0.7 mm wide, entire, lacking midrib, glabrous. Petals 3, hooded, non-unguiculate, apex hooked,1.7-2.5 mm long, 0.6 mm wide (keel to margin), single row of hairs along keel, the hairs as for the stem, but sometimes only 2-3 celled, 0.05-0.20 mm long. Stamens 6, filaments 0.1 mm long; anthers yellow, oblong, 1.8-2.1 mm long, 0.2-0.3 mm wide, non-apiculate, 4-locular. Styles 3, bulbous based, 0.4-0.5 mm long, stigmas oblong. Ovary trigonous, 0.6-0.7 mm long, 0.5 mm wide,, 3-ribbed opposite petals, 3-furrowed opposite sepals, 1 locule, central columella, 3 pedulous ovules.

Fruit not seen.

Distribution. (Map 10)

This subspecies is known only from the vicinity of Pemberton on the Warren River, about 270 km south of Perth in south-western Western Australia.

Ecology.

The most favoured localities for this plant are apparently wet or boggy. Collectors' notes include "herbaceous perennial growing in moist places" (Koch 2259) and "springs and banks Warren River" (Walcott MEL1003568). Flowers present in December and January, fruiting period unknown.

Specimens examined.

Western Australia: Koch 2259, -.xii.1916, Big Brook, MEL (fl.); Koch 2259, -.i.1917, Big Brook, Pemberton, NSW (fl.); Koch 2259, Pemberton, MEL, NSW (fl.); Walcott s.n., W.A.[Western Australia],MEL1003571 (fl.) - syntype of *H. hexandra* var. *serrata*; Walcott s.n., -.xii.1867, Karri Dale, MEL1003564 (fl.) - lectotype of *H. hexandra* var. *serrata*; Walcott s.n., -.i.1868, Warren River, MEL1003568 (fl.) - syntype of *H. hexandra* var. *serrata*.

Notes.

1. The choice of a lectotype is necessary as the holotype in B cited by Schindler has been destroyed. No duplicate of Diels n.7832 which could serve as lectotype, can be located, but three collections in MEL, all matching Schindler's description, have the collector P.Walcott. All three are from Western Australia. As it appears likely that Schindler's locality Port Walcott was in fact the collector's name, P. Walcott, one of the MEL collections can be chosen as lectotype, the other two becoming syntypes. The specimen here designated lectotype is chosen because of the two sheets

with adequate labels, this one (MEL1003564) contains the better and more copious material.

iii. subsp. *integrifolius* (Schindler) Orchard, comb. et stat. nov.

Haloragis hexandra var. β. *integrifolia* Schindler, Pflrch. 23(1905)54 [Typus: "West Australien: Swan River (Drummond IV. n. 84) - Herb. Boiss., Delessert, Petersb., Wien." Lectotypus (Orchard): J. Drummond IV. 84, Australia, ad fl. Cygnorum, LE (young fr.)! Syntypi (Isolectotypi): Drummond 84, 1848, Swan River, G (herb. Boiss., herb. Delessert) (fr.)!, J. Dr. 84, W.A., MEL1003565 (fl.,fr.)!]; Blackall & Grieve, W.Aust. Wildfls. 3(1965)47.

Prostrate or weakly ascending densely branched perennial herb, up to 1.75 m tall, stems 4-ribbed, glabrous. Leaves opposite in lower parts, alternate above, not fleshy, lanceolate to oblanceolate, 3.0-5.0 cm long, 0.7-1.3 cm wide, widest at or just above the middle, tapering gradually towards the sessile base, more abruptly towards the apex, 3-5 minute teeth 0.5 mm long in upper part, midrib sunken above, prominent below, lateral veins obscure, diverging from the midrib at 20^{o}-25^{o}, glabrous.

Inflorescence an indeterminate spike of 3-7 flowered (1-3 functional) dichasia in the axils of alternate primary bracts. Lateral inflorescences arise in the axils of the upper leaves. Primary bracts green, leaflike, lanceolate, 3-6 mm long, 0.5-1.0 mm wide, entire, no midrib; secondary bracts brown, membranous, lanceolate, 0.4-0.5 mm long, 0.1 mm wide, entire; tertiary bracts brown, membranous, 0.1 mm long.

Flowers trimerous, on pedicels 0.5 mm long, peduncles minute or ± absent. Sepals 3, green, deltoid, 0.5 mm long, 0.4-0.5 mm wide, entire, glabrous. Petals 3, cream, hooded, 2.2-2.5 mm long, 0.3-0.4 mm wide (keel to margin), glabrous. Stamens 6, filaments 0.5 mm long; anthers cream to red, linear-oblong, 1.0 mm long, 0.2 mm wide, non-apiculate. Styles 3, ± oblong, 0.5 mm long, stigmas fimbriate, cream. Ovary green, ovoid, 0.7 mm long, 0.6-0.7 mm wide, 3-ribbed opposite petals, 3-furrowed opposite sepals, glabrous, 1-celled except at base (3 membranous septa as base only), columella present, 3 pendulous ovules.

Fruit shaped as for ovary, 1.0-1.5 mm long, 0.6-1.0 mm wide, 3-ribbed opposite petals, 3-furrowed opposite sepals, irregularly rugose between; sepals persistent, erect, 0.7 mm long, 0.6 mm wide, with styles reflexed between them; 1 locule (± 3-loculed at extreme base), 1 seed.

Distribution. (Map 10)

This subspecies has been collected from tributaries of the Swan River just east of Perth, Western Australia, and from near Bunbury, ca 160 km due south of Perth.

Ecology.

Like the other two subspecies, subsp. *integrifolius* appears to favour wet habitats. It has only been collected near major, permanent watercourses. Collectors' notes include "growing in a tangled mass near water" (Koch 2140) and "prostrate, herbaceous, a tangled mass of branches" (Koch 2166). Flowers and fruits are present from October until January.

Specimens examined.

Western Australia: Drummond 84, W.A., MEL1003565 (fl.,fr.); Drummond 84, 1848, Swan River, G (herb. Delessert, Boiss.) (fr.) - syntypes *H. hexandra* var. β. *integrifolia*; Drummond IV. 84, Australia, ad fl. Cygnorum, LE (fr.) - lectotype of *H. hexandra* var. β. *integrifolia*: Koch 2140,

-.x.1909, Lowden, Preston River distr., MEL, NSW (fl.); Koch 2166, -.xii.1912, Swan Mill, Lowden, NSW (2 sheets) (fr.); Morrison s.n., 8.i.1898, Midland Junction, Helena River, CANB136629 (fl.,fr.).

Notes.

1. The choice of a lectotype is necessary as Schindler failed to designate as holotype any one of the four duplicates of Drummond's collection. The specimen in LE is here chosen as the lectotype as it is the only one in which the numeral "IV" (= 4th collection) appears on the label. However, there is little doubt that the specimens in G and MEL are duplicates of the lectotype.

6. *Gonocarpus halconensis* (Merr.) Orchard, comb. nov.

Haloragis halconensis Merrill, Philip. J. Sci. (Bot.) 2(1907)288 [Typus: "In open heaths at 2400 m. alt. (No. 5700)". Holotypus: n.v. Isotypus: Elmer D. Merrill 5700, Nov. 1906, Philippines, Mt. Halcon, Mindoro, US710841 (fl.)!]; Gibbs, Phytog. & Fl. Arfak Mts. (1917)159; van Steenis, Bull. Jard. Bot. Buitenz. III.13(1934)218; Borgmann, Zeitschr. f. Bot. 52(1964)143, 160.

Haloragis suffruticosa Gibbs, Phytog. & Fl. Arfak Mts. (1917)159 [Typus: "Arfak Mts., Angi lakes, open marsh by ♀ lake, 7000'. abundant. Fl. (♂ stage). Dec. 5555. - Fl. (♀ stage) 5942". n.v.]; Mansfeld, Bot. Jb. 61(1927)27; van Steenis, Bull. Jard. Bot. Buitenz. III. 13(1934)218; Merrill & Perry, J. Arn. Arb. 29(1948)162.

Haloragis suffruticosa var. *ramosa* Went, Nova Guinea 14(1924)108 [Typus: "Niederlandish Neu-Guinea: im Arfak-Gebirge bei den Angi-Seen 1900 m. u. M. '40 cm hoher Strauch auf moosbewachsener nasser Ebene mit gelben Bluten und blaulich - grunen Blattern' (Gjellerup n. 1161, - 29 April 1912)" Holotypus: n.v. Isotypus: K. Gjellerup 1161, 29.iv.1912, Nova Guinea neerlandica septemtrionalis, pr. lac. Angi in mont. Arfak. alt. 1900m., U85737 (fl.)!]; Mansfeld, Bot. Jb. 61(1927)27.

Haloragis suffruticosa var. *galioides* Went, Nova Guinea 14(1924)109 [Typus: "Niederländisch Neu-Guinea: im Gautier-Gebirge 900 m. u. M. 'in offenem moosbewachsenem Walde, auf Kalkboden; Blüten rötlich braun, Antheren gelb' (Gjellerup n. 878, - 5 November 1911)". Holotypus: n.v.]; Mansfeld, Bot. Jb. 61(1927)27.

Haloragis fruticosa Went, Nova Guinea 14(1924)106, Tab. XI A. [Typus: "Niederländisch Neu Guinea: Gipfel des Wichmann - Gebirges, 3000 m. u. M. 'Blüten rötlich braun, 2 m hoher Strauch' (Pulle n. 1008, - 3 Februar 1913); Rücken des Kajan - Gebirges 3200m. u. M. 'Kletterpflanze (?) in offener Vegetation, Blüten rötlich braun' (Versteeg n. 2467 - 10 Februar 1913); Fuss des Doorman - Gipfels, 3280 m. u. M. '1 m hoher Strauch auf offenem Abhang zwischen Felsenblocken, Blütenteile rot his dunkelrot' (Lam n. 1604, - 17 October 1920)" Lectotypus (Orchard): Pulle 1008 (as above), n.v., Tab. XI A l.c.! Isolectotypus: A.Pulle 1008, 3.ii.1913, Novam Guineam Meridionalem in mont. Wichmann, U8570 (fl.,fr.)! Syntypi: H.J. Lam 1604, 17.x.1920, Nova Guineam neerlandica in reg. flum. Mamberamo, alt. 3280 m. in mont Doorman, U85734 (fl.,fr.); G. Versteeg 2467, 10.ii.1913, in Novam Guineam Meridionalem in summ. mont. Kajan, U85739 (fr.)!]; Mansfeld, Bot. Jb. 61(1927)26; van Steenis, Bull. Bot. Jard. Buitenz. III. 13(1934)218; Merrill & Perry, J. Arn. Arb. 23(1942)408; Merrill & Perry, J. Arn. Arb. 29(1948)162; Hoogland, Blumea Suppl. 4(1958)229.

Haloragis nemorosa Went, Nova Guinea 14(1924)107-108, Tab. XI B [Typus: "Niederländish Neu Guinea: im Arfak - Gebirge bei den Angi - Seen. 1900 m. u. M. '1.5 m hoher Strauch im Wald auf nassem Humus: Bluten gelb, Blätter dunkelgrun' (Gjellerup n.1050, - 26 April 1912)." Holotypus: n.v. (Went, l.c., Tab. XI B!) Isotypus: K. Gjellerup 1050, 26.iv.1912, Nova Guinea neerlandica septemtrionalis, pr. lac. Angi in mont. Arfak. alt. 1900 m., U85736 (fl.)!]; Mansfeld, Bot. Jb. 61(1927)26; van Steenis, Bull. Jard. Bot. Buitenz. III. 13(1934)218; Merrill & Perry, J. Arn. Arb. 23(1942)408.

? Haloragis secunda Ridley, Trans. Linn. Soc. 9(1916)41 [Typus: "Camp VI b, 3900 ft." n.v.]; Went, Nova Guinea 14(1924)107-108;

mansfeld, Bot. Jb. 61(1927)26; van Steenis, Bull. Jard. Bot. Buitenz. III. 13(1934)218.

?Haloragis gjellerupi Went, Nova Guinea 14(1924)107 [Typus: Niederländisch Neu Guinea: im Arfak - Begirge bei den Angi - Seen, 1900 m. u. M. 'nasser mooriger Seeufer auf Humus; Kelch rotlich braun gelb' (Gjellerup n. 1125, - 28 April 1912)" n.v.]; Mansfeld, Bot. Jb. 61(1927)26; van Steenis, Bull. Jard. Bot. Buitenz. III. 13(1934)218.

Perennial erect or semi-scandent herb or subshrub, 60 cm to 1 m tall, stems red-brown, ± 6 angled, at least the smaller ones clothed in semi-appressed or spreading, simple, 2-3-celled,transparent hairs 0.3-0.4(-1.0) mm long.

Leaves relatively widely spaced (1-2 cm), in whorls of (2-)3(-5), on petioles 1.5-2.5(-4.0) mm long, lanceolate to ovate, (1.0-)1.5-2.0 (-4.0) cm long, (0.5-)0.7-0.8(-1.5) cm wide, thin, apex acute, base rounded, serrulate with (15-)20-25 teeth, ± revolute in dried specimens, midrib sunken above, prominent below, lateral veins obscure, appressed pilose with hairs as for the stems at least on the lower surface and usually on the upper surface, upper surface ± shiny, lower surface dull.

Inflorescence an indeterminate spike of individual flowers solitary in the axils of alternate primary bracts and subtended by two secondary bracts. Lateral inforescences borne in the axils of the reduced upper whorled or alternate leaves. Primary bracts leaflike, green, fleshy, lanceolate, 1.5-3.0 mm long, 0.5-0.8 mm wide, ± sessile, entire, midrib faint, ± pilose on lower surface. Secondary bracts brown, membranous, linear, 0.6-0.7 mm long, 0.1 mm wide, ± glabrous.

Flower red, 4-merous. Sepals 4, green, lanceolate, 1.2-1.5 mm long, 0.6-0.8 mm wide, faint median rib and basal median callus, margins thickened. Petals 4, red, hooded, tip hooked, non-unguiculate, 2.3-3.2 mm long, 0.4-0.7 mm wide (keel to margin),pilose on keel. Stamens 8, filaments 0.1-0.2 mm long; anthers yellow to red, oblong, 1.7-2.2 mm long, 0.2-0.3 mm wide, 4-celled, non-apiculate, anther of anti-sepalous stamen ca. 0.4 mm longer than that of the antipetalous stamen. Styles 4, stigmas ± sessile, red, fimbriate, capitate. Ovary red-purple, ovoid, 0.8-1.3 mm long, 0.5-0.8 mm wide, ± 8-ribbed, pilose with very short, simple hairs at least on ribs; 1 locule (± 4 septa at extreme apex only), columella present, 4 pendulous ovules.

Fruit red-purplish, ovoid, 1.2-1.3 mm long, 1.0 mm wide, 8-ribbed, ± tuberculate on ribs because of hairs; sepals persistent, erect, green, lanceolate, 1.1 mm long, 0.7 mm wide, ± concave, margins thickened, midrib ± prominent, median basal callus; 1 seed, filling the entire fruit.

Distribution. (Map 15)

This species is known from the highlands of West Irian and the territories of Papua and New Guinea, where it is fairly widespread, and from scattered localities in the Philippines and Celebes.

Ecology.

The shrubby or herbaceous form of *G. halconensis* is usually found in open situations at or near the tree (= shrub) line in subalpine vegetation, within the altitudinal limits 1600-2700(-3500) m. A semi-scandent form is sometimes found in more overgrown situations in mossy or mixed *Nothofagus* forest. In this latter habitat the leaves are often wholly or partly in opposite pairs instead of the usual whorls of three (see note 2 below). This species grows side by side with *G. sanguineus* at their region of altitudinal overlap on Mt. Wilhelm (3500m - Brass 30134, unspecified - Balgooy 594). There are also a number of intermediate specimens (Intergrade material - see below) in this region, suggesting a certain amount of hybridization. Collectors' notes on habitat include "forming shrubberies on edges of *Equisetum* - *Carex* bog in forest" (Brass 30543), "common on grassy banks of a stream" (Brass 11672), "mossy forest, massed in a small opening, scrambling" (Brass 12673); "open crest in *Nothofagus* - Ericaceae forest" (van Royen NGF20298), "vigorous vine in lower moss forest" (Hartley & Sayers 12670), "in tall grassland on peaty soil, usually on open patches" (Hoogland & Pullen 6048), and "edge of mixed *Nothofagus*, *Podocarpus*, *Pandanus* forest, herb semi-scandent to 4 ft. high" (Pullen 137). Flowering occurs more or less all year round but particularly from January to October, while fruiting occurs from February to November.

Specimens examined.

Philippines: Lobb 448, Luzon, CGE (fl.,fr.); Merrill 238, -.iv.1910, Canlaon volcano, Negros, U (fl.,fr.); Merrill 5700, -.xi.1906, Mt. Halcon, Mindora, US (fl.) - isotype of *H. halconensis*.

Celebes: Eyma 3607, 4.ix.1938, Rec. Menado. subdiv. Poso. G. Loemoet, between bivouac II & III top of G. Loemoet, U (fl.,fr.).

West Irian: Brass 11672, -.xii.1938, Balim River, BRI (fl.); Brass 12673, -.ii.1939, 18 km SW of Bernhard Camp, Idenberg River, BRI (st.); Gjellerup 1050, 26.iv.1912, pr. lac Angi in mont. Arfak, U (fl.) - isotype of *H. nemorosa;* Gjellerup 1161, 29.iv.1912, pr. lac. Angi in mont. Arfak, U (fl.) - isotype of *H. suffruticosa* var. *ramosa;*Lam 1604, 17.x.1920, in reg. flum. Mamberamo, in mont. Doorman, U (fl.,fr.) - syntype *H. fruticosa;* Pulle 1008, 3.ii.1913, in mont. Wichmann, U (fl.,fr.) - isolectotype of *H. fruticosa;* Versteegh BW285, 22.ii.1954, Anggigita lake, G. Mesenuk, CANB (fl.,fr.).

Territories of Papua and New Guinea: Balgooy 594, 7.vi.1965, Pindeaunde valley, Mt. Wilhelm, T.N.G., CANB (fl.); Brass 24524, 9.x.1953, Goodenough Island, Papua, CANB (fl.); Brass 30134, 24.vi.1959, east slopes Mt.Wilhelm, T.N.G., CANB (fl.); Brass 30266, 2.vii.1959, east slopes Mt. Wilhelm, T.N.G., CANB (fr.); Brass 30543, 16.vii.1959, east slopes Mt.Wilhelm, T.N.G., CANB (fl.,fr.); Brass 31438, Mt. Michael, CANB (fl.,fr.); Hartley & Sayers 12670, 17.xii.1963, Mt. Shungol - about 5 miles SW of Wagau, T.N.G., BRI (fl.); Hoogland & Pullen 6048, 28.viii.1956, near Tomba village, south slope of Mount Hagen Range, CANB (fl.); Pullen 137, 12.vii.1957, east rim of Mt. Oga, ca. 12 miles east of Hagen Station, T.N.G., CANB (fl.,fr.); Robbins 256, 7.vii.1957, road above Tomba, T.N.G., CANB (fl.); van Royen N.G.F. 18376, 3.ix.1963, Mt.Ormogadzin, W of Mt. O Dan, T.N.G., BRI, CANB (fr.); van Royen, NGF20298, 11.i.1965, road from Woitape to Kosipi, E slope of Wosa, Papua, BRI, CANB (fl.).

Notes.

1. Specimens of this species from the Philippines differ from those in New Guinea in having much larger leaves (4.0 x 1.5 cm vs. 1.5-2.0 x 0.7-0.8 cm) and longer, narrower sepals with ± suppression of the median basal callus. However, in view of the paucity of Philippines material, and the wide variation apparent in the New Guinean specimens, it seems unwise to attach much importance to these differences.

2. Some collections, particularly those from mossy forests where the plant often assumes a semi-scandent habit, have opposite leaves instead of the more usual whorls of three (e.g. Brass 12673, Gjellerup 1050, Pullen 137 and van Royen NGF18376). That this is not particularly significant is shown by other specimens where a variety of leaf arrangements occur on the one plant (e.g. van Royen NGF20298 - whorls of 3 or opposite, Versteegh BW285 - alternate, opposite, whorls of 3, 4 and 5). Went used the presence of opposite leaves as one of the features separating *H. gjellerupi*, *H. nemorosa* and *H. fruticosa* from other New Guinean species of this group, a distinction that no longer seems valid.

3. Lectotypification of the name *Haloragis fruticosa* Went is necessary as three specimens were cited with the original description. The one here designated (Pulle n. 1008) is illustrated by a photograph in the original publication and therefore seems the logical choice.

4. The specimen Lam 1604 differs in having glabrous petals, although it is normal in other respects.

Intergrade material of *G. halconensis* × *G. sanguineus*.

Although *G. halconensis* and *G. sanguineus* are more or less separated geographically and altitudinally, there is some overlap of range, particularly in the region of Mt. Wilhelm, in the Territory of New Guinea. As the two species are closely related, there is, not unexpectedly, some intergradation suggestive of hybridization. Some marginally intergrade specimens fairly closely resembling *G. halconensis* have been referred to that species (e.g. Brass 30134, 30543, 31438). Others, distinctly intermediate, are listed below.

Specimens examined. (Map 15)

West Irian: Versteeg 2467, 10.ii.1913, in summ. mont. Kajan, U (fr.) - syntype of *H. fruticosa*.

Territory of New Guinea: Balgooy 102, 26.iv.1965, ridge N. of Lake Aunde, alt. 3600 m, Mt. Wilhelm, CANB (st.); Balgooy 421, 22.v.1965, S of Lake Aunde, alt. 3560 m, Mt. Wilhelm, CANB (fl.); Balgooy 892, 27.vi.1965, Pengagl Creek, alt. 2900 m Mt. Wilhelm, CANB (fl., fr.); Brass & Collins 31015, 12.viii.1959, Mt. Otto, alt. 3500m, CANB (fl.,fr.).

Note.

1. One of the syntypes of *Haloragis fruticosa* (Versteeg 2467) falls into this category of intergrade specimens, although the lectotype and the other syntype are referable to *G. halconensis*.

7. *Gonocarpus sanguineus* (Merr. & Perry) Orchard, comb. nov.

Haloragis sanguinea Merrill & Perry, J. Arn. Arb. 29(1948)162 [Typus: "North Eastern New Guinea: Matap, Clemens 11345, February-April 1940, alt. 1500-1800 m. (shrub; flowers dull sanguine colour)" Holotypus: A (fl.)!]

Haloragis microphylla Hoogland, Blumea Suppl. 4(1958)229 [Typus: "Hoogland and Pullen 5631, near Lake Aunde, E. slope of Mount Wilhelm, Bismarck Range, Terr. of New Guinea (Eastern Highlands District); common on forest (= shrubbery) - grassland edge; alt. ca. 3500 m (11700 ft), collected 18 July 1956" Holotypus: CANB (fl.)! Isotypi: LAE, L, A, BM, BRI, US!, MEL, K, G!, BO, PNH, BISH.] Wade & McVean, Publ. Research School Pac. Stud. A.N.U. BG/1(1969)97 et seq.

Shrub or small tree (½-)1-2(-4) m tall, densely branched, stems dark reddish-brown, ± 6-angled, striate, densely spreading pubescent with simple, transparent 2-4-celled hairs 0.3-0.5 mm long.

Leaves closely packed, verticillate in whorls of 3, on petioles 0.3-0.7 mm long, coriaceous, lanceolate, 3.0-5.0 mm long, (1.0-)1.5-2.2 mm wide, margins thickened, almost entire or up to 4 small serrations, apex acute, base obtuse, midrib deeply sunken above, prominent below, lateral veins not apparent, upper surface glabrous (± pilose on larger leaves on old, non-flowering branches) extremely glossly light green, lower surface duller, pilose only on midrib with hairs as for stems.

Inflorescence an indeterminate spike of flowers borne singly in the axils of primary bracts and subtended by two secondary bracts; the fertile portion of the flowering branchlets usually unbranched. Primary bracts leaf-like, green, fleshy, petiolate, lanceolate, 3.0-3.5 mm long, 1.3-1.5 mm wide, entire or 1-2 serrulate, glabrous and glossy above with sunken midrib, pilose on prominent midrib below, arranged in whorls of 3 at least in lower part, but more widely spaced than sterile leaves. Secondary bracts linear-lanceolate, 0.6-0.8 mm long, 0.2-0.3 mm wide, 2-serrulate near base, sessile, ± fleshy, midrib faint, glabrous.

Flowers tetramerous, reddish, all developing to anthesis, on penuncles 0.5-1.0 mm long. Sepals 4, green or reddish, ovate, weakly mid-ribbed, median basal callus, 0.8-1.1 mm long, 0.7-1.1 mm wide, glabrous. Petals 4, red to yellowish, hooded, tip hooked, non-unguiculate, (2.1-)2.6-3.0 mm long, 0.7-1.0 mm wide (keel to margin), pilose with simple 2-3 celled hairs 0.2-0.3 mm long on keel. Stamens 8, filaments 0.1 mm long; anthers yellow or red, oblong, (1.5-)1.8-2.0 mm long, 0.4-0.5 mm wide, 4-celled, equisized, nonapiculate. Styles 4, clavate, 0.3-0.4 mm long, stigmas globular, yellow-orange, fimbriate. Ovary orbicular to turbinate, 1.0 mm long, 1.0 mm wide, 8-ribbed, ± glabrous, sometimes pilose (and tuberculate) on ribs, 1-locular (4 septa at extreme apex only), 4 pendulous ovules, columella present.

Fruit on peduncle 1.0 mm long, globular, 1.0 mm long, 0.9-1.0 mm wide, 8-ribbed, ± glabrous or pilose (and tuberculate) on ribs only, sepals persistent, enclosing the styles or spreading, 0.9-1.1 mm long, (0.6-)0.9-1.1 mm wide. Solitary seed occupies entire fruit.

Distribution. (Map 15)

G. sanguineus is confined to the highlands of central and eastern Papua-New Guinea.

Ecology.

This species favours open grasslands or the shrub boundary of the upper tree line, within the altitudinal limit 2230-4000 m. Collectors' notes include "common in long-grass community of alpine grassland" (Brass 29802), "in shelter of rocks in an exposed stone field" (Brass 30112), "gregarious on edges of *Equisetum* - *Carex* bog in forest" (Brass 30542), "in tussock grassland on ridge" (Hoogland 9792), "slope about 70% covered tussock grassland, formerly forested, black amorphous, richly organic soil." (Walker ANU5063) and "common on forest - grassland edge" (Hoogland & Pullen 5631). Flowering occurs from (February-)April to August, fruiting from May to September.

Common name:Ninbug (Chimbu: Waimambano) (Hoogland & Pullen 5631)

Specimens examined.

Territories of Papua and New Guinea: Balgooy 936, 29.vi.1965, Bendenumban Valley, Mt. Wilhelm, T.N.G., CANB (fl.); Brass 22252, 19.v.1953, Maneau Peak, Mt. Dayman, Papua, CANB (fl.); Brass 22447, 24.v.1953, north slopes of Mt. Dayman, Papua, CANB (fl.,fr.); Brass 29802, 11.vi.1959, east slopes Mt. Wilhelm, T.N.G., CANB (fl.); Brass 30112, 23.vi.1959, east slopes Mt. Wilhelm, T.N.G., CANB (fl.); Brass 30542, 16.vii.1959, east slopes Mt. Wilhelm, T.N.G., CANB (fl.,fr.); Brass & Collins 31016, 12.viii.1959, Mt. Otto, T.N.G. CANB (fl.); Brass & Collins 31254, 31.viii.1959, Mt. Michael, T.N.G. CANB (fl.,fr.); Clemens 11345, 6.ii.1940, Matap, T.N.G., A (fl.) - type of *H. sanguinea*; Hoogland 9792, 8.ix.1964, Korongowet, Salawaket Range, Huon Peninsula, T.N.G., CANB (fr.); Hoogland & Pullen 5631, 18.vii.1956, near Lake Aunde, E. slope of Mt. Wilhelm, T.N.G., CANB, US, (fl.) - types of *H. microphylla*; Millar NGF23206, 3.ii.1964, Pengagl Creek, T.N.G., CANB (fl.,fr.); Millar & Sayers NGF23680, 21.viii.1964, Pengagl Creek, T.N.G., CANB (fr.); Sayers & Millar NGF19883, 24.viii.1964, Lake Aunde, T.N.G., CANB (fl.); Walker ANU5063, 6.v.1965, south slope of Pindeaunde Valley, east slopes of Mt. Wilhelm, T.N.G., CANB (fl.); Womersley NGF8922, 31.vii.1956, vicinity Lake Aunde, Mt. Wilhelm, T.N.G., CANB (fl.).

Notes.

1. The specimen Brass 22447 differs from the normal form of the species in having markedly smaller flowers (ovary turbinate, 0.6 mm

long, 0.8 mm wide, petals 1.2 mm long). However, another specimen from the same locality (Brass 22252) is normal in this respect, so more material would be desirable before any recognition of the former specimen as taxonomically distinct.

XIII. DISCUSSION OF RELATIONSHIPS.

A. *Haloragaceae*

Until the nineteenth century the genera and species now included in this family were too little known for any comprehensive consideration of their relationships. During the early 1800's L. Richard (1808, "*Hygrobiae*"), Brown (1814, "*Halorageae*") and Jussieu (1817, "*Cercodianae*") all recognized the affinities of the major Haloragacean genera and gave the group family ['Ordo'] status. In Robert Brown's discussion of Haloragaceae *Haloragis* was considered to possess the basic characters of the family, and all other genera were seen to "differ by the suppression of parts or separation of sexes". This view of the family agrees quite well with the system arrived at in the present study, once allowance has been made for genera unknown to Brown, and after the removal of *Callitriche* and *Hippuris* (included in the family by Brown, with some reservations).

De Candolle (1828) recognized the anomalous nature of the latter two genera and put them in separate Tribes from the true Haloragaceae. However, his criteria for distinguishing the genera *Cercodia*, *Haloragis* and *Gonocarpus* (*'Goniocarpus'*) (differences in the ribbing of the fruit) broke down when further species were added to the total of ten known to him.

Bentham (1864) recognized 36 species of *Haloragis*, divided into three Series on account of the arrangement of the leaves and primary bracts. Characters of the leaves, presence or absence of an indumentum, and the number of flower parts were the main features used to distinguish the species, and the relationships proposed between the species as well as their delineation, agree well with the present treatment. However, Bentham failed to recognize the differences in the inflorescences, flowers and fruits which distinguish the species of true *Haloragis* from *Gonocarpus* and *Haloragodendron*, and intermingled species of all three genera. At the infra-family level, Bentham recognized two subdivisions, "True Halorageae" consisting of *Loudonia, Haloragis, Meionectes* and *Myriophyllum* (separated by overall shape of the inflorescence, petal and fruit characters) and "Anomalous genera" comprising *Gunnera, Ceratophyllum Callitriche*. Bentham (in Bentham & Hooker, 1865), in considering the family as a whole, added the genera *Serpicula, Proserpinaca* and *Hippuris* to the ones in his 1864 treatment, but excluded *Ceratophyllum*. *Trapa* was referred to Onagraceae. The major distinguishing characteristics of the genera were the number of flower parts and the distribution of the sexes. Haloragaceae was placed in the vicinity of, but not close to, Onagraceae, differing in habit, the small often imperfect flowers, the coriaceous, hooded, valvate (?) petals, the often 1-ovulate ovary with pendulous ovules, the free styles, copious endosperm and shape of the embryo. This judgment, and the basis for it, have been generally accepted by most authors as defining the position and characterization of Haloragaceae until very recently.

Schindler (1904), in a prelude to his monograph of Haloragaceae (1905) discussed the characters and relationships of the genera, and concluded that *Hippuris* should be removed from the family. In 1905 Schindler excluded the genera *Hippuris, Callitriche, Trapa* and *Ceratophyllum* from Haloragaceae and separated *Gunnera* from the rest of the family in a monogeneric subfamily. The other genera, with the exception of *Myriophyllum* which was placed in its own Tribe, were considered to be fairly closely inter-related. He placed the family near Onagraceae, but pointed out the similarities between Haloragaceae and Cornaceae in, for example, the abundant endosperm of the seeds.

Joergensen (1923) and Soueges (1952) provided embryological evidence strongly supporting the removal of *Callitriche* from Haloragaceae, and suggested a position near Verbenaceae-Lamiaceae for this genus. Erdtman (1966) excluded *Callitriche* from Haloragaceae, based on considerations of pollen morphology.

Erdtman (1966), also pointed out a marked dissimilarity between the pollen of *Hippuris* and Haloragaceae. When this evidence is combined with the unusual mode of fertilization, unitegmic ovules and haustorial suspensor of *Hippuris* described by Juel (1910, 1911) and Soueges (1922), and differences in basic chromosome number, the exclusion of *Hippuris* from Haloragaceae seems fully justified. However in modern phylogenetic schemes Haloragaceae and Hippuridaceae are still placed together in Haloragales/Hippuridales (Cronquist, 1968; Takhtajan, 1969), or in suborder Haloragidineae (Thorne, 1968). An even wider separation is justified, but finding another place for Hippuridaceae is difficult.

Trapa, considered by e.g. de Jussieu (1805), to be closely allied to some genera now placed in Haloragaceae, was referred to Onagraceae by most later authors. Raimann (1893) put *Trapa* in its own family, Hydrocaryaceae, which came between Onagraceae and Haloragaceae. This separation had earlier been made by Dumortier (1829) ['Trapaceae']. A relationship between Trapaceae and Haloragaceae is not supported by pollen morphology (Erdtman, 1966), embryology (Ghosh, 1954; Ram, 1956) or chromosome number (Trela-Sawicka, 1965).

Gunnera has usually been included in Haloragaceae (Bentham, 1864;

Schindler, 1905), although recently it has been placed in the monogeneric family Gunneraceae (dating from Meisner, 1841, but not generally accepted until about 1935). Wettstein (1935) recognized the family principally on morphological grounds, but was probably strongly influenced by the embryological work of Modilewski (1908) and Samuels (1912). This evidence, in conjunction with the embryological work of Virkki (1962) and Bala Bawa (1969), the palynological findings of Cranwell (1942), Erdtman (1943, 1966), Selling (1947), Cookson & Pike (1954) and Praglowski (1970) and the data available from the chromosome number determinations of, for example, Beuzenberg & Hair (1963) strongly opposes the commonly held view of a close relationship between Gunneraceae and Haloragaceae.

Ceratophyllum, included in Haloragaceae by Bentham (1864), and placed close to that family by many earlier authors, has no real affinity there, as shown by many differences in flower and fruit structure, embryology (Davis, 1966) and pollen morphology (Erdtman, 1966).

When the genera *Ceratophyllum*, *Hippuris*, *Callitriche*, *Gunnera* and *Trapa* are removed, Haloragaceae consists of eight genera: *Haloragis*, *Gonocarpus*, *Haloragodendron*, *Glischrocaryon*, *Meziella*, *Proserpinaca*, *Laurembergia* and *Myriophyllum*. In discussing the relationships of these genera and of the family as a whole, Robert Brown's choice of *Haloragis* as the "type" (i.e. typical or most generalized) genus, from which all other genera can be derived by reduction, may usefully be followed. Some of the more constant and distinctive morphological features of this archetype include its semi-shrub type of habit (perennial, ± woody), simple exstipulate leaves, 4-merous flowers with one whorl of sepals, petals and carpels, but 2 whorls of stamens; inferior, 4-locular ovary with 2 pendulous, anatropous ovules in each locule (one ovule per locule aborts at an early stage); 4 free styles, capitate stigmas, and an indehiscent, nut-like fruit.

This combination of characters has led most authors, from de Jussieu onwards, to place *Haloragis* and its allies either in or near to Onagraceae, and linked through this family to Lythraceae. Schindler (1905) suggested, in addition, an affinity with Cornaceae. Other workers, notably Hallier (1912), and Bentham (1864), suggested a relationship of at least some of the genera with *Ceratophyllum*. Airy-Shaw (perhaps influenced by Reichenbach, 1828) suggested an affinity with Datiscaceae, while Hallier (1912), Pulle (1952) and Cronquist (1968) saw links between Haloragaceae (particularly *Gunnera*) and Theligonaceae. Thorne placed Haloragaceae between Cornaceae and its allies and Araliaceae (including Apiaceae). Other families worth considering in a discussion of relationships are those members of the Myrtalean alliance characterized by a 4-merous flower with a ± inferior, indehiscent ovary and few pendulous, anatropous ovules. These families include Combretaceae and Rhizophoraceae. The families Celastraceae and Aquifoliaceae (usually placed in Celastrales) also resemble Haloragaceae in some respects.

Ceratophyllum, Gunnera, Hippuris, Trapa and *Callitriche*, as discussed above, have no real affinity with Haloragaceae. Similarly, Theligonaceae and Datiscaceae differ from Haloragaceae on a large number of characteristics, particularly in embryology (Davis, 1966; Kapil & Rao, 1966) and pollen morphology (Erdtman, 1966), and are therefore most unlikely to be closely related to the latter family.

Aquifoliaceae, although not usually considered to be closely related to Haloragaceae (they are placed in different orders) have some features in common with that family. Of all of the families under consideration Aquifoliaceae most closely resemble Haloragaceae in details of embryology and have a primitive type of wood ray structure that could be ancestral to that in Haloragaceae. Unfortunately, no suitable comparative data are available on the floral vasculature of Aquifoliaceae. Factors tending to reduce the probability of a relationship between these families are the disagreement in basic chromosome numbers and in pollen morphology. In addition, the presence of stipules in Aquifoliaceae, and the unisexual flowers (and dioecious plants) found in many species, make a close relationship between this family and Haloragaceae unlikely.

Celastraceae, usually considered closely related to Aquifoliaceae, also closely resemble Haloragaceae in features of embryology. However, Celastraceae have a relatively advanced type of wood ray structure in comparison with *Haloragis*, and only a weak resemblance to Haloragaceae in pollen morphology and basic chromosome number. The flowers of Celastraceae are sometimes unisexual and usually have a disc associated with the ovary. Because of these differences, Celastraceae, like Aquifoliaceae, can be dismissed from further consideration as close relatives of Haloragaceae: their few points of resemblance to Haloragaceae are probably the result of convergence.

Rhizophoraceae and Combretaceae, although appearing in the same Order as Haloragaceae in many phylogenetic schemes, are not usually considered to be closely related to that family. LeMaout & Decaisne (1873) dismissed the popular idea of a relationship between Haloragaceae and Onagraceae and suggested instead a relationship between the former family and Combretaceae. This suggestion has been disregarded (or overlooked) by subsequent authors. In embryological details, Rhizophoraceae and Combretaceae show quite good agreement with Haloragaceae, and in pollen morphology there is a slight resemblance between the grains of Haloragaceae and the other two families. Rhizophoraceae, but not Combretaceae, have a wood ray structure compatible with a common ancestry with *Haloragis*. Combretaceae also differ from Haloragaceae in possessing inter- and intra-xylary phloem. Other points of dissimilarity with the latter family are in the basic chromosome numbers, the stipules of Rhizophoraceae, the marked specialization in Rhizophoraceae concomitant with its littoral habitat preference, and the tendency towards 5-merous flowers in Combretaceae. In aspects of their floral vasculature, Combretaceae and Rhizophoraceae show some similarity to Haloragaceae in that the girdle formed by their placental supply may be homologous with the placental vascular network of the latter family.

When all of the above characters, plus general morphology are taken into account, the relationship between Haloragaceae and Rhizophoraceae-Combretaceae is seen to be fairly close, probably compatible with their inclusion in the same Order (as, for example, Rendle, 1925; Wettstein, 1935; Thorne, 1968) or in closely related Orders (Cronquist, 1968; Takhtajan, 1969). However, the similarities are not strong enough to postulate the derivation of Haloragaceae from Rhizophoraceae-Combretaceae (or vice versa).

Onagraceae, until very recently, have been considered to be the family most closely related to Haloragaceae (see, for example, Schindler, 1905; Rendle 1925; Wettstein, 1935; Pulle, 1952). However, the studies of

Bala Bawa (1969) on the embryology of Haloragaceae revealed a number of major discrepancies (in e.g. embryo-sac development and embryogeny) between Haloragaceae and Onagraceae. Erdtman (1966) and Praglowski(1970) found only a slight resemblance between the pollen of Haloragaceae and some Onagraceae: Haloragaceae pollen apparently most closely resembles that of some members of the old "Amentiferae". Although the structure of the wood rays of Onagraceae is compatible with a relationship to Haloragaceae, the interxylary phloem found in the former family is not present in the latter. Another major difference between the two families is in the derivation of their placental and ovular traces. In Onagraceae the traces to the ovules traverse the septa from the peripheral bundles, but in Haloragaceae there is a central placental supply and the ovular traces come from a placental network at the apex of the ovary. However, Onagraceae share with Haloragaceae the annulus formed by fusion of the sepal and petal traces in their flowers, and also agree in basic chromosome number, in their tetramerous flowers and in their exstipulate leaves. Despite these similarities, it seems that the weight of evidence is against a close relationship between Haloragaceae and Onagraceae, since the agreement between these families in such aspects as embryology, pollen morphology, wood anatomy and floral vasculature is only as great, or less, than the agreement between Haloragaceae and Rhizophoraceae-Combretaceae.

Lythraceae, usually considered to be closely related to Onagraceae, and hence to Haloragaceae, show very good agreement to the former in aspects of embryology, pollen morphology, basic chromosome number, wood anatomy and floral vasculature. Lythraceae consequently show little agreement with Haloragaceae in these respects and must be dismissed as possible close relatives of that family.

Thorne (1968) placed Haloragaceae in fairly close proximity to Araliaceae. However, apart from a resemblance to Haloragaceae in general floral morphology, Araliaceae differ in their usually compound leaves with sheathing bases and stipular appendages, aspects of embryology and wood anatomy, in their basic chromosome number and in the glandular disc of the generally pentamerous flowers. On the other hand, Erdtman (1966) indicated some similarities in the pollen morphology of Araliaceae and Haloragaceae, and the placental network demonstrated in some Araliaceae by Philipson (1967) very closely resembles that in Haloragaceae, although the outer annulus formed from the petal and sepal traces is absent in Araliaceae. Overall, the resemblance of Araliaceae to Haloragaceae is slightly less than that of Rhizophoraceae to the latter family, but probably justifies the inclusion of all three in the one order. Araliaceae cannot, on the evidence outlined above, be considered closely related to Haloragaceae.

Apiaceae closely resemble Araliaceae in details of embryology, pollen morphology, wood anatomy and floral vascular anatomy, consequently bearing a similar relationship to Haloragaceae as the latter family. Thorne's inclusion of Apiaceae in Araliaceae seems justified on this evidence. However the close relationship of Araliaceae s.l. to Haloragaceae is not supported.

The final family to be considered here is Cornaceae. Schindler (1905) mentioned that this family were possibly related to Haloragaceae, and Thorne (1968) placed the two families in adjacent suborders. Three groups within Cornaceae are worth considering separately: subfamily Cornoideae (esp. *Cornus*), the genus *Griselinia*, and the genus *Corokia*.

Cornoideae, although poorly known in this respect, resemble Haloragaceae fairly well in details of embryology, and the pollen of the two groups is comparable. The wood ray structure of Cornaceae is relatively primitive and could be ancestral to that found in Haloragaceae. Floral vasculature was studied in *Cornus* by Wilkinson (1944) and she was the first to note the constancy of the splitting and reuniting of the placental bundles in this genus. Eyde (1967) and Philipson (1967) both discussed this unusual pattern and came to different conclusions as to its significance. Neither author compared the pattern in Cornaceae with that in Haloragaceae (then unknown), yet there is a close similarity. Eyde suggested that the placental bundles in *Cornus* had been displaced from a formerly axial position. If they are (mentally) placed in an axial position and the placental ring rearranged accordingly, then the placentation pattern in *Cornus* comes very close to that in Haloragaceae. The outer annulus present in Haloragaceae is absent in Cornaceae.

The resemblance between *Corokia* and Haloragaceae is even stronger, as far as derivation of the placental supply is concerned. *Corokia* has an axial strand as well as the lateral bundles, but branches from the peripheral strands (antisepalous and antipetalous bundles) also contribute to the ovular supply. Eyde (1966) interpreted the placentation of *Corokia* as indicating an affinity with *Argophyllum* (Saxifragaceae) while Philipson (1967) thought that an affinity with Escalloniaceae was indicated (in Thorne's classification this amounts to the same thing). It seems equally reasonable to suggest a link between Haloragaceae and

Corokia in the light of the above evidence.

Griselinia, an anomalous genus often included in Cornaceae, was given an isolated position between Escalloniaceae and Araliaceae-Cornaceae by Philipson (1967). When compared with Haloragaceae, the floral vasculature of *Griselinia* does not support a close relationship with that family.

Little is recorded of wood anatomy of either *Corokia* or *Griselinia*, and apparently neither has been investigated embryologically. Information in both of these fields would be useful to gauge their relationships more accurately. The basic chromosome numbers of *Corokia* and *Griselinia*, as determined by Hair & Beuzenberg (1959), do not support a close relationship between these genera and Haloragaceae.

In summary, the evidence from embryology, pollen morphology, wood anatomy, floral vasculature, basic chromosome number and gross morphology suggests that the family most closely related to Haloragaceae is Cornaceae, although the relationship of *Corokia*, recently removed from Cornaceae, (Philipson, 1967 & Eyde, 1966) deserves closer attention. The two families Rhizophoraceae and Combretaceae also show a fairly close resemblance to Haloragaceae.

The view held by many authors, of a close relationship between Onagraceae and Haloragaceae via Trapaceae (often expressed as "a reduction series") is shown to be without foundation, as is the idea of a close relationship between Haloragaceae and the families Gunneraceae and Hippuridaceae.

Of the three recently proposed major phylogenetic schemes for the Angiosperms (Cronquist, 1968; Thorne, 1968; and Takhtajan, 1969) the above placement of the family is probably closest to that of Thorne, although the agreement is not complete. Thorne leaves *Gunnera* as a subfamily of Haloragaceae and includes Hippuridaceae in the same suborder. He also places suborder Haloragidineae closer to Araliineae than to Rhizophorineae, a view not supported by the evidence presented here.

B. *Haloragis* (Fig. 27, 28)

Only three previous attempts have been made to describe interspecific relationships within this genus in a comprehensive manner. These were those of de Candolle (1828), Bentham (1864) and Schindler (1904, 1905).

De Candolle recognised six genera in his Tribe Cercodianae of Halorageae, viz. *Serpicula*, *Goniocarpus*, *Haloragis*, *Cercodia*, *Proserpinaca* and *Myriophyllum*. This tribe corresponds to the modern concept of the family Haloragaceae; the other tribes of de Candolle (Callitrichineae, Hippurideae and Gunnereae (1868)) are now usually given individual family status. Of the genera mentioned above, only *Goniocarpus*, *Haloragis* and *Cercodia* are relevant to this discussion. They were distinguished from each other by the type of ribbing on the fruit: *Goniocarpus* had fruits which were 8-angled or 8-ribbed, *Haloragis* had smooth fruits and *Cercodia* had 4-angled, 4-winged fruits. *Goniocarpus* comprised *G. micranthus*, *G. scaber*, *G. microcarpus*, *G. tetragynus*, *G. tennellus* and *G. teucrioides*. These species are all included in *Gonocarpus* in the present study, and are discussed further under that genus. *Haloragis* contained only *H. prostrata* and *H. digyna* while *Cercodia* comprised *C. erecta* and *C. racemosa*. The present system cuts across that of de Candolle in that *C. racemosa* is made the type species of the new genus *Haloragodendron*, and *C. erecta* and *H. prostrata*, both species of *Haloragis*, are considered to be more closely allied to each other than either is to *H. digyna*.

In the definition of generic boundaries, de Candolle preferred to keep *Goniocarpus*, *Haloragis* and *Cercodia* separate, seeing *Cercodia* as intermediate between *Haloragis* and *Proserpinaca*. At the same time he recognized the possibility of combining them in a single genus, ("Goniocarpus et Cercodia forsan ut sectiones Haloragis habende"), as Robert Brown had done in 1814 .

Bentham (1864) followed Brown in reducing *Gonocarpus* and *Cercodia* to synonymy under *Haloragis*. The genus was divided into three series: Series 1. Alternifoliae with leaves ± alternate, Series 2. Oppositifoliae with leaves opposite and primary bracts alternate, and Series 3, Oppositiflorae with both leaves and primary bracts opposite. Series Oppositiflorae contained only three species, all of which are now referred to *Gonocarpus*. The other two series contained a mixture of species now considered to represent both *Haloragis* and *Gonocarpus*.

When the *Gonocarpus* species are removed from Bentham's scheme, the arrangement is very close to the one postulated below, with one or two exceptions. *H. racemosa* should be transferred from Bentham's Series Oppositifoliae to the new genus *Haloragodendron*, and *H. glauca* and *H. heterophylla* are considered to be out of place in Series Oppositifoliae, having greater affinity with the basically alternate leaves species. (The leaves of *H. glauca* are usually alternate, sometimes subopposite at the base, while those of *H. heterophylla* are usually alternate or subopposite, rarely opposite.)

Schindler's arrangement of the species of *Haloragis* differed considerably from that of Bentham. Again *Gonocarpus* was included in *Haloragis*, but the two were (with a few exceptions) kept distinct in the Sections Monanthus (= *Gonocarpus*) and Pleianthus (= *Haloragis*). The exceptions are *H. pinnatifida*, *H. viridis*, *H. hexandra*, *H. paniculata* and *H. lanceolata* which were all included in Section Pleianthus by Schindler, but are here considered to be better placed in *Gonocarpus*. *H. monosperma* and *H. racemosa* (incl. *H. baeuerlenii*), included in Section Pleianthus (as part of subsection Spongiocarpus) by Schindler are now placed in the new genus *Haloragodendron*, allied to *Glischrocaryon*. Schindler (1904, p.35) pointed out the similarity of the winged fruits of *H. gossei*, *H. trigonocarpa*, *H. stricta(?)*, *H. racemosa*, *H. odontocarpa* and *Glischrocaryon ('Loudonia')* but kept the genera distinct and the species of *Haloragis* in different subsections.

In the present treatment the species *H. racemosa*, *H. baeuerlenii*, *H. monosperma*, *H. lucasii* and the newly described *H. glandulosum* are segregated from *Haloragis* in the new genus *Haloragodendron* on the basis of differences in habit, ovary, anther, pollen, inflorescence and fruit characteristics. (for details see under *Haloragodendron*). The remaining species in *Haloragis* (sensu Schindler) are divided almost equally between *Gonocarpus* and *Haloragis*, separated largely on characters of the fruit, ovary and inflorescence. *Gonocarpus* is characterized by an ovary with a central placental column and no septa except at the extreme base and apex, where it is divided into 2-4 locules by insubstantial septal partitions of hyphae-like cells. There is no increase in ovary size during fruit formation and maturation, and only a single seed matures from the 4-8 ovules. The fruit pericarp is usually membranous in texture, never woody or spongy. In the inflorescence, the flowers occur singly in the axils of the primary bracts (except in *G. hexandrus)*.

Haloragis s. str. differs from *Gonocarpus* in having well developed septa which support the central placental strand. The septa run the entire length of the ovary, and become ± woody in the fruit. The ovary increases at least 2-3 times in size during fruit development and maturation, the septa and pericarp become ± woody, and the outer layers of the pericarp (exocarp) may become spongy or form wings, protuberances, etc. One to four seeds per fruit may develop, but irrespective of the number of mature seeds, each locule develops fully, even if empty (except in *H. eichleri)*. In the inflorescence, the flowers occur in dichasia of (1-)2-15 in the axils of the primary bracts.

Within the genus *Haloragis* (s. str.) the species fall into two main groups, centred about *H. aspera* and *H. exalata*. The groups are not given formal names and descriptions because of a number of intermediate species (e.g. *H. acutangula)* and some which are difficult to place (e.g. *H. platycarpa)*. The species of the first group (centred about *H. aspera)* all normally have alternate leaves (rarely opposite or subopposite in some species) while the leaves of those in the second group (centred about *H. exalata)* are all opposite with the exception of *H.odontocarpa*, *H. gossei* and *H. trigonocarpa*.

H. aspera appears to be at the centre of a complex consisting of over half of the species of *Haloragis*, and has a number of closely related satellite species as well as being the starting point for four major lines of development. The species is widespread in the drier regions of eastern and south-central Australia, and is characterized by its hook-tipped scabrous hairs, green-glaucous leaves and stoloniferous rootstock. On the margins of its geographical range, *H. aspera* gives way to three closely related species, *H. uncatipila* in the north-west, *H. glauca* in the north-east and *H. heterophylla* in the east and south. Specimens suggesting introgression between *H. aspera* and each of these three species are known (see under each species for details), but no introgression between the three marginal species has been observed. *H. uncatipila* shares with *H. aspera* the hook-tipped hairs and green-glaucous serrate leaves, but differs in its spongy/exocarp and lack of a stoloniferous rootstock. It is also the most robust plant of the four, forming rounded bushes up to 80 cm tall, while the others exist as semiprostrate or ascending straggling single stems from a stoloniferous rootstock. *H. glauca* has the same rootstock and basic fruit type (texture, ± shape) as *H. aspera*, but has grey-glaucous, ± entire leaves and is either glabrous or sparsely scabrous with straight or curved, not hooked, hairs. *H. heterophylla* also has a stoloniferous rootstock and hook-tipped hairs, but is a much more slender plant than any of the three previous species, with trifid leaves and much smaller fruits than *H. aspera*.

In Western Australia, *H. aspera* is parallelled in habit and general morphology by the three poorly known species *H. aculeolata*, *H. scoparia* and *H. foliosa*. Of these, *H. foliosa* is probably most closely related to *H. aspera*, differing mainly in its ovate-cordate rather than deltoid sepals, and in its relatively longer, narrower leaves. *H. aculeolata* can also be readily derived from *H. aspera*, which it resembles in hair type and general leaf shape, by loss of the stoloniferous rootstock and a reduction in the gynoecium from 4 carpels to an unstable number of 2-3 carpels. From *H. aculeolata* can be derived *H. scoparia,* which is glabrous and has a stable 2-pertite gynoecium. *H. platycarpa* probably is allied to these three species but its exact affinities are difficult to determine. In general habit and leaf morphology, and in possessing a 4-partite gynoecium, *H. platycarpa* most closely resembles *H. foliosa,* but differs in being glabrous or papillose-hairy and in its peculiar depressed-globose, spongy fruit. More material of these four Western Australian species is badly needed to assess their variability and to determine more accurately their inter-relationships.

From *H. heterophylla* two lines of development lead respectively to *H. myriocarpa* - *H. digyna* and to *H. tenuifolia* - *H. brownii.* *H. myriocarpa* resembles *H. heterophylla* in its slender habit and small, 4-locular fruits. It differs however in having terete undivided leaves instead of trifid leaves; probably lacks a stoloniferous rootstock, and is glabrous or when sparsely scabrous on the leaves, has curved hairs, not hooked as in *H. heterophylla.* *H. myriocarpa* is found at and beyond the western limit of the range of *H. heterophylla* and occasional intermediate specimens collected in their region of overlap suggest possible introgression. *H. heterophylla* is usually found on heavy clay soils, often in low lying areas subject to flooding after heavy rain, while *H. myriocarpa* is found on emergent tussocks in fresh-water swamps. *H. digyna* is amore westerly species than *H. heterophylla* and *H. myriocarpa* but has some affinity with both. With *H. heterophylla* it shares its stoloniferous rootstock and general habit, while resembling

H. myriocarpa in its hair type and linear (but shorter and flattened, ± toothed) leaves. It differs from both species in its reduction to a (1-)2-3-merous floral plan. The other line of development from *H. heterophylla* also shows a trend towards an aquatic habitat and reduction in number of floral parts. *H. tenuifolia* and *H. brownii* share with *H. heterophylla* its deeply dissected alternate leaves and perhaps a creeping rootstock, but are glabrous and have trimerous (*H. tenuifolia*) or bimerous (*H. brownii*) flowers and fruits. *H. tenuifolia* is found in swampy areas of Western Australia; *H. brownii* is a ± obligate emergent aquatic of south-western and south-eastern Australia.

H. acutangula, although almost certainly allied to this *H. aspera*-centred complex, is difficult to place more exactly. In leaf and fruit morphology it most closely resembles *H. aspera*, and furthermore occurs on the south-western margin of that species's range, but in a completely different habitat. *H. aspera* is found on heavy clay soils in inland localities, often associated with creeks and rivers, while *H. acutangula* grows in deep sand or in shallow sandy soils over limestone, mainly in coastal communities. In hair-type *H. acutangula* resembles the inland species *H. glauca*. Finally, although occurring in isolated, compact communities, the plants seem to be distinct, without a stoloniferous rootstock, resembling in this respect and in general habit, *H. uncatipila*. Overall it seems likely that *H. acutangula* represents an independent line of development from the core of the complex, and may provide a link between this and the complex centred around *H. exalata*.

As mentioned earlier, the species of the *H. exalata* group are (with 3 exceptions) opposite-leaved and comprise less than half of the

the genus. The species with opposite leaves were the subject of an intensive genetical and morphological study by Forde (1964), and the results of the present study agree well with her conclusions.

In this group the species *H. exalata* occupies a central position analagous to that of *H. aspera* in the other part of the genus. *H. exalata*, confined to coastal eastern and south-eastern Australia, is divided into 2 clearly defined subspecies on morphological and distributional criteria. The northern subspecies *(velutina)* is distinguished from subspecies *exalata* by its relatively narrower leaves and dense velvety tomentum. *H. stricta* is superficially very similar to subsp. *velutina* but differs in leaf (fewer teeth, margins revolute) and hair (more sparse, coarser) characters. The distributional range of the two taxa overlaps in part. *H. serra* is also very closely allied to the *H. exalata*-*H. stricta* group but differs from it in its 2-locular ovary and fruit. It is also the only species of this opposite-leaved group known to possess a stoloniferous rootstock (as occurs in *H. aspera* and associated species), but the presence of this character in, for example, *H. exalata* or *H. stricta* is not ruled out, as little is known of their rootstocks.

H. erecta, of New Zealand and nearby islands, is very close to *H. exalata* in habit, fruit, flower and hair characteristics, but differs in its petiolate, usually smaller, leaves and habitat preferences. While *H. exalata* is usually found in climax or subclimax natural vegetation along riverbanks, *H. erecta* is a weedy species of disturbed habitats, and is found in such places as abandoned cultivation plots and roadsides. *H. exalata* gives the impression of an old established species, perhaps relict as judged by its rarity and disjunct distribution, while *H. erecta* seems to be a recent, colonizing, still expanding and diversifying species. It is not difficult to visualize the origin of the Juan Fernandez species (*H. masafuerana* and *H. masatierrana*) from *H. erecta*. Indeed, it is only with difficulty that the three species can be distinguished.

H. eichleri presents some difficulty in determination of its place in this scheme. In its fruit and leaf characters it resembles to some extent *H. exalata* subsp. *exalata*, and the distributional areas of these two taxa are adjacent. In hair type, habit and habitat preference *H. eichleri* resembles *H. acutangula*, and also adjoins that species in range, but differs in leaf arrangement. The tendency for one locule of the floral ovary to abort in the formation of the fruit is unique to *H. eichleri* among all species of *Haloragis*. *H. eichleri* is probably best considered as representing, with *H. acutangula*, a connecting link between species centred around *H. aspera* and the *H. exalata* group.

The only opposite-leaved species still to be considered is the type of the genus, *H. prostrata*. Schindler placed this species near *H. platycarpa*, with which it has nothing in common except the shape of its fruit. However, *H. prostrata* has no obvious links with any of the species of the *H. exalata* group either, except for its opposite leaves. In its habitat preference (sandy shores) and distribution (New Caledonia and nearby islands) it is unique for the genus, but in both of these attributes comes closest to *H. erecta*. Tentatively, *H. prostrata* is placed near *H. erecta* and *H. exalata*, but more information is needed about this species.

The last three species to be considered, *H. odontocarpa*, *H. gossei*, and *H. trigonocarpa*, form a close-knit group of somewhat uncertain affinity. All three are annual (ephemeral) species of arid or semi-arid inland habitats, often growing on or associated with deep sandy soils, and all three have ± fleshy, petiolate, bluntly toothed leaves and (with the exception of *H. odontocarpa* f. *rugosa*) winged fruits. The 4-merous flowers and fruits of *H. odontocarpa* are reduced to 3-merous flowers and fruits in the other two species, although occasional fruits of *H. gossei* are 4-merous. The fruit of *H. gossei* closely resembles that of *H. odontocarpa* in size, form and texture of the wings, while that of *H. trigonocarpa* has more elaborate wings and a strongly woody nature. When this is added to the distributional patterns (*H. odontocarpa* and *H. gossei* widespread throughout central Australia, *H. trigonocarpa* localized near Kalgoorlie) the latter species seems to represent the most derived of the three. Thus a series *H. odontocarpa* → *H. gossei* → *H. trigonocarpa* can be envisaged, but where this impinges on the rest of the genus is uncertain. Some similarity in leaf and fruit morphology and a preference for sandy soils suggest a possible link between *H. odontocarpa* and *H. eichleri*, and this is strengthened by the tendency in *H. eichleri* for the upper leaves to become alternate, and for the fruit to become falsely 3-merous (reminiscent of *H. gossei* and *H. trigonocarpa*). On the other hand the trio under discussion share their winged fruits only with *H. acutangula* (the extra-Australian species aside), and this species also has alternate leaves and a preference for sandy soils. Overall, it appears that the *H. odontocarpa* - *H. gossei* - *H. trigonocarpa* group represents an offshoot from the genus, which has become considerably modified to conditions in arid sandy habitats, and has as its closest allies *H. acutangula* and *H. eichleri*.

Viewing the genus as a whole, a number of trends can be distinguished. Although in this genus and in the family as a whole the flowers and fruits are typically 4-merous, there are at least five distinct lines of development leading to a reduction in number of parts, viz. *H. exalata* - *H. serra*, *H. exalata (-H. eichleri)* - *H. trigonocarpa*, *H. aspera (-H. aculeolata)* - *H. scoparia*, *H. heterophylla* - *H. digyna* and *H. heterophylla* - *H. brownii*. Schindler segregated all species showing reduction to the 2-3-merous condition into 3 subsections (Digynium, Meionectes and Trihalorrhagis) of *Haloragis* Sect. Pleianthus (= *Haloragis* s. str.). This resulted in the separation of very closely related species such as *H. brownii* and *H. tenuifolia* and the aggregation of such diverse species as *H. digyna*, *H. serra* and *H. scoparia*. In the present study, the reduction process is considered to have occurred several times, and given rise to several parallel lines of development, all of which can be traced back to related 4-merous species.

Another distinct trend in the genus is from an opposite (i.e. decussate)-leaved state to an alternate (i.e. spiral)-leaved state. Species such as *H. exalata*, *H. erecta*, *H. masafuerana* and *H. masatierrana* have entirely opposite leaves, and in *H. prostrata* the lower primary bracts are also opposite, although in the other species they are alternate. In *H. eichleri* the leaves are usually opposite, although on some branches, the upper leaves are alternate. The species of the *H. aspera* group are all basically alternate-leaved, although in some species (e.g. *H. heterophylla)* occasional plants are wholly or partly opposite-leaved, while in others the first 2-8 seedling leaves may be opposite and the others alternate (e.g. *H. aspera, H. gossei)*.

The third major trend that can be traced through the genus is from ± woody plants to herbaceous plants. Although it is difficult to place some species into either a "woody" or "non woody" category, some generalizations can be made. The *H. exalata* group contains mainly "woody" species (the possible exceptions being *H. prostrata* and *H. stricta)* characterized by a well-developed branch system in which the lower branches are perennial and woody and only the flowering branches die back each year, while the *H. aspera* group tends to consist mainly of "non woody" species (exceptions being *H. acutangula* and *H. uncatipila)* in which the stems are all more or less herbaceous and die back to ground level after flowering.

Of these major trends, the woody-herbaceous and opposite-alternate-leaved characteristics are very well correlated. In general, the woodier plants have opposite leaves and the herbaceous plants have alternate leaves. The third trend, from 4-merous to 2-3-merous, is not as well correlated with the other two as they are with each other, but it seems that the herbaceous, alternate-leaved species have a greater tendency towards fewer floral parts.

In any discussion of primitive and derived characters there is usually the difficulty of interpreting the direction of trends. With the characters described above it does seem possible to decide with a fair degree of certainty on the direction in which the series should be read. The reduction in the number of parts in some species is almost certainly a derived condition, when it is considered that those species showing this reduction have, in general, little else in common, while the

4-merous species are closely inter-related. In addition, species of all genera of Haloragaceae (except *Proserpinaca)* are predominantly 4-merous. The direction of the woody versus herbaceous tendencies is harder to determine, but it is generally agreed (e.g. Takhtajan, 1969) that the herbaceous condition is derived. However, as Haloragaceae is a relatively advanced family there wouldbe the possibility of a previous woody to herbaceous trend being reversed, yet in support of the general principle, in *Haloragis* the species showing the herbaceous character at its most pronounced (i.e. the annuals) are those growing in the most extreme habitats (e.g. *H. brownii*, an aquatic; *H. odontocarpa*, *H. gossei*, *H. trigonocarpa*, desert ephemerals). Finally, the leaf arrangement series can be read with equal justification in either direction, but the appearance of rare opposite-leaved specimens of otherwise alternate-leaved species, but not the reverse, suggests that the opposite-leaved condition is perhaps most likely to be primitive in this group.

If the three trends are read in the directions suggested, then the *H. exalata* group, which consists predominantly of species which are woody, have opposite leaves, 4-merous flowers and fruits, represents the more primitive elements of the genus, while the *H. aspera* group, particularly species such as *H. brownii*, *H. gossei* and *H. digyna*, is the more derived one.

C. *Haloragodendron*

As most of the species of this new genus have been described since Bentham's treatment of the genus in Flora Australiensis (1864) and two of them since Schindler's treatment (1905), the literature contains little discussion of their relationships. The type species, however, was one of the first *'Haloragis'* to be described, and appears in most accounts of the family.

Haloragis racemosa was described by Labillardiere in 1805 from south-western Western Australia. In 1828 de Candolle transferred the species to *Cercodia* on the basis of its 4-winged fruits and shrubby habit. The only other species of *Cercodia* was the New Zealand *C. erecta*. Subsequent authors, who almost invariably included *Cercodia* and *Gonocarpus* in *Haloragis*, after Brown (1814), considered the species under *Haloragis*. Bentham (1864) placed *H. racemosa* in his series *Oppositifoliae* (leaves opposite, primary bracts alternate) next to *H. alata* (which encompassed the present *H. erecta* and *H. exalata)*. In this judgment, Bentham's treatment agreed with that of de Candolle.

Schindler (1904) recognized a similarity between the winged fruits of *Haloragis trigonocarpa, H. gossei, H. stricta(?), H. racemosa* and *Glischrocaryon ('Loudonia')*, but kept the genera separate and placed the *Haloragis* species in different subsections of his Section *Pleianthus*. *H. erecta* went into subsection *Cercodia* while *H. racemosa* was part of subsection *Spongiocarpus*. This latter subsection contained a curious assortment of species, and formed a dumping ground for several species of uncertain (in Schindler's opinion) affinity. *H. monosperma, H.racemosa* and *H. baeuerlenii* (as var. β. of *H. racemosa*) comprised half of the subsection, and these are the species that are removed from genus *Haloragis* in the present treatment to form the backbone of *Haloragodendron* (*H. lucasii* and *H. glandulosum* were unknown in 1905). The fourth species of the subsection was *H. stricta*, included probably on account of its opposite leaves. As discussed elsewhere, this species is a true *Haloragis* closely related to *H. exalata* subsp. *velutina*. The final two species, *H. paniculata* and *H. lanceolata* were included here as plants unknown to Schindler, but considered by him to belong in Section *Pleianthus*. In the present treatment they are considered to be species of *Gonocarpus*.

The close affinity, already noted by Schindler, between *H. monosperma*, *H. racemosa* and *H. baeuerlenii*, and the relationship of these with the subsequently described species *H. lucasii* and *H. glandulosum* led to the segregation of all five from *Haloragis* to form the new genus *Haloragodendron* in the present study. The species of *Haloragodendron* are characterized by their woody, shrub or small tree habit, their determinate inflorescences with opposite primary bracts, navicular or ± planar petals, apiculate anthers, and their 4-locular, 4-ovuled ovaries which form 1-seeded fruits by the displacement of the ± solid but flexible septa. In contrast, the species of *Haloragis* are usually herbaceous or woody only at the base of the plant (never as robust as *Haloragodendron*), have indeterminate inflorescences with alternate primary bracts, hooded petals, non-apiculate anthers, and their (usually) 4-locular ovaries have (potentially) one seed in each locule, but even if one or more seeds do not develop, the septa are not displaced, and the empty locules reach full size.

In many respects, *Haloragodendron* has more in common with *Glischrocaryon* than with *Haloragis*. *Glischrocaryon* species are herbaceous, or woody only at the base, have determinate inflorescences with alternate primary bracts, navicular petals, apiculate anthers, and no septa. A single seed, occupying the whole fruit, develops from the four ovules.

Whereas the leaves of *Haloragodendron* are all opposite, the leaves of all species of *Glischrocaryon* are alternate, while in *Haloragis* the leaves may be opposite (*H. exalata* group) or alternate (*H. aspera* group). Both *Haloragodendron* and *Glischrocaryon* show the phenomenon of juvenile leaf forms, which are unknown in other genera. Praglowski (1970) found that the pollen of the species of *Haloragodendron* and *Glischrocaryon* investigated by him was almost identical, and distinct from all other members of Haloragaceae.

Taking all of these characters into account, it appears that *Haloragodendron* comes closest to *Glischrocaryon* in affinity, but the differences in leaf and primary bract arrangement, habit, and septum morphology do not support the suggestion of Praglowski (1970) to amalgamate the two groups. In these characters *Haloragodendron* shows affinity with *Haloragis* species of the *H. exalata* group.

Within the genus *Haloragodendron*, relationships are more difficult to determine. All five species are narrowly restricted to areas with little or no overlap. The two Western Australian species (*H. racemosum*, *H. glandulosum*) are separated from the eastern species by about 1900 km, yet the relationships seem to be east-west rather than within the disjunct groups. In its distribution pattern the genus has the appearance of a formerly more widespread group now reduced to five disjunct species. The eastern species all grow at relatively high altitudes in restricted mountainous areas, while the western species occur at or near sea-level.

The species showing the greatest similarity are *H. racemosum* and *H. baeuerlenii*. Schindler made the latter species a variety of the former, but the geographical isolation as well as such differences as habitat preference and the size and shape of the fruits and size of the leaves, justify the maintenance of the two taxa as distinct species. The other three species seem to be equally distinct, both from the species above, and from each other. In (adult) leaf morphology and habit *H. monospermum* and *H. glandulosum* show some similarity, but the glandular processes of the latter are unparallelled in the family. The fruits of *H. glandulosum* resemble those of *H. baeuerlenii*, while those of *H. monospermum* are similar to those of *H. racemosum*, but lack the swollen pericarp of the latter species. Both *H. monospermum* and *H. baeuerlenii* have deeply dissected juvenile leaves. *H. lucasii* is unique in the peculiar twisted nature of the flower buds with the tips of the petals recurved slightly, as in *Glischrocaryon flavescens*. In leaf shape *H. lucasii* comes closest to *H. racemosum* and *H. baeuerlenii*. Of the eastern species, *H. lucasii* grows on sandstone soild while *H. monospermum* and *H. baeuerlenii* occur on granitic soils.

To summarize: *Haloragodendron* is most closely allied to *Glischrocaryon*, but shows some affinity with the *H. exalata* group of *Haloragis*. Within the genus, the only two species to show reasonably close relationships are *H. baeuerlenii* and *H. racemosum*; the others have more or less widely divergent characters and show no pronounced affinities in any direction. The species of *Haloragodendron* may represent the relict descendants of a formerly more widespread group.

D. *Glischrocaryon*

The type species (*G. roei*) of the genus was described in December, 1838, accompanied by a separate generic description. The author

(Endlicher) placed the genus in the family Santalaceae. In July 1839 the description was reprinted in Endlicher & Fenzl's Decades. Here, as in the first account, the young fruits lacking petals and anthers were mistaken for female flowers with sterile stamens, and the number of stamens (filaments) was given as twelve instead of eight.

In 1840 Lindley described a second species of this genus under the name *Loudonia,* and considered that its affinities were with Haloragaceae (*'Halorageae'*). Lindley also suggested that *Haloragis cordigera* and *H. scoparia* should be placed in *Loudonia,* although he failed to make the combinations. This suggestion was taken up by Hereman in Paxton's Bot. Dict. (1868) where the combinations were made. In the present study, these two species are placed in *Gonocarpus* and *Haloragis* respectively. Endlicher recognized the identity of *Loudonia* and *Glischrocaryon,* and in his Genera Plantarum (June 1840) combined the two names, unfortunately maintaining *Loudonia*, the later of the two. In this he was followed by all subsequent authors until the priority of *Glischrocaryon* was pointed out by Orchard (1970).

Relationships within the genus are difficult to determine. *G. flavescens* is somewhat isolated from the others by its larger size, woody habit, large compact inflorescences and navicular petals. The flowers and young fruits are superficially indistinguishable from those of *Haloragodendron racemosum,* but the two can be separated easily on differences in the septa, inflorescence and habit. *G. flavescens* is also distinguished by the wide disjunction in its range between south-western Western Australia and Eyre Peninsula in South Australia. This disjunction (although unaccompanied by marked differentiation), combined with its woody habit and isolated position within the genus could be interpreted as being an indication that *G. flavescens* is a species retaining ancestral characteristics, a view supported by the similarity of its flowers to those of *Haloragodendron*.

Glischrocaryon aureum var. *aureum* matches *G. flavescens* in size and habit, and bears a close similarity in the shape and size of its leaves. It differs in its hooded (not navicular) petals and strongly winged fruits. *G. aureum* var. *aureum* is confined to Western Australia, almost entirely to the Darling Range area near Perth, and is thus a north-western extension of the range of *G. flavescens*. It is therefore not difficult to suspect the derivation of the former from the latter.

In the south-western part of Western Australia, the peculiar species *G. roei* is found, principally near Albany and Esperance. It differs from the species so far discussed in its slender habit, weedy tendencies, unusual swollen fruits, and very much smaller leaves. In its floral characters it very closely resembles *G. aureum* var. *aureum*. The link between *G. roei* and *G. aureum* is forged by the occurrence of *G. aureum* var. *angustifolium* which is almost complete intermediate between the other two taxa. In leaf characteristics, habit and habitat preference *G. aureum* var. *angustifolium* is almost indistinguishable from *G. roei*, but the fruits are strongly 4-winged and (usually) not swollen. There is also a subtle difference in the appearance of the inflorescences (and infructescences) of the two species. The heads of flowers in *G. aureum* are more lax, larger, and probably contain more flowers on average than those of *G. roei* which tend to be more compact. *G. aureum* var. *angustifolium* is widespread in Western Australia, encompassing the ranges of both *G. aureum* var. *aureum* and *G. roei* as well as the area between, and also extends to South Australia. Because of its aggressive weedy nature, distribution and intermediate characteristics, it is here suggested that *G. aureum* var. *angustifolium* may have arisen as the result of hybridization between *G. roei* and *G. aureum* var. *aureum* and subsequently become more or less stabilized as a distinct taxon. Genetic studies to test this hypothesis would be worthwhile.

The final species in the genus is *G. behrii* which differs from all the others in possessing bimerous flowers and fruits. It extends from western Victoria to Eyre Peninsula in South Australia, and thus has the most easterly range of any species of this genus. At the western end of its range, *G. behrii* co-exists with *G. aureum* var. *angustifolium*, and their similarity in almost all characteristics strongly indicates a probable derivation of the former from the latter by the reduction in number of floral parts. This hypothesis is supported by the relatively large number of collections from Kangaroo Island of plants with predominantly 3-merous flowers and fruits, as well as normal *G. behrii* and *G. aureum* var. *angustifolium*.

In summary, *G. flavescens* is probably the most primitive species in the genus and could provide a link to *Haloragodendron*. *G. aureum* var. *aureum* is closest to *G. flavescens* and is linked via var. *angustifolium* to *G. roei*. *G. behrii* can be derived from *G. aureum* var. *angustifolium* by reduction of the floral parts.

B. *Meziella*

The single species constituting this genus was described by Nees

(1844) as a member of *Gonocarpus*. In 1846 it was transferred to *Haloragis* by Walpers, and in 1905 was segregated by Schindler to form the distinct genus *Meziella*.

The plant is known only from a single Preiss collection made near Albany, Western Australia. The specimens from this collection are now extremely fragmentary and were insufficient for a complete re-examination of the taxon in the present study. The following discussion is based largely on Schindler's description.

M. trifida is a creeping bog plant with trifid leaves, resembling in these respects some *Myriophyllum* species. However, unlike *Myriophyllum*, the *Meziella* leaves have tiny teeth between the lobes, a condition found also in *Proserpinaca*, although there the leaves are pinnatifid.

The sepals of *Meziella* have a large median basal callus (characteristic of *Gonocarpus*), and the petals are reported to be linear-navicular (characteristic of *Haloragodendron* and *Glischrocaryon*). The flowers are bisexual, perfect, and borne singly in the axils of the primary bracts, as in *Gonocarpus* (rarely in *Haloragis*), but the stamens are reduced to 4, that is half the normal number (cf. *Gonocarpus nodulosus, G. isomerus, Proserpinaca,* some species of *Laurembergia* and *Myriophyllum*). According to Schindler the ovary is four-locular with four ovules (characteristic of *Haloragis, Haloragodendron* and *Myriophyllum*). Unfortunately, no fruits are available.

Schindler placed the genus between *Haloragis* (including *Gonocarpus* and *Haloragodendron*) and *Laurembergia*. On the basis of the differences in inflorescence, sex distribution, leaf shape and floral structure, a relationship between *Meziella* and *Laurembergia* seems unlikely. Similarly, the apparent resemblance between *Meziella* and *Myriophyllum* is not supported by the leaf and flower characters of *Meziella*. The agreement in the presence of teeth between the foliar lobes in *Meziella* and *Proserpinaca* may be significant. For biogeographical reasons such a relationship appears unlikely and, judged on overall characteristics, it seems best to assign *Meziella* a position near *Haloragis* until more material is available for a detailed examination.

F. *Gonocarpus*

The genus *Gonocarpus* was described by Thunberg (1783, 1784), based on Japanese material of *G. micranthus*. Schreber (1789) and Koenig (1805) considered that the name *Gonocarpus* was too similar to *Conocarpus* (Combretaceae) and proposed the variants *Gonatocarpus* and *Goniocarpus* respectively. Koenig's name for the genus was generally accepted by later authors. Both of these later names, as well as *Linociria* Necker, are illegitimate under the International Code of Botanical Nomenclature (1966).

When Robert Brown described the family Haloragaceae ('Halorageae') he included *Gonocarpus* as a synonym of *Haloragis*. This placement of the genus was followed by all later authors with the exceptions of A.-P. de Candolle (1828) and Cunningham (1839). In the present study *Gonocarpus* is recognized as distinct from *Haloragis* on the basis of differences in inflorescence structure, septum and pericarp morphology, and the number of seeds per fruit.

In the inflorescence of *Gonocarpus* the flowers (with 1 or 2 exceptions) are solitary in the axils of the primary bracts, whereas in *Haloragis* these bracts subtend dichasia of (1-)3-15 flowers. In this respect *Gonocarpus* resembles *Proserpinaca, Meziella* and *Myriophyllum*. The weak to absent septa, non-woody pericarp and 1-seeded fruit of *Gonocarpus* provide points of similarity between this genus and *Laurembergia*. *Gonocarpus* shares with *Haloragis* and *Laurembergia* its (usually) scabrous indumentum. The flowers of *Gonocarpus* are usually perfect and bisexual (as in *Haloragis, Meziella, Haloragodendron* and *Glischrocaryon)* but some species show tendencies toward unisexual flowers (e.g. *G. tetragynus*). In features of its wood anatomy (see Chapter VI) *Gonocarpus* is more advanced than *Haloragis, Glischrocaryon* and *Haloragodendron*. Praglowski (1970) found little or no significant difference between the pollen morphology of *Gonocarpus, Haloragis, Laurembergia* and *Proserpinaca,* but major differences between these genera and *Glischrocaryon* and *Haloragodendron*.

On the basis of the above evidence, a position for *Gonocarpus* close to *Laurembergia* seems to be indicated. While there is some similarity in habit and indumentum between *Gonocarpus* and *Haloragis*, the relationship between these two genera is probably not close.

Very little can be said here on the inter-relationships of the species within *Gonocarpus* as only a few have been studied in detail. Judging by its reduced size,flowers and fruit and wide distribution, *G. micranthus* is probably one of the most advanced species in the genus, while the species *G. sanguineus* and *G. halconensis*, which possess just the opposite features, are probably some of the more primitive members of *Gonocarpus*. *G. cordiger, G. confertifolius* and *G. elatus,* which fall between the extremes above, are representative of the majority of the species. *G. hexandrus*, in its trimerous flowers and unusual (for *Gonocarpus*) inflorescence structure occupies an isolated position in the genus.

G. *Laurembergia*

The genus *Laurembergia* was described by Bergius (Sept. 1767) to accommodate the species *L. repens* from Cape Colony, South Africa. Two months later Linnaeus described the same species under the generic name *Serpicula*. A.-L. de Jussieu (1789) favoured the latter name when he combined the two "genera", and he was followed in this choice by all subsequent authors until the priority of *Laurembergia* was pointed out by Schindler (1904, 1905).

Shortly after the description of *Laurembergia*, its relationship to *Haloragis* ['*Cercodia*'] was recognized by e.g. A.-L. de Jussieu (1789). It was one of the genera placed in the family Halorageae at its inception by Brown (1814), and was derived from *Haloragis* via *Myriophyllum* by segregation of the sexes. Schindler (l.c.) gave *Laurembergia* a position between *Haloragis-Meziella* and *Proserpinaca*, and divided the genus into two subgenera based on the number of stamens in the male flower (either 4 or 8). This division correlates well with the distribution of the species. Raynal (1965) divided the genus into three subgenera on phytogeographical criteria.

In habit and leaf shape, the species of *Laurembergia* most closely resemble *Gonocarpus* or some of the smaller *Haloragis* species. The hooded petals and linear-oblong, non-apiculate anthers of the male flowers of

Laurembergia resemble those in the bisexual flowers of *Gonocarpus* and *Haloragis*, and the male flowers of *Myriophyllum*. *Laurembergia* also resembles *Gonocarpus* but not *Haloragis*, in its uni-locular ovary which increases in size only very slightly during fruit development.

The separation of the sexes in male and female flowers in *Laurembergia* brings to mind *Myriophyllum*, but there are indications that *Gonocarpus* also has tendencies in this direction (for details, see chapter on diagnostic characters). The inflorescence structure of *Laurembergia*, consisting of (dichasial) fascicles of flowers in the axils of leaf-like primary bracts, most closely agrees with that in *Haloragis*. The scabrous indumentum of several species of *Laurembergia* is another indication of affinity with *Haloragis* and *Gonocarpus*; all the other genera are glabrous. Finally, Praglowski (1970) found that the pollen of *Laurembergia* species closely resembles that of *Myriophyllum*, *Haloragis* (including *Gonocarpus*) and *Proserpinaca*, and Bala Bawa (1969a) reported a close similarity in details of embryology between *Laurembergia*, *Haloragis* and *Myriophyllum*.

On the basis of the evidence above, it seems that *Laurembergia* is most closely allied to *Gonocarpus*, with perhaps some links to *Haloragis*. In its unisexual flowers and semi-aquatic habitat preference, *Laurembergia* may represent a link between *Haloragis* and *Myriophyllum*, but the connection with *Myriophyllum* is tenuous.

H. *Proserpinaca*

This genus of 2-3 central American species is difficult to place within Haloragaceae because of a number of features unusual within the family. The anthers are ellipsoid, instead of oblong as in the rest of the family, and have the connective produced into a short apiculum, as occurs also in *Glischrocaryon* and *Haloragodendron*. Praglowski (1970) found that the pollen of *Proserpinaca* more closely resembles that of *Myriophyllum*, *Haloragis* and *Laurembergia*, than that of the former two genera.

The leaves (particularly the submerged ones) of *Proserpinaca* are deeply dissected (cf. *Myriophyllum*, *Meziella* and some *Haloragis* spp.) and have tiny teeth in the sinuses of the lobes, as in *Meziella*. In the loss of one whorl of stamens and the reduction of the petals to vestigal organs, *Proserpinaca* shows a tendency towards unisexual flowers, a feature of *Myriophyllum* and *Laurembergia*. However, a relationship with *Laurembergia* is probably ruled out by the leaf structure and by the solid septa in the ovary of *Proserpinaca*. In this latter character *Proserpinaca* most closely resembles *Haloragis*.

On the basis of all of these characters, *Proserpinaca* appears to occupy a fairly isolated position within the family, possibly providing a link between *Haloragis* and *Myriophyllum*, but further investigations of, e.g. embryology and chromosome number, would be valuable in clarifying its position.

I. *Myriophyllum*.

This genus was described by Linnaeus (1754) and dates from 1753. In many early systems, it was placed with other aquatic genera, such as *Ceratophyllum*, *Callitriche* and *Hippuris*, in families ('Ordo') far removed from other Halorages (e.g. Ara, Adanson (1763), Naiades, de Jussieu (1789)). When the affinity of *Myriophyllum* to genera such as *Cercodia* was recognized, *Hippuris*, *Ceratophyllum* and *Callitriche* were also transferred to Haloragaceae. Only recent evidence made the removal of these last three genera from Haloragaceae necessary.

Schindler (1904, 1905) placed *Myriophyllum* in a separate Tribe of his subfamily Haloragoideae, mainly on the basis of its fruit. Unlike the situation in all other genera, the fruits of *Myriophyllum* species split at maturity into 2 or 4 single-seeded nutlets or mericarps. However, apart from this unique feature and its lack of both sepals and petals in the female flowers, *Myriophyllum* has a large number of characters in common with the remaining genera of Haloragaceae. In its unisexual flowers *Myriophyllum* resembles *Laurembergia*, and the hooded petals and non-apiculate anthers of its male flowers are closely matched by those in *Haloragis*, *Gonocarpus* and *Laurembergia*. The whorled leaves of the aquatic species of *Myriophyllum*, one of the most distinctive features of the genus, are parallelled by the whorled leaves of e.g. *Gonocarpus sanguineus*, and the shape of the deeply dissected leaves of the aquatic species is matched by species of *Proserpinaca*, *Meziella* and some *Haloragis*.

Praglowski (1970) found that the pollen of *Myriophyllum* very closely resembles *Haloragis*, *Proserpinaca* and *Laurembergia* in general morphology, and Bala Bawa (1969a) found that *Myriophyllum* is almost indistinguishable from *Haloragis* and *Laurembergia* in details of embryology. The chromosome members of most species of *Myriophyllum* (2n = 28) is matched in at least some of the few species of *Haloragis* and *Gonocarpus* for which counts are available.

Thus, despite its reduced flowers and fragmenting fruit, there is no doubt that *Myriophyllum* belongs in Haloragaceae, but within the family its relationships are obscure. In its reduced flowers and generally aquatic nature *Myriophyllum* has some resemblance to *Laurembergia* and *Proserpinaca*, but the affinity is not close. Schindler's segregation of this genus as a distinct tribe seems justified on the presently available evidence, but when more is known about the aquatic species of the family, it may become desirable to segregate *Myriophyllum* even on the rank of subfamily from the other genera of Haloragaceae.

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INDEX TO SCIENTIFIC NAMES.

(Page numbers with single underlining refer to main taxonomic treatments; numbers with double underlining indicate keys; numbers with round brackets indicate synonyms and misapplied names; numbers with square brackets refer to excluded species.).

ILLUSTRATIONS.

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(Figures 1-16)

Illustrations to Chapter VI
(Plates 1-12)

Illustrations to Chapter XII
(Figures 17-26, Plates 13-22, Maps 1-15)

Illustrations to Chapter XIII
(Figures 27, 28)

Abbreviations used (Figures 1-16):

ann. = annulus	l.sty.= lateral stylar trace
a.p. = antipetalous bundle	m.sep.= median sepal trace
a.s. = antisepalous bundle	ov. = ovule trace
ax. = axial bundle (stele)	p. = placental bundle
d. = disc	ped. = pedicel bundle
d.sty.= dorsal stylar trace	pet. = petal trace
g. = girdle	p.net.= placental network
l. = lateral shoot	st. = stamen trace
l.sep.= lateral sepal trace	sty. = stylar trace

Figure 1. Transverse sections of a flower of *Haloragis heterophylla* showing the arrangement of the vascular tissue. (from Orchard 2636)

FIGURE 1

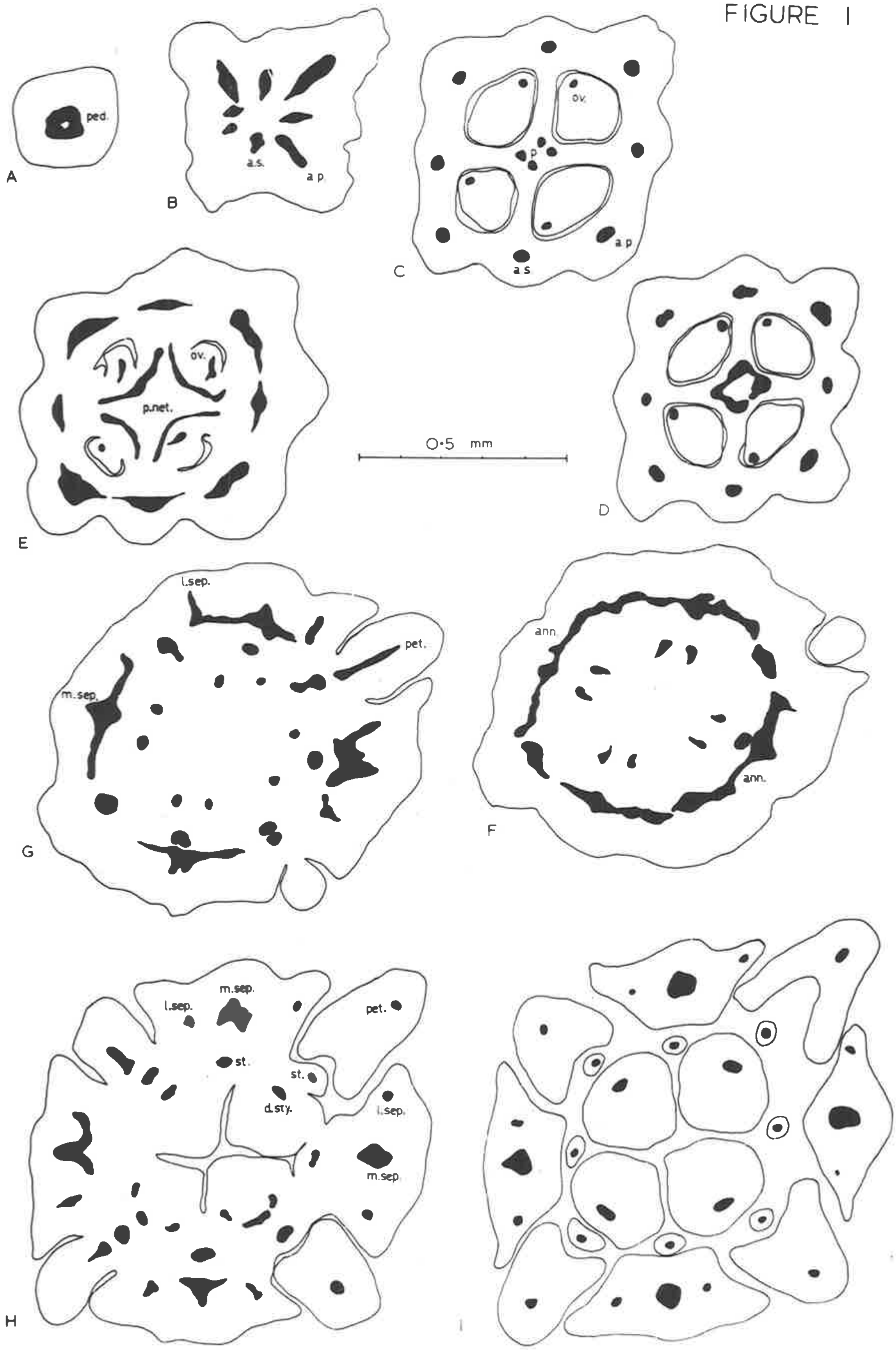
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Figure 2. Transverse sections of a flower of *Haloragis eichleri*, showing the arrangement of the vascular tissue. (from type specimen, Eichler 20806).

FIGURE 2

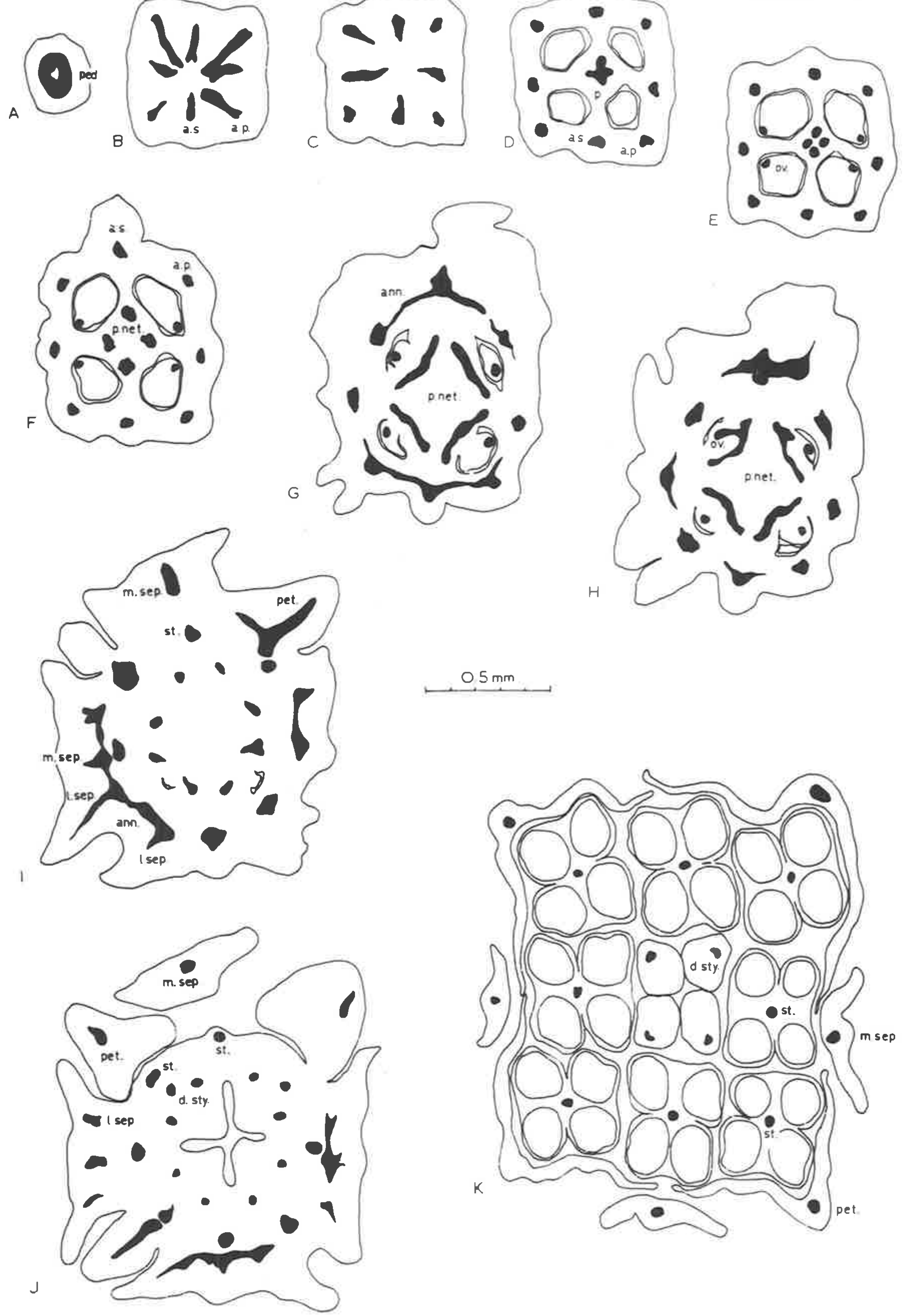
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Figure 3. Transverse sections of flowers of *Haloragis myriocarpa* and *Haloragis acutangula* f. *turbinata*, showing the arrangement of the vascular tissue.

A–N. *Haloragis myriocarpa* (from Beauglehole 33405)

A–I. Sections of a flower.

J–K. Sections of an anther (Endothecial cells stippled in K).

L–N. Hairs on pedicel.

O–Y. *Haloragis acutangula* f. *tetraptera* (from Orchard 2812).

O–W. Sections of a flower.

X–Y. Sections of an anther. (Endothecial cells stippled in Y).

FIGURE 3

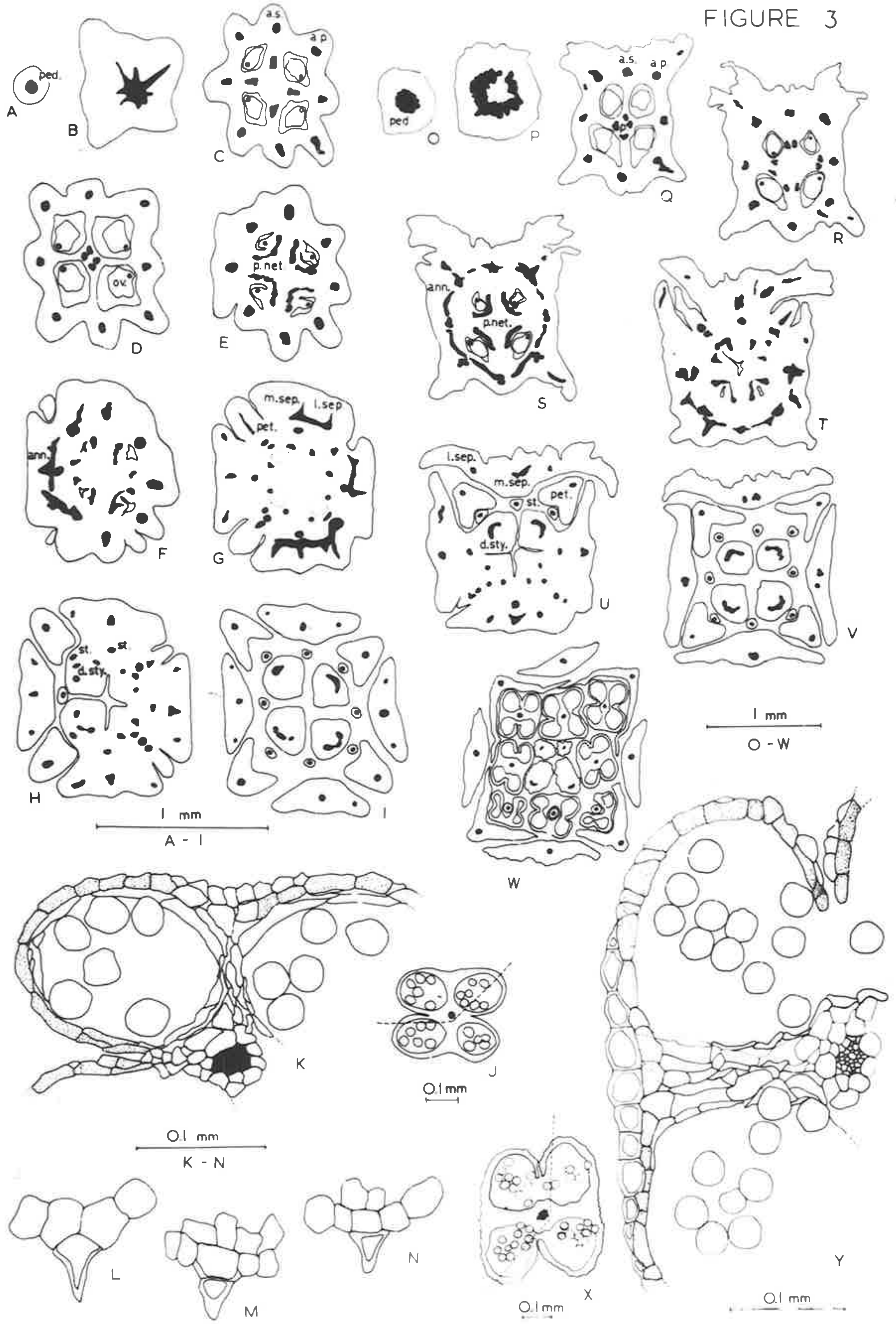
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Figure 4. **Transverse sections of flowers of *Haloragis erecta* and *Haloragis trigonocarpa*, showing the arrangement of the vascular tissue.**

A-I. *Haloragis erecta* (from Orchard 2417)

J-S *Haloragis trigonocarpa* (from Orchard 1263)

FIGURE 4

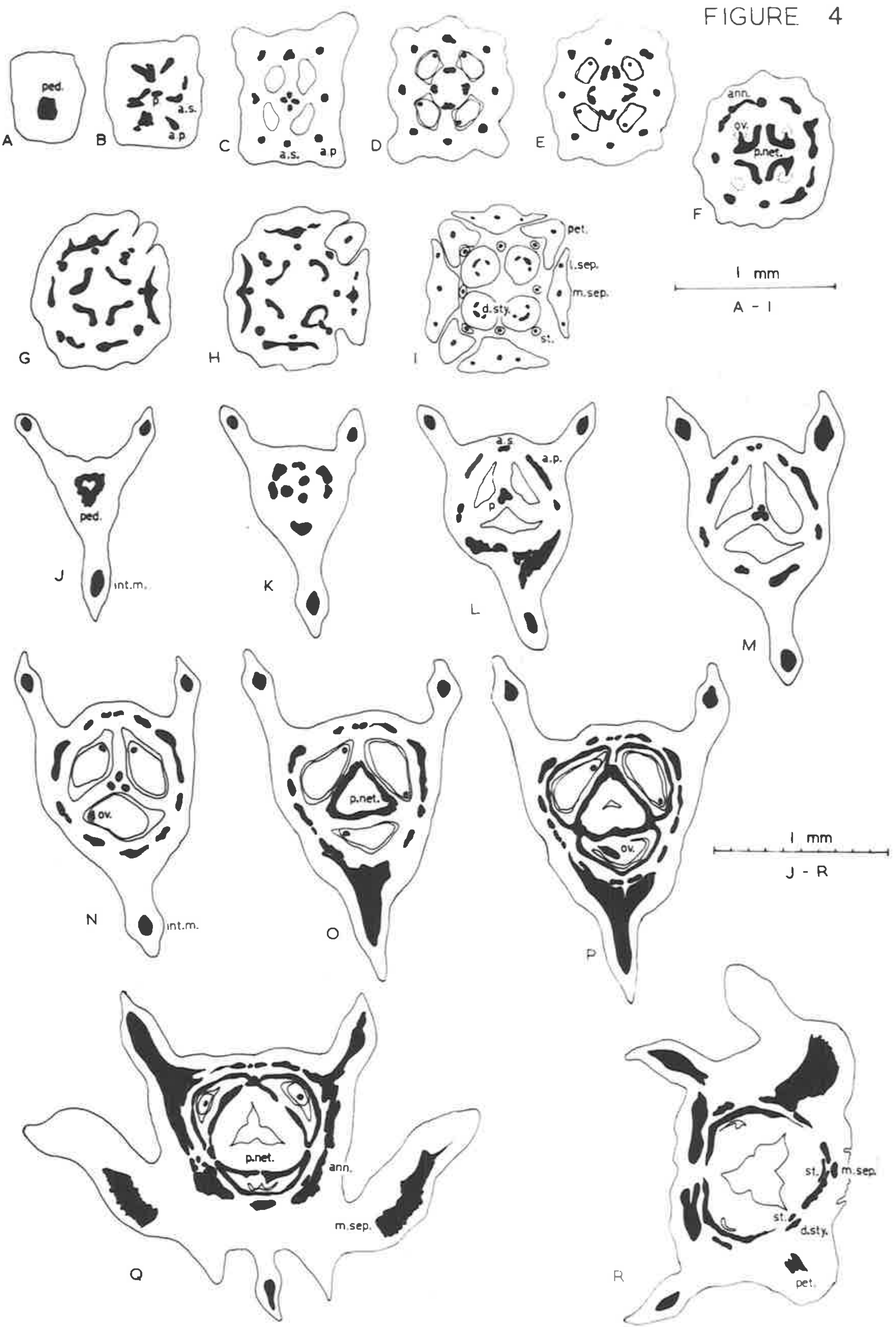

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Figure 5. Transverse sections of a young fruit of *Haloragodendron racemosum* (from Orchard 1285).

A-N. Sections of the fruit showing the arrangement of the vascular tissue.

A-H. Complete section of the flower.

I-N. Stylar column only.

O. Section of the ovary and seed showing the displacement of the septa.

FIGURE 5

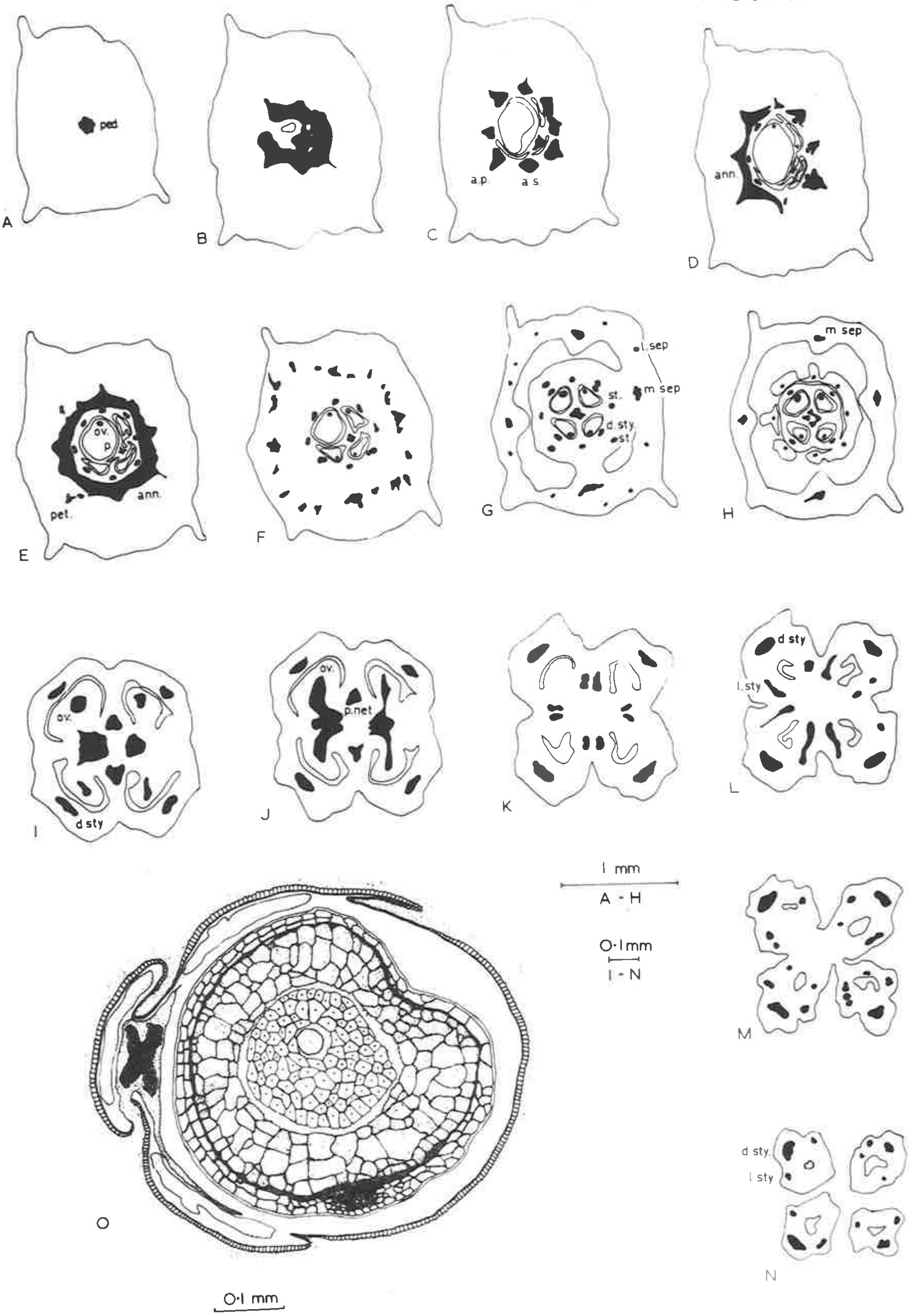
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Figure 6. Transverse sections of flowers of *Haloragodendron baeuerlenii*.

A-M. Sections of a flower showing the arrangement of the vascular tissue. (from Orchard 2647).

A-I. Complete sections of the flower.

J-M. Stylar column only.

N-O. Sections of an anther. (from Orchard 2785). Endothecial cells stippled in O.

FIGURE 6

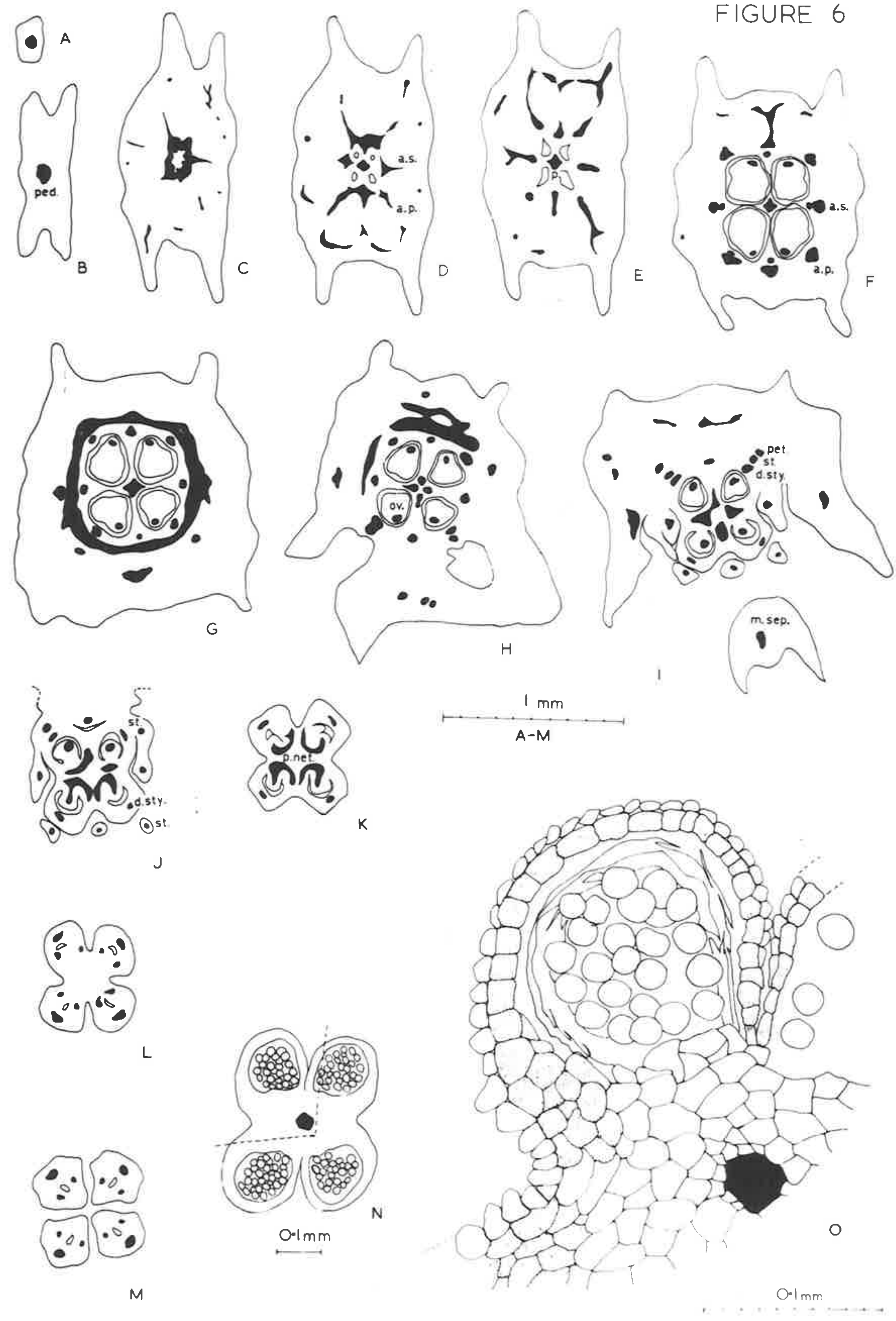
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Figure 7. Transverse sections of flowers showing the arrangement of vascular tissue.

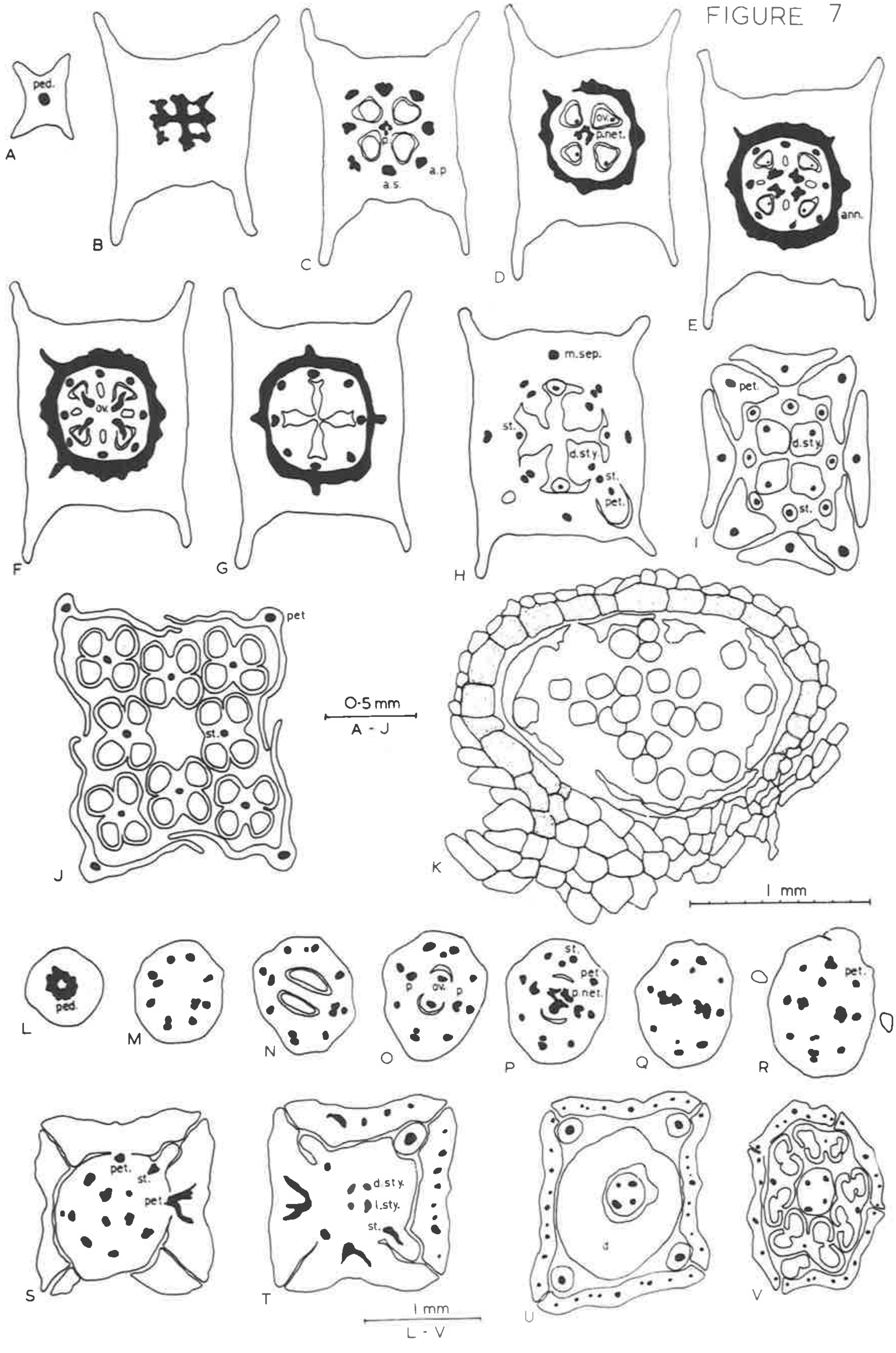
A-K. *Haloragodendron glandulosum* (from Eichler 21106).

A-J. Flower.

K. Anther (Endothecial cells stippled).

L-V. Flower of *Cornus alba* (from Orchard 2589)

FIGURE 7



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<u>Figure 8.</u> Transverse sections of a flower of *Glischrocaryon aureum* var. *angustifolium* (from Orchard 1703).

A-E. Complete sections of the flower.

I-M. Stylar column only.

FIGURE 8

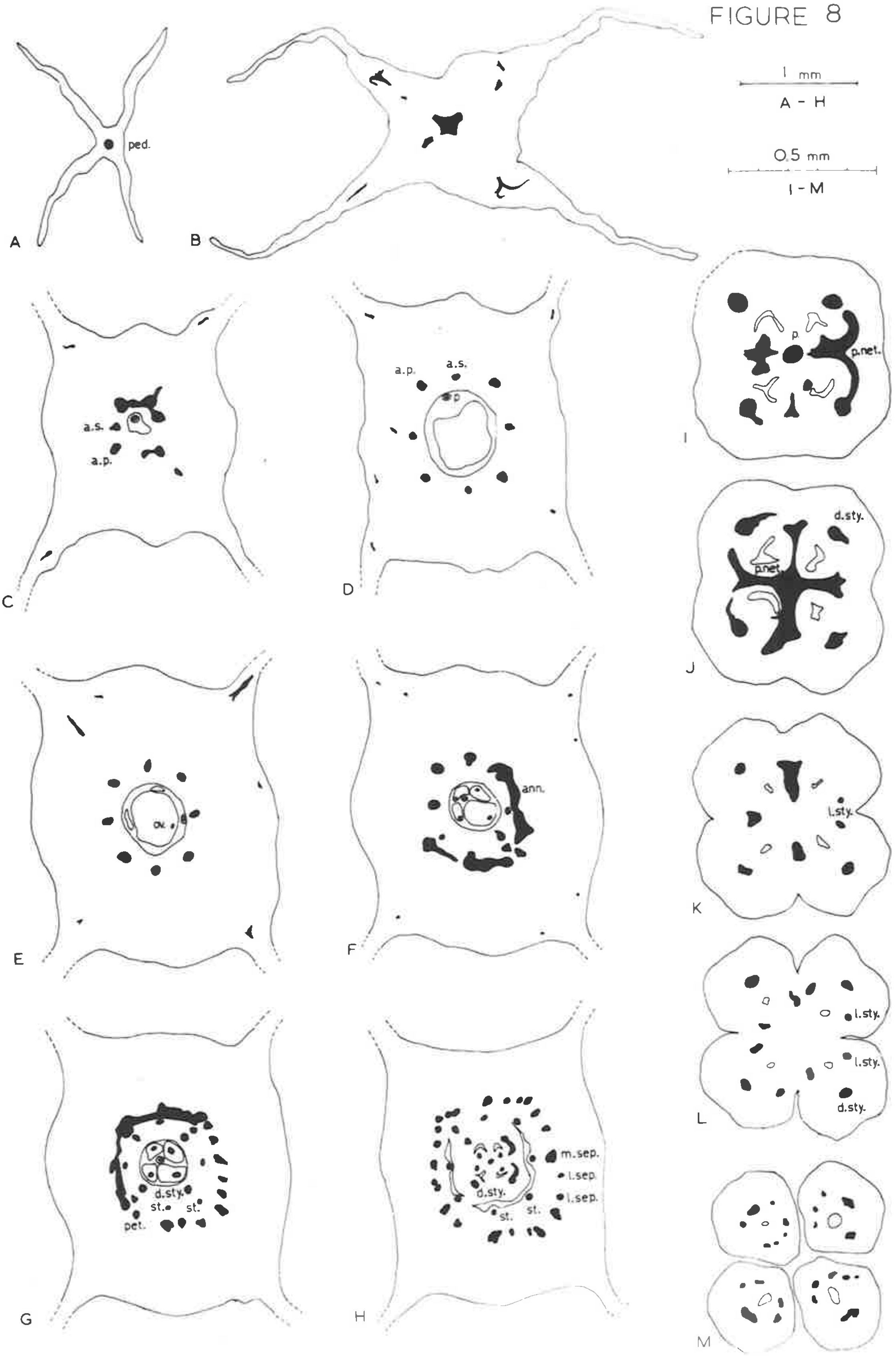
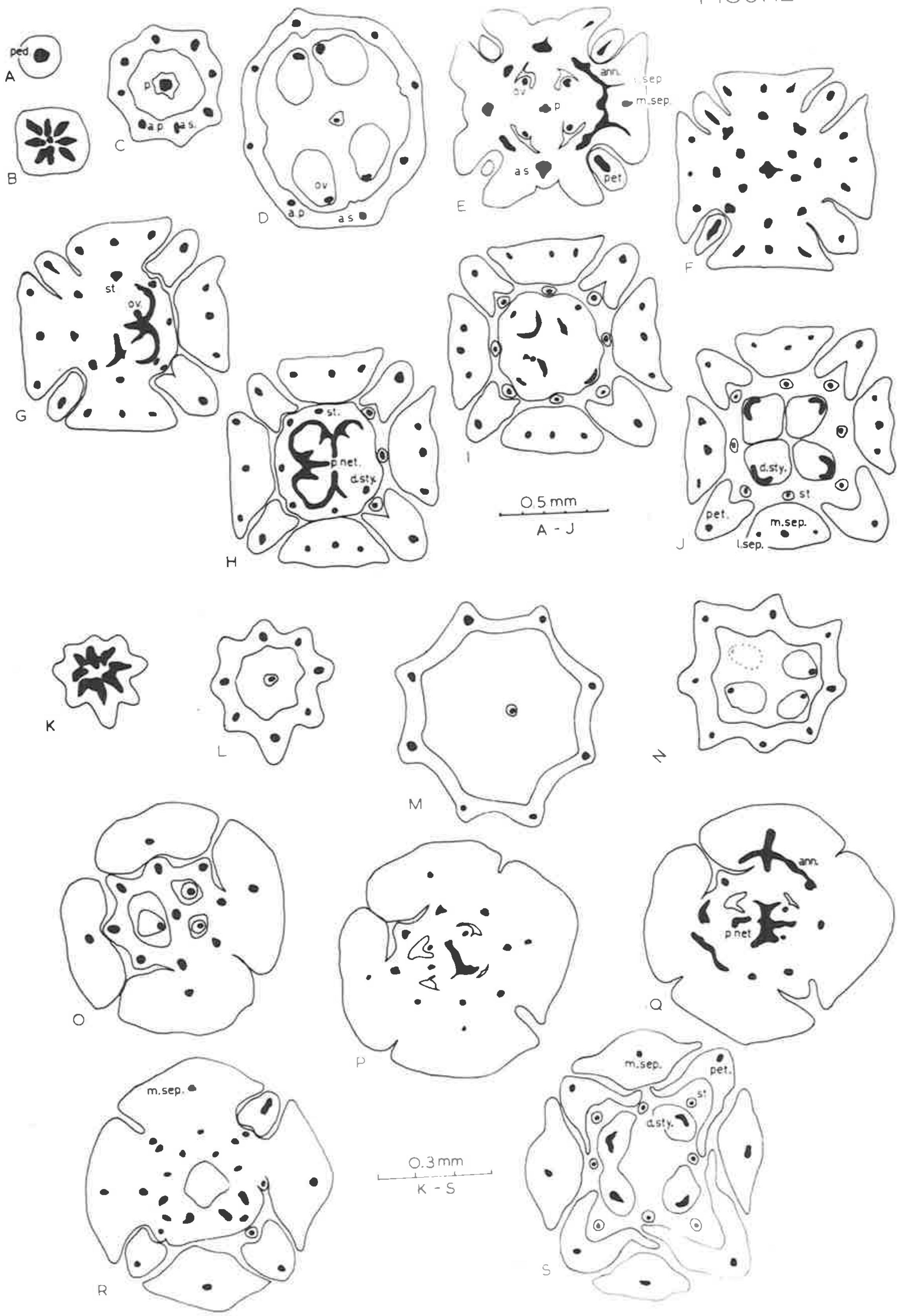

1 mm
A - H
0.5 mm
I - M
ped.
a.s.
a.p.
p
ov.
ann.
d.sty.
st.
pet.
m.sep.
l.sep.
p.net.
l.sty.
A
B
C
D
E
F
G
H
I
J
K
L
M

Figure 9. Transverse sections of flowers of *Gonocarpus* showing the arrangement of vascular tissue.

A-J. *Gonocarpus teucrioides* (from Orchard 1810)

K-S. *Gonocarpus micranthus* ssp. *ramosissimus* (from type specimen, Orchard 2383).

FIGURE 9



ped
A
B
p
a.p.
a.s.
C
ov
a.p
a.s
D
ann.
l. sep
m. sep.
ov
p
a.s
pet
E
F
st
ov
G
st.
p.net.
d.sty.
H
I
0.5 mm
A - J
d.sty.
st
pet.
m.sep.
l.sep.
J
K
L
M
N
O
P
ann.
p.net
Q
m.sep.
R
0.3 mm
K - S
m.sep.
pet.
st
d.sty.
S

Figure 10. Transverse sections of flowers showing the arrangement of vascular tissue.

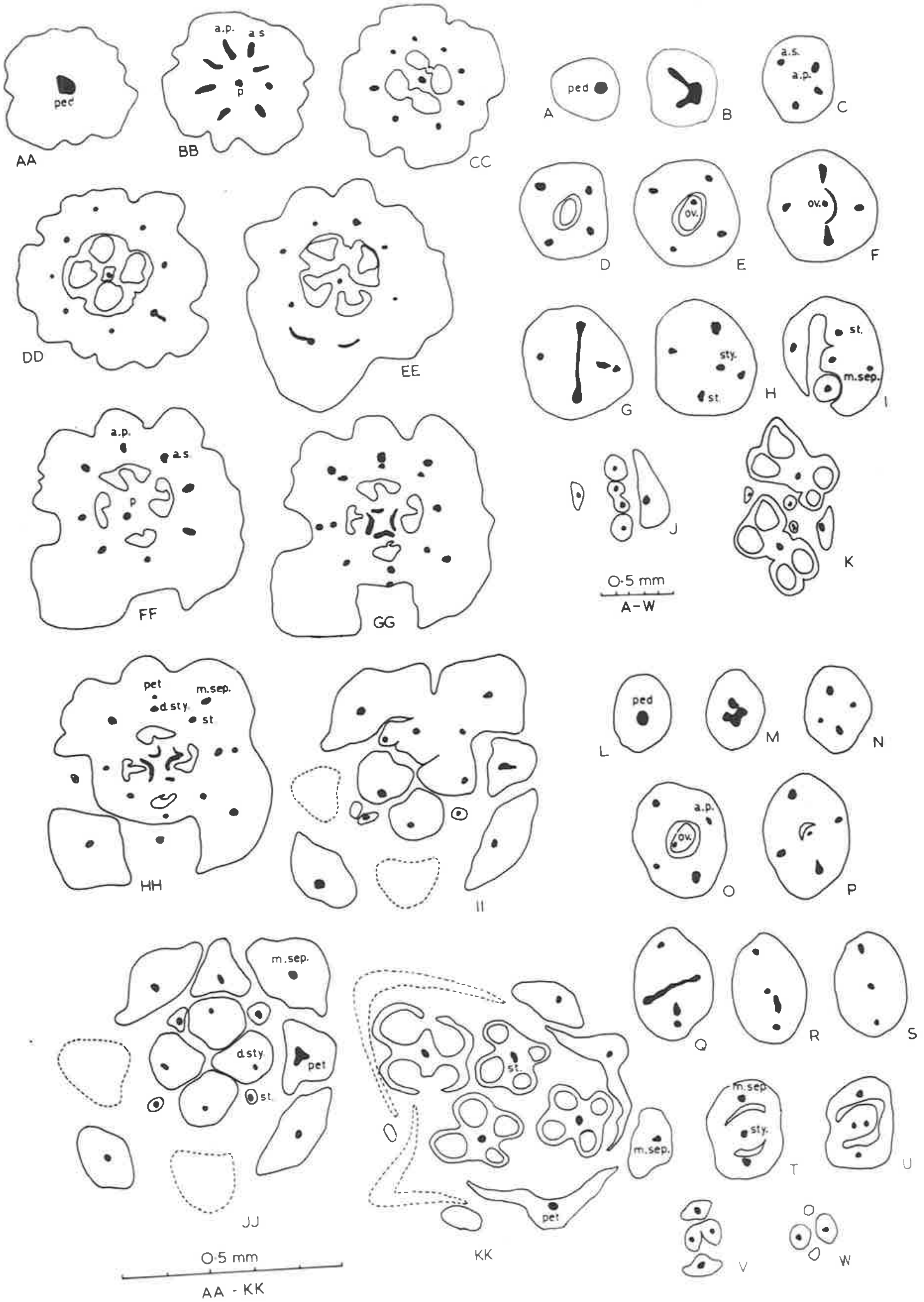
A-W. *Gunnera macrophylla* (from Hoogland 9551)

A-K. male flower

L-W. female flower.

AA-KK. *Laurembergia tetrandra*, male flower. (from Hatschbach 5133)

FIGURE 10



ped
AA
a.p.
a s
p
BB
CC
DD
EE
a.p.
a.s
p
FF
GG
pet
m.sep.
d.sty.
st
HH
II
m.sep.
d.sty.
pet
st
JJ
st.
m.sep.
pet
KK
0·5 mm
AA - KK
ped
A
B
a.s.
a.p.
C
D
ov.
E
ov.
F
G
sty.
st
H
st.
m.sep.
I
J
K
0·5 mm
A - W
ped
L
M
N
a.p.
ov.
O
P
Q
R
S
m.sep.
sty.
T
U
V
W

Figure 11. Transverse sections of flowers showing the arrangement of vascular tissue.

AA-II. Female flower of *Laurembergia tetrandra* (from Hatschbach 5133)

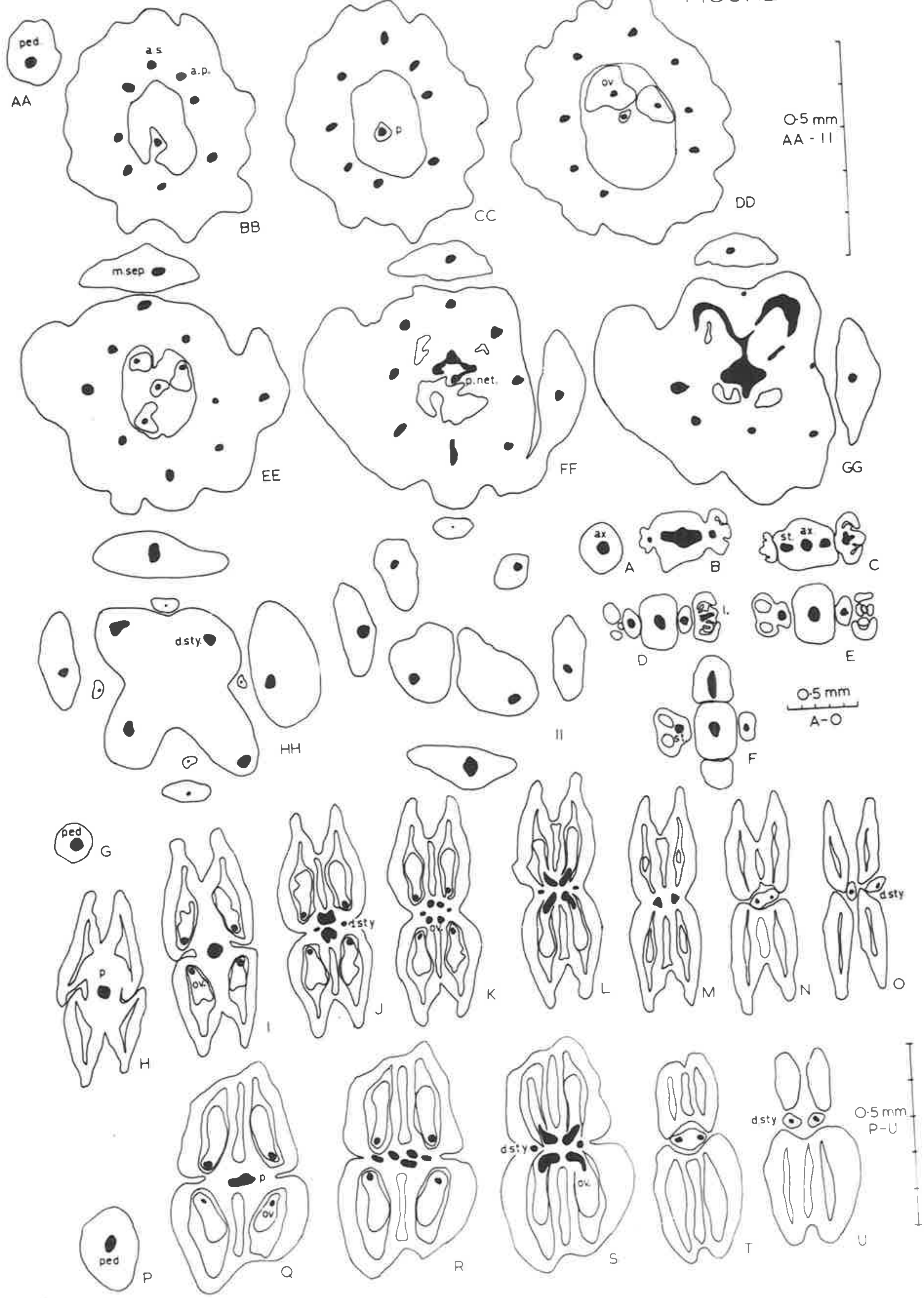
A-O. *Callitriche stagnalis* (from Orchard 2590)

A-F. Portion of axis with male flower.

G-O. Female flower

P-U. Female flower of *Callitriche sonderi* (from Eichler 13798)

FIGURE 11



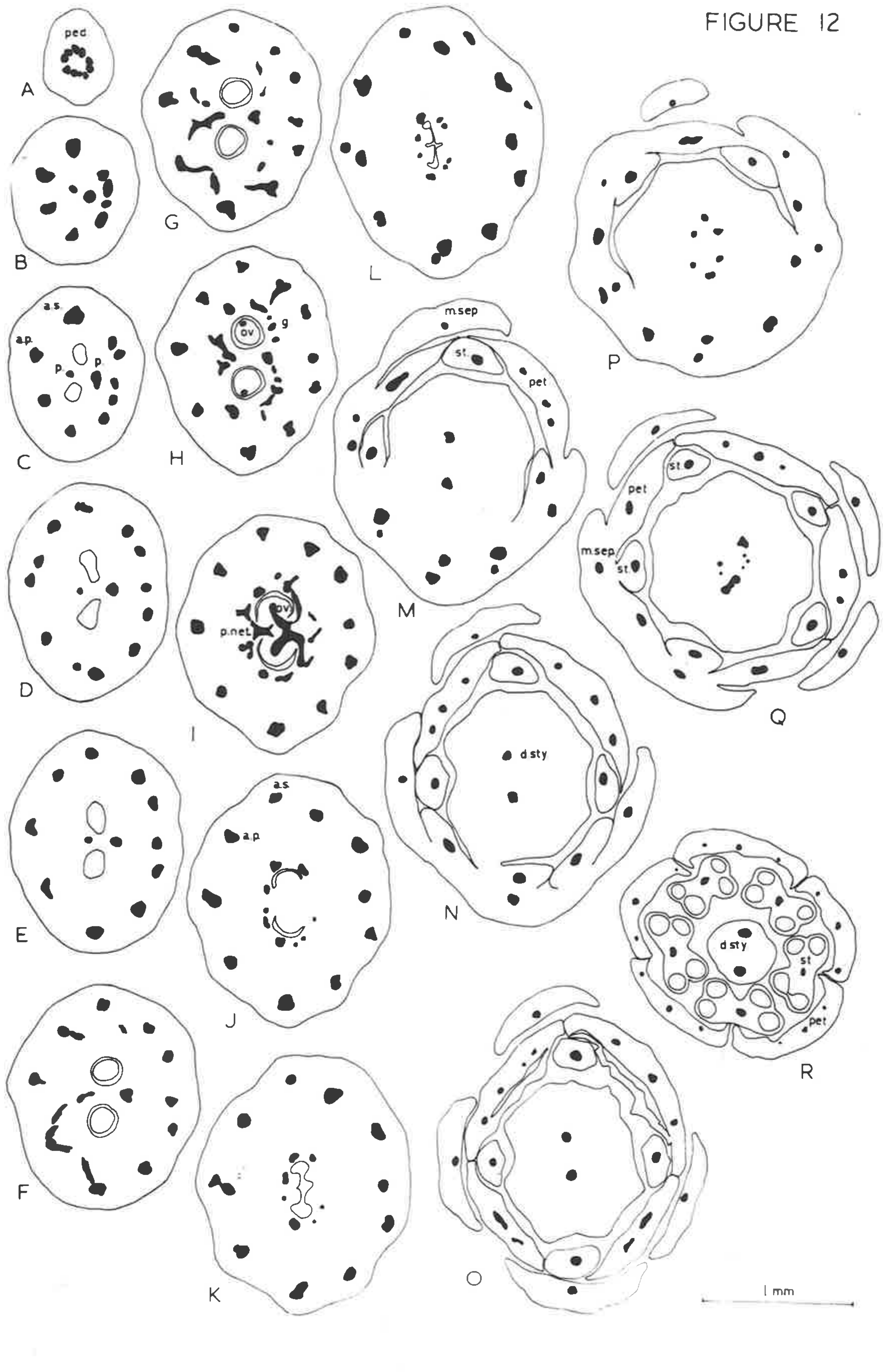
ped
AA
a.s.
a.p.
BB
p
CC
ov
DD
0·5 mm
AA - II
m.sep
EE
p.net.
FF
GG
ax
A
B
st.
ax
C
D
E
d.sty.
HH
II
st.
F
0·5 mm
A-O
ped
G
p
H
ov.
I
d.sty
J
ov.
K
L
M
N
d.sty
O
ped
P
p
ov
Q
R
d.sty
ov.
S
T
d.sty
U
0·5 mm
P-U

Figure 12. Transverse sections of flowers of *Corokia buddleoides*, showing the arrangement of vascular tissue (from Sampson, WELT).

A-O. 4-merous flower.

P-R. 5-merous flower.

FIGURE 12



A
ped
B
C
a.s.
a.p.
p.
p.
D
E
F
G
H
ov
g
I
ov
p.net.
J
a.s.
a.p.
K
L
M
m.sep
st.
pet
N
d.sty
O
P
Q
st.
pet
m.sep
st.
R
d.sty
st.
pet
1 mm

Figure 13. Transverse sections of a flower of *Trapa bicornis* (from Tun-Yee, AD).

A-Q. Sections of the flower showing the arrangement of vascular tissue.

A-M,Q. Complete section of the flower

N-P. Ovary and style.

R-S. Sections of the anther (Endothecial cells stippled in S).

T. Hair from ovary wall.

FIGURE 13

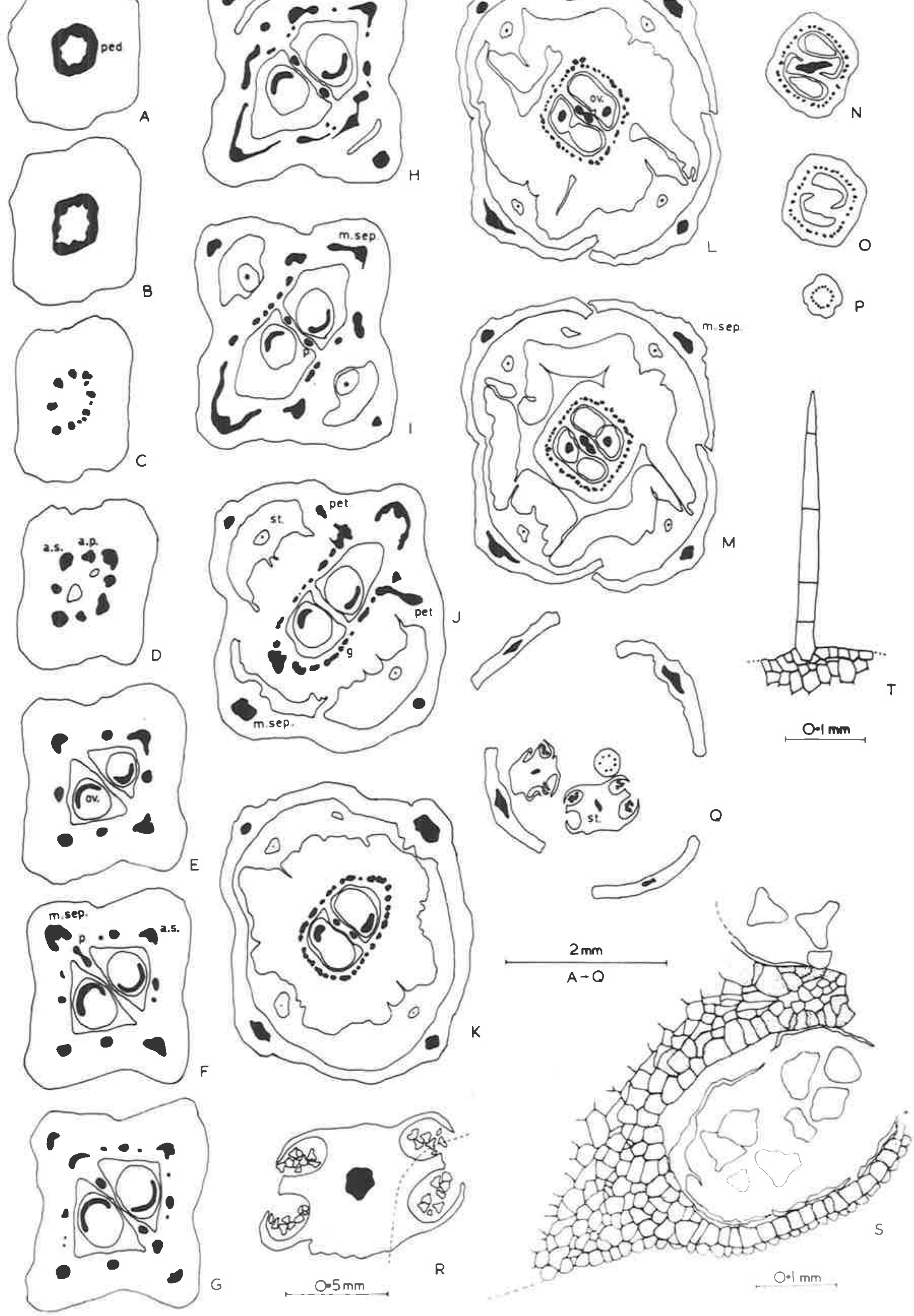
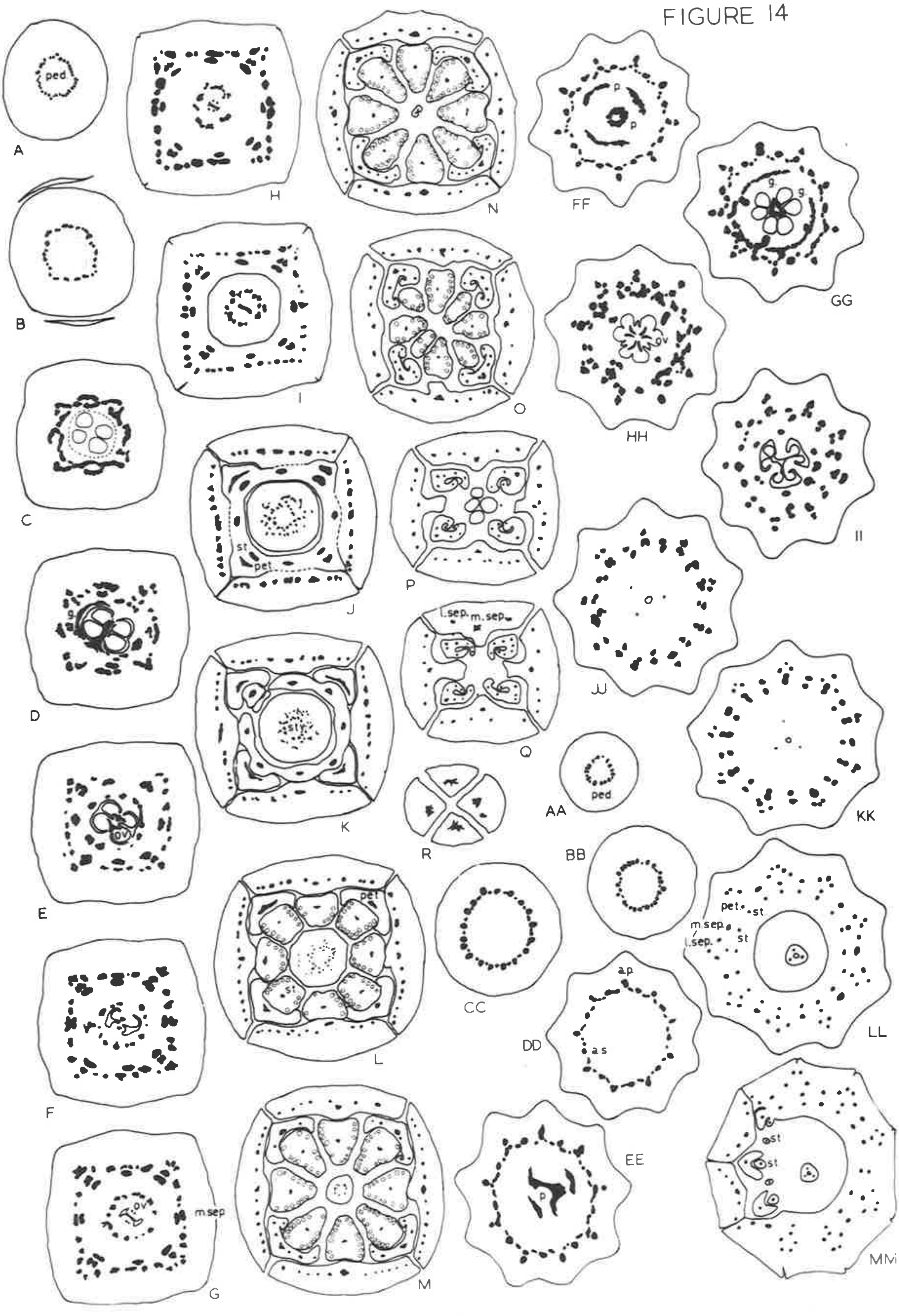

ped
A
B
C
a.s.
a.p.
D
ov.
E
m.sep.
p
a.s.
F
G
H
m.sep.
I
st.
pet
pet
g
m.sep.
J
K
ov.
L
m.sep.
M
N
O
P
st.
Q
2 mm
A – Q
R
0·5 mm
S
0·1 mm
T
0·1 mm

Figure 14. Transverse sections of flowers of *Rhizophora mucronata* and *Bruguiera exaristata*, showing the arrangement of vascular tissue.

A-R. *Rhizophora mucronata* (from Darbyshire 620).

AA-MM. *Bruguiera exaristata* (from Schodde 2735).

FIGURE 14



ped
A
H
N
FF
p
p
GG
g
g
B
I
O
HH
ov
C
J
st
pet
P
II
D
g
K
st
Q
l.sep.
m.sep.
JJ
E
ov
R
AA
ped
KK
L
pet
st
CC
BB
LL
pet
st
m sep
l.sep.
st
F
DD
a.p
a.s
G
ov
m.sep
M
EE
p
MM
st
st

Figure 15. Reconstruction from serial sections of the vascular structure of flowers of Haloragaceae.

A. *Haloragis brownii* (from Orchard 2018).

B. *Haloragis trigonocarpa,* top of the ovary. (from Orchard 1263).

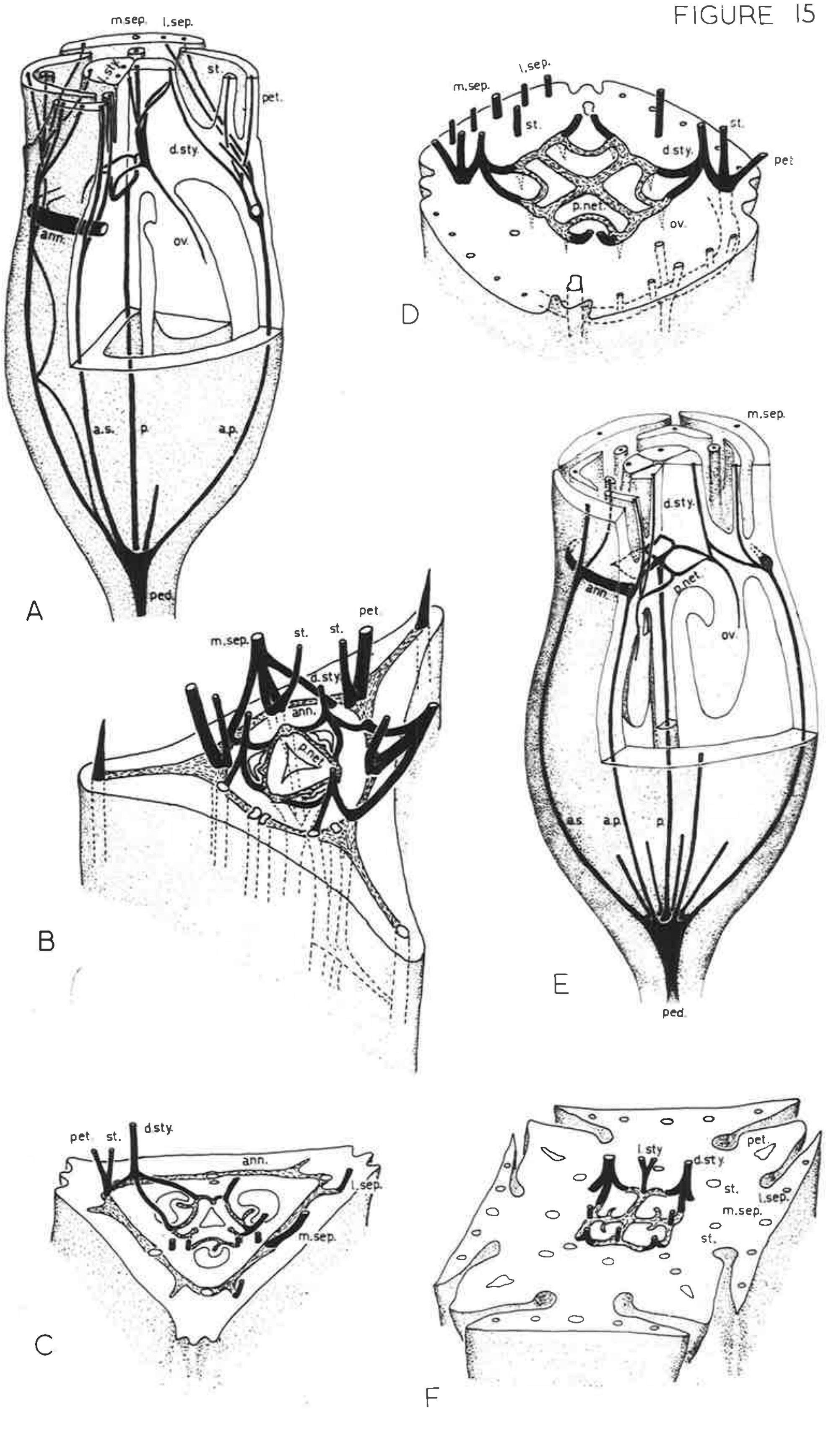
C. *Haloragis gossei,* top of the ovary. (from Nelson 1738).

D. *Gonocarpus pycnostachyus,* top of the ovary. (from Orchard 1079).

E. *Gonocarpus nodulosus.* (from Orchard 1080).

F. *Glischrocaryon flavescens,* top of the ovary. (from Orchard 1799).

FIGURE 15



A
m.sep.
l.sep.
l.sty.
st.
pet.
d.sty.
ann.
ov.
a.s.
p.
a.p.
ped.
B
m.sep.
st.
st.
pet.
d.sty.
ann.
p.net.
C
pet
st.
d.sty.
ann.
l.sep.
m.sep.
D
m.sep.
l.sep.
st.
d.sty.
st.
pet
p.net.
ov.
E
m.sep.
d.sty.
ann.
p.net.
ov.
a.s.
a.p.
p.
ped.
F
l.sty
d.sty
pet.
st.
l.sep.
m.sep.
st.

Figure 16. **Reconstruction from serial sections of the vascular structure of flowers of Haloragaceae and Gunneraceae.**

A. *Haloragodendron racemosum*, base of stylar column. (from Orchard 1285).

B. *Haloragodendron baeuerlenii*, top of ovary. (from A.C. Beauglehole 33376).

C. *Proserpinaca palustris* var. *crebra*, top of ovary. (from Cook & Griggs 429).

D. *Gunnera macrophylla*, male flower. (from Hoogland 9551).

E. *Gunnera macrophylla*, female flower. (from Hoogland 9551).

FIGURE 16

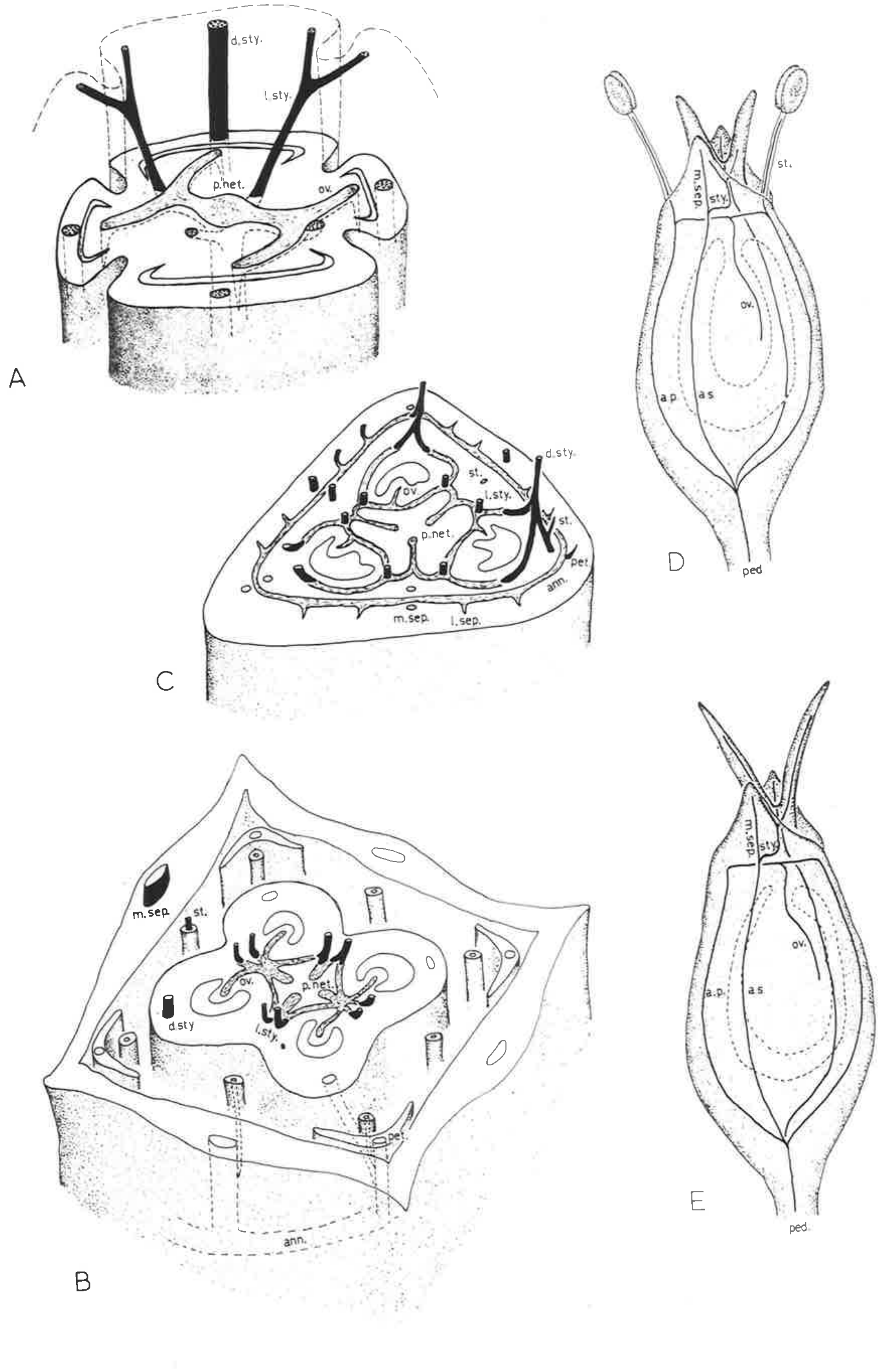
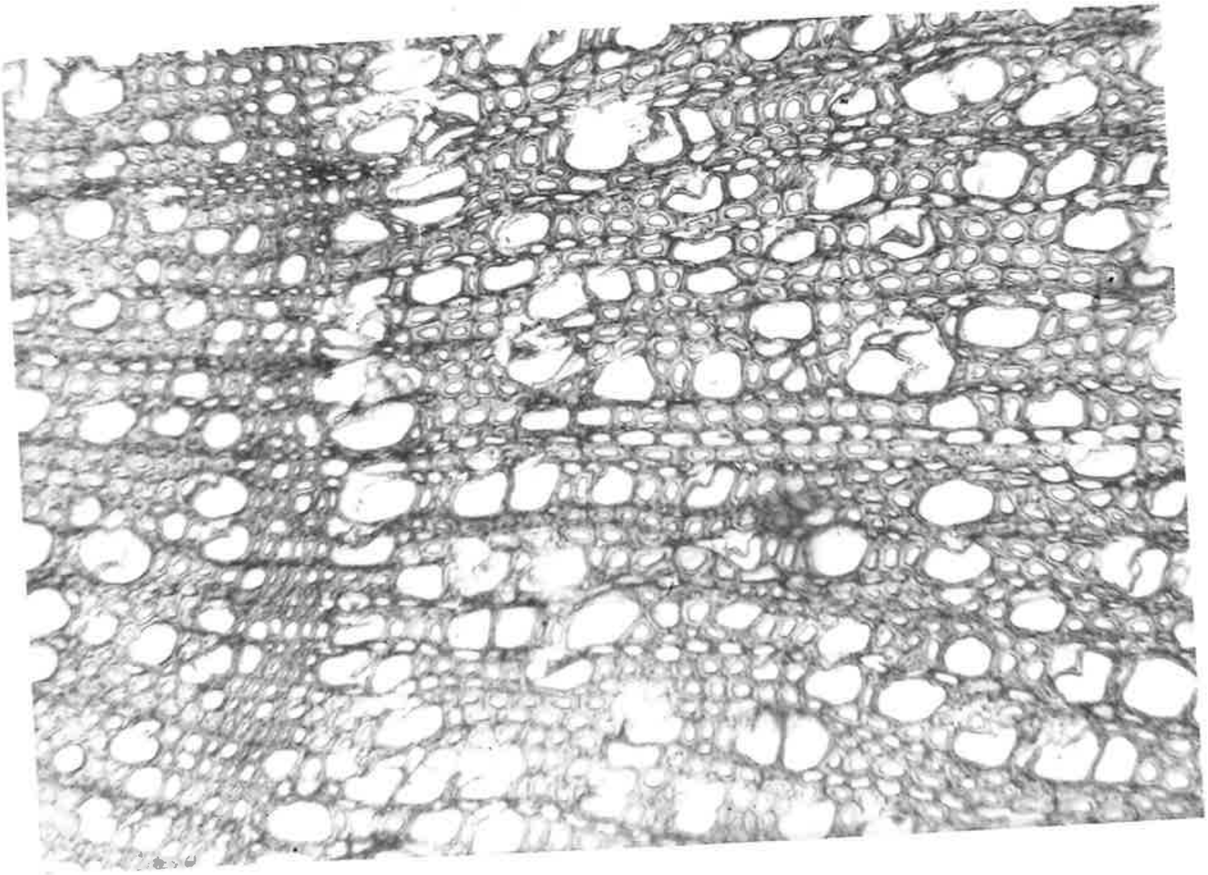

A
d.sty.
l.sty.
p.net.
ov.
B
m.sep.
st.
ov.
p.net.
d.sty
l.sty.
pet.
ann.
C
d.sty.
st.
ov.
l.sty.
p.net.
st.
pet.
ann.
m.sep.
l.sep.
D
st.
m.sep.
sty.
ov.
a.p.
a.s.
ped
E
m.sep.
sty.
ov.
a.p.
a.s.
ped.

PLATE 1.

Transverse section of the stem of *Haloragis uncatipila* (X 200). (from Orchard 900).

Transverse section of the root of *Haloragis uncatipila* (X 200). (from Orchard 900).



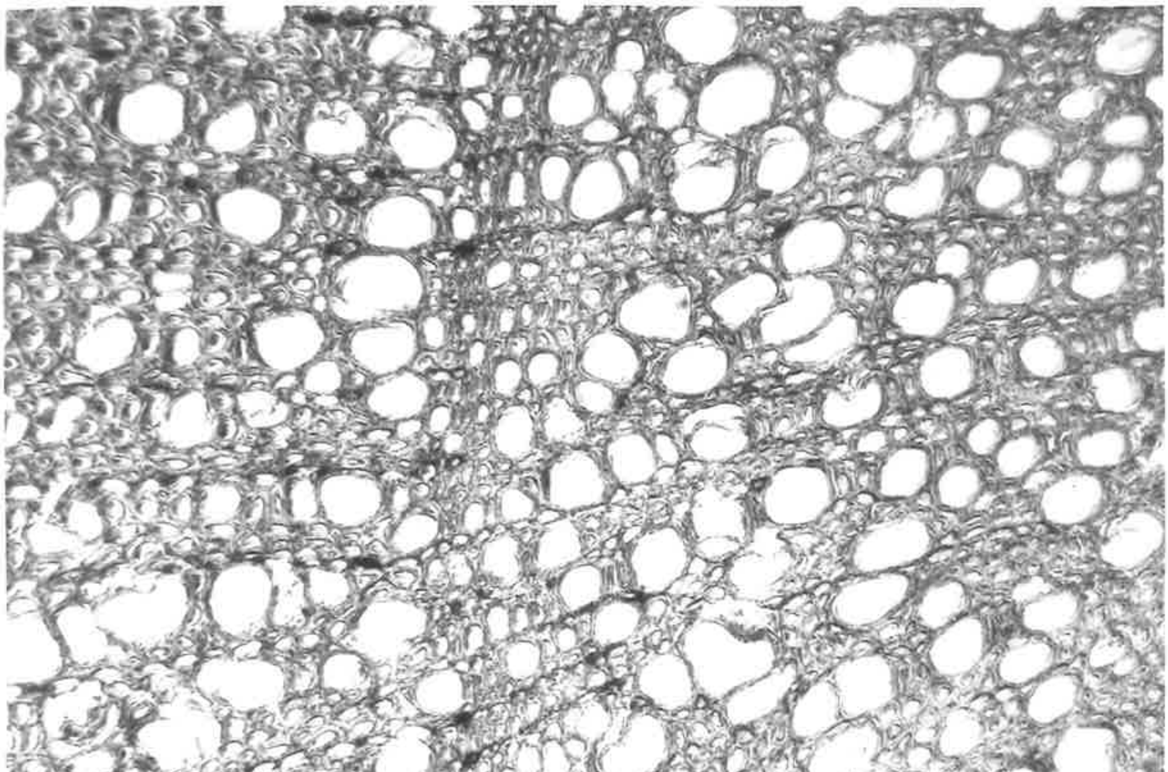
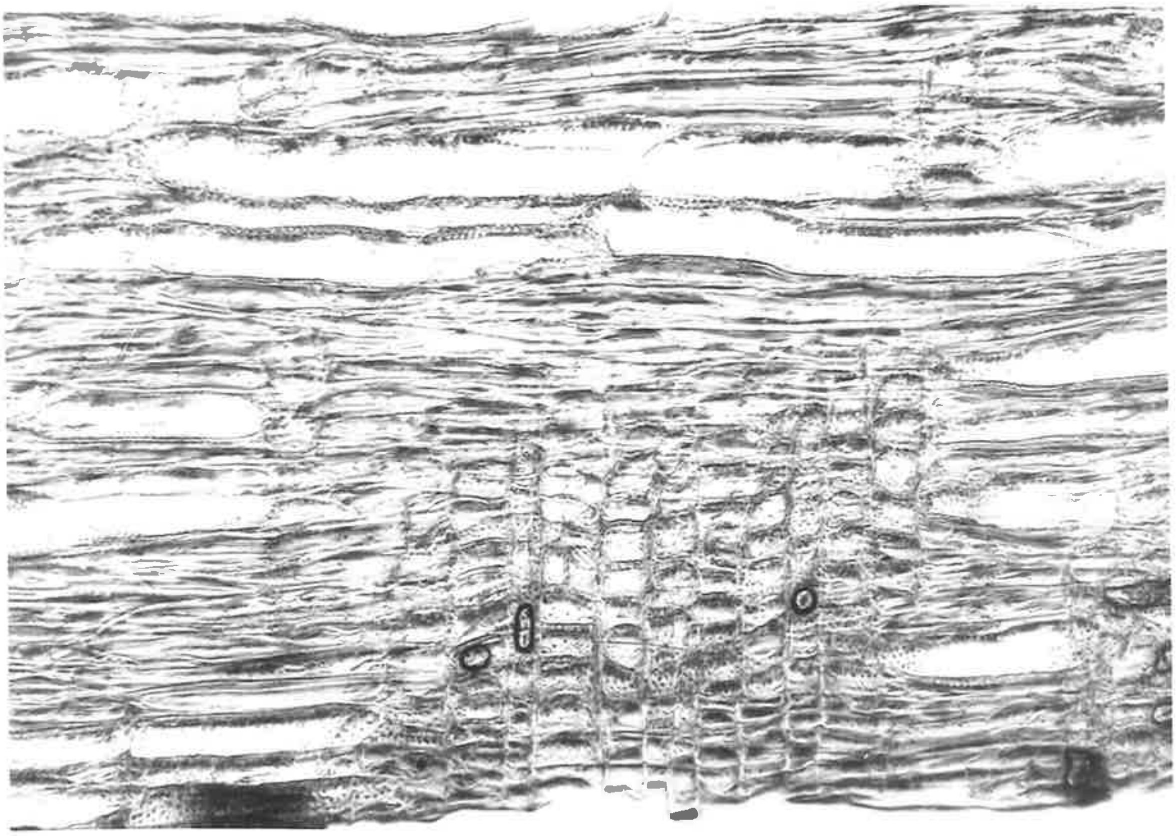


PLATE 2.

Radial longitudinal section of the stem of *Haloragis uncatipila* (X 200). (from Orchard 900).

Tangential longitudinal section of the stem of *Haloragis uncatipila* (X 200). (from Orchard 900).



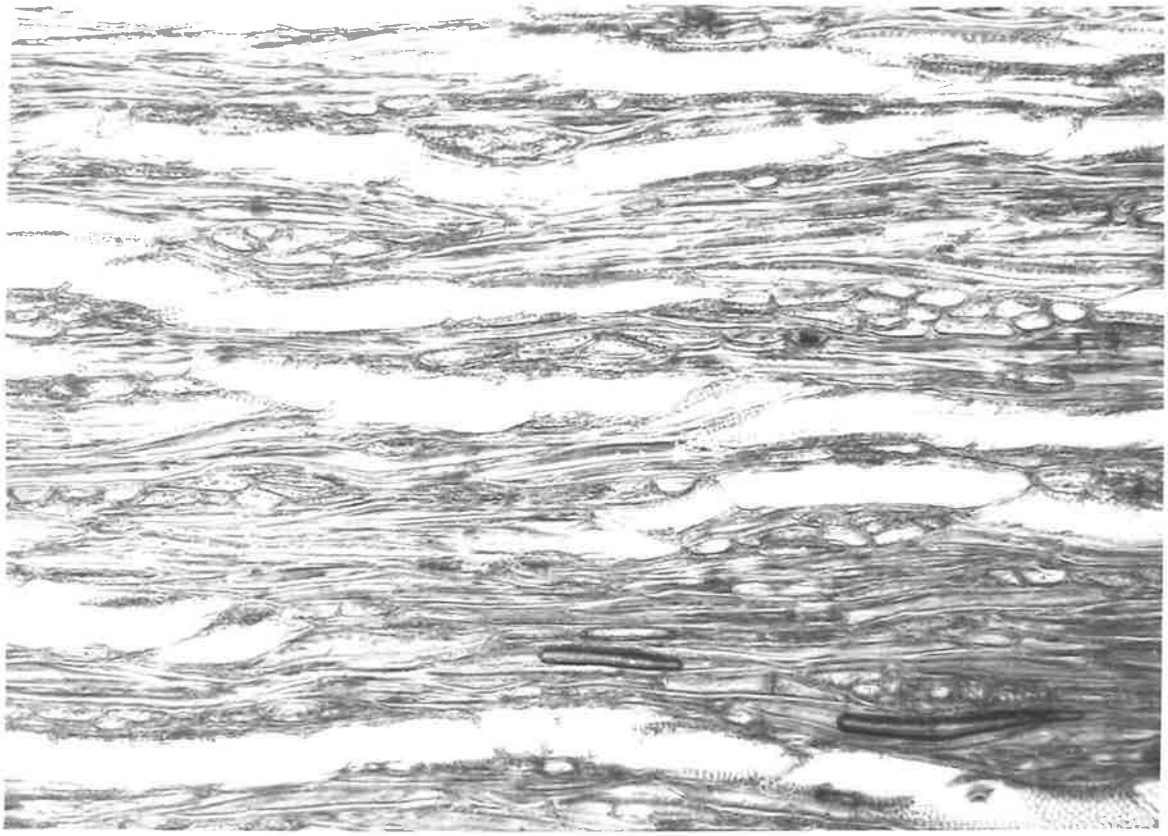
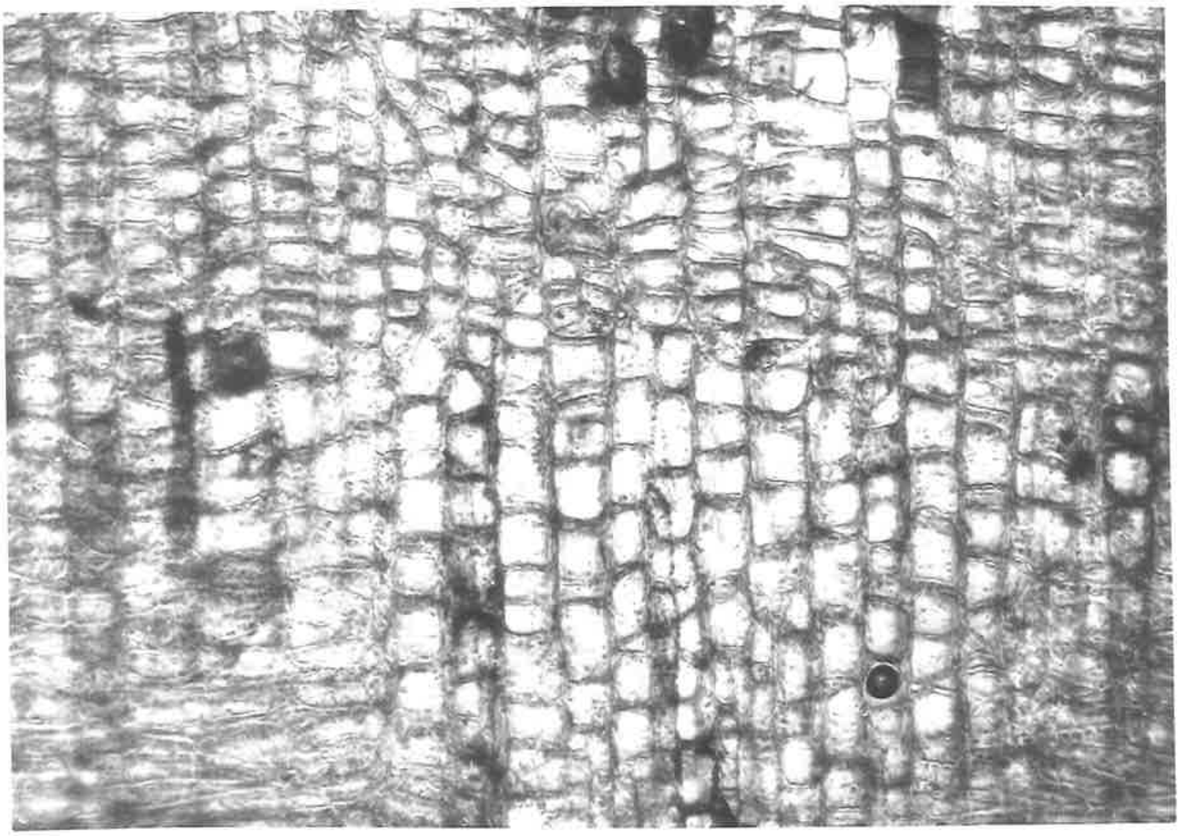


PLATE 3.

Radial longitudinal section of the root of *Haloragis uncatipila* (X 200) (from Orchard 900).

Tangential longitudinal section of the root of *Haloragis uncatipila* (X 200). (from Orchard 900).



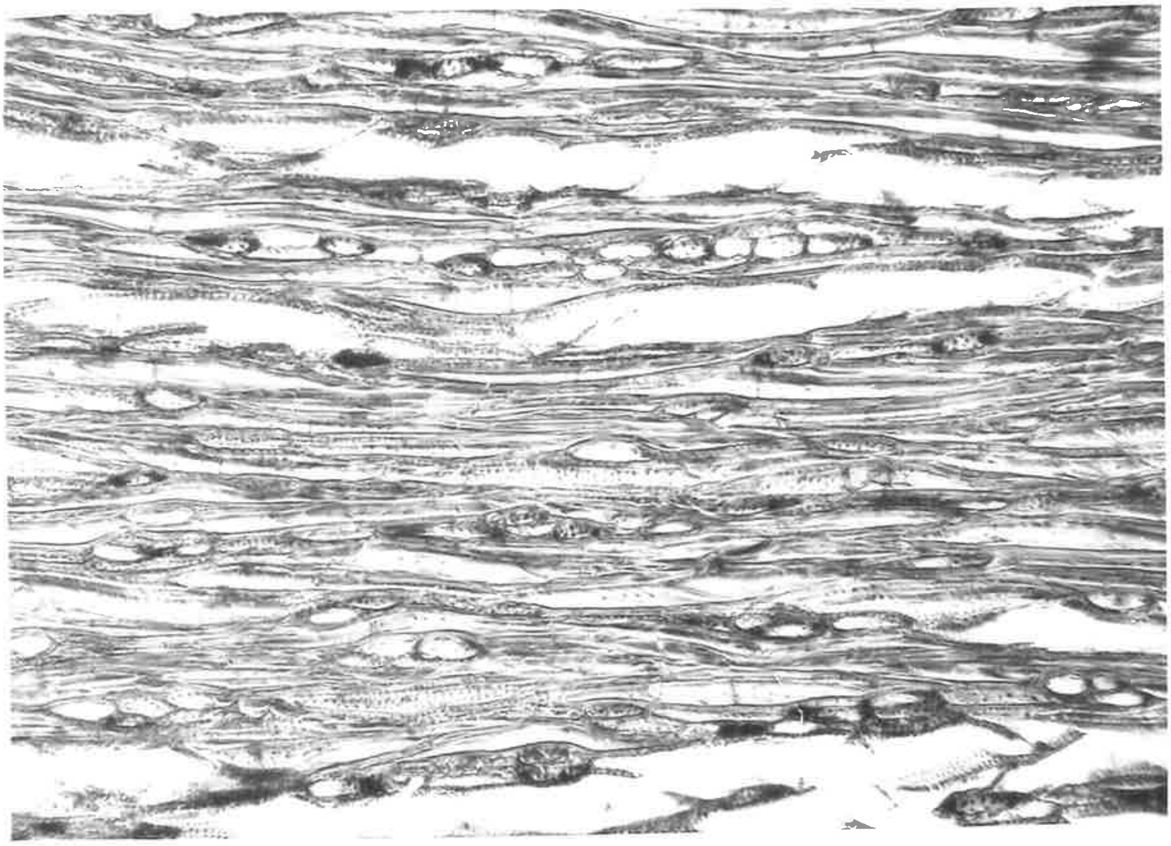
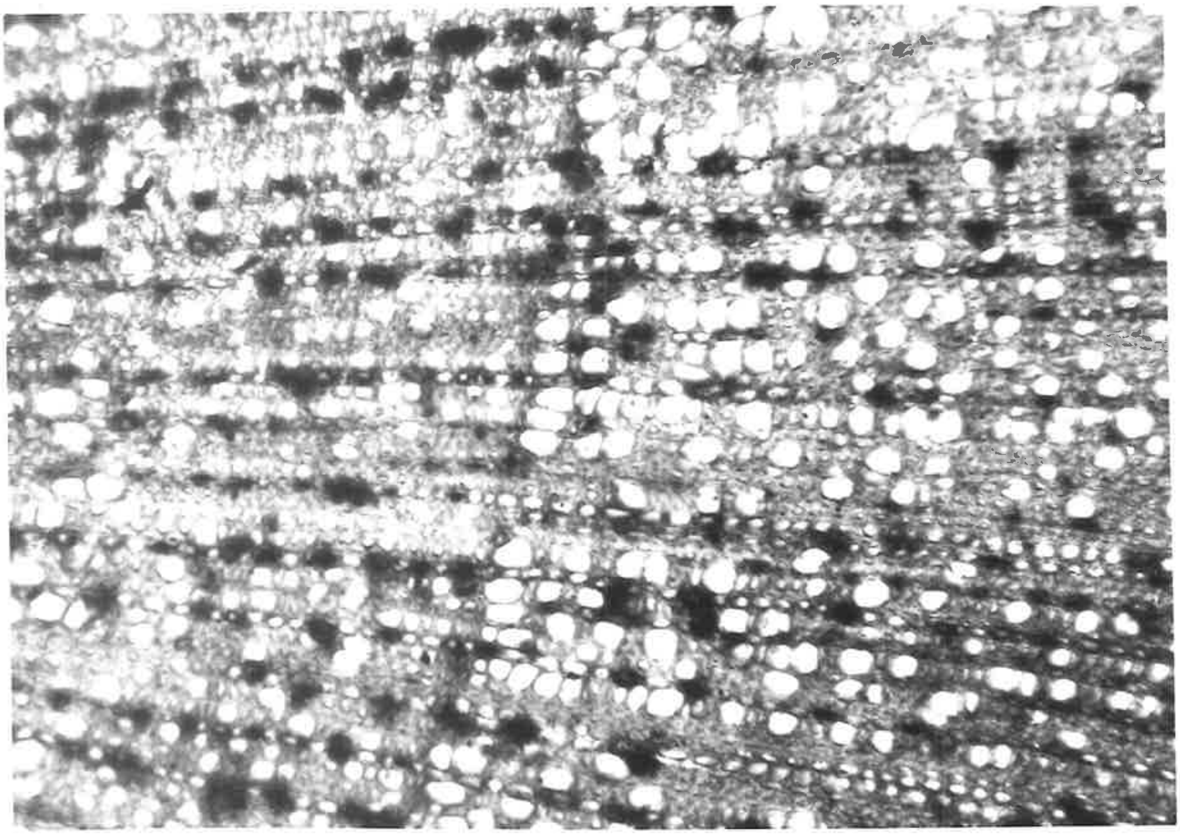


PLATE 4.

Transverse section of the stem of *Haloragodendron monospermum* (X 200). (from Orchard 2389).

Transverse section of the root of *Haloragodendron monospermum* (X 200). (from Orchard 2391).



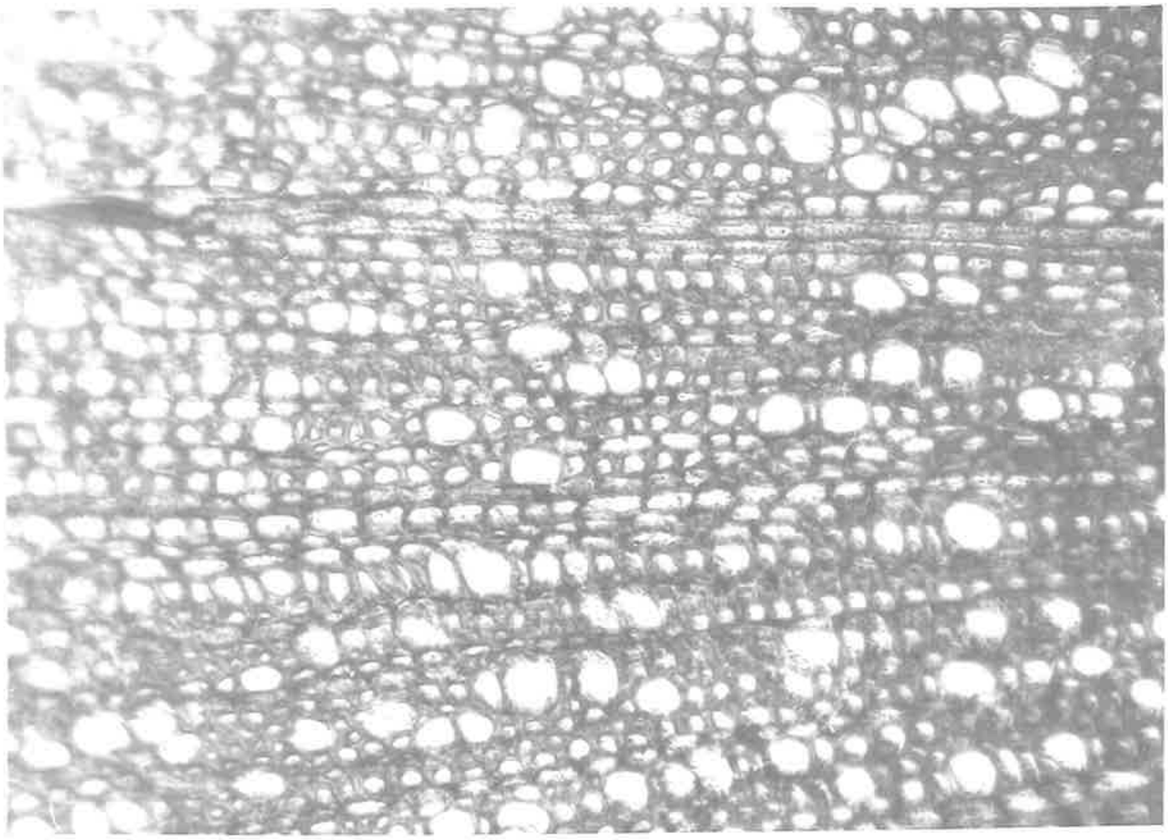
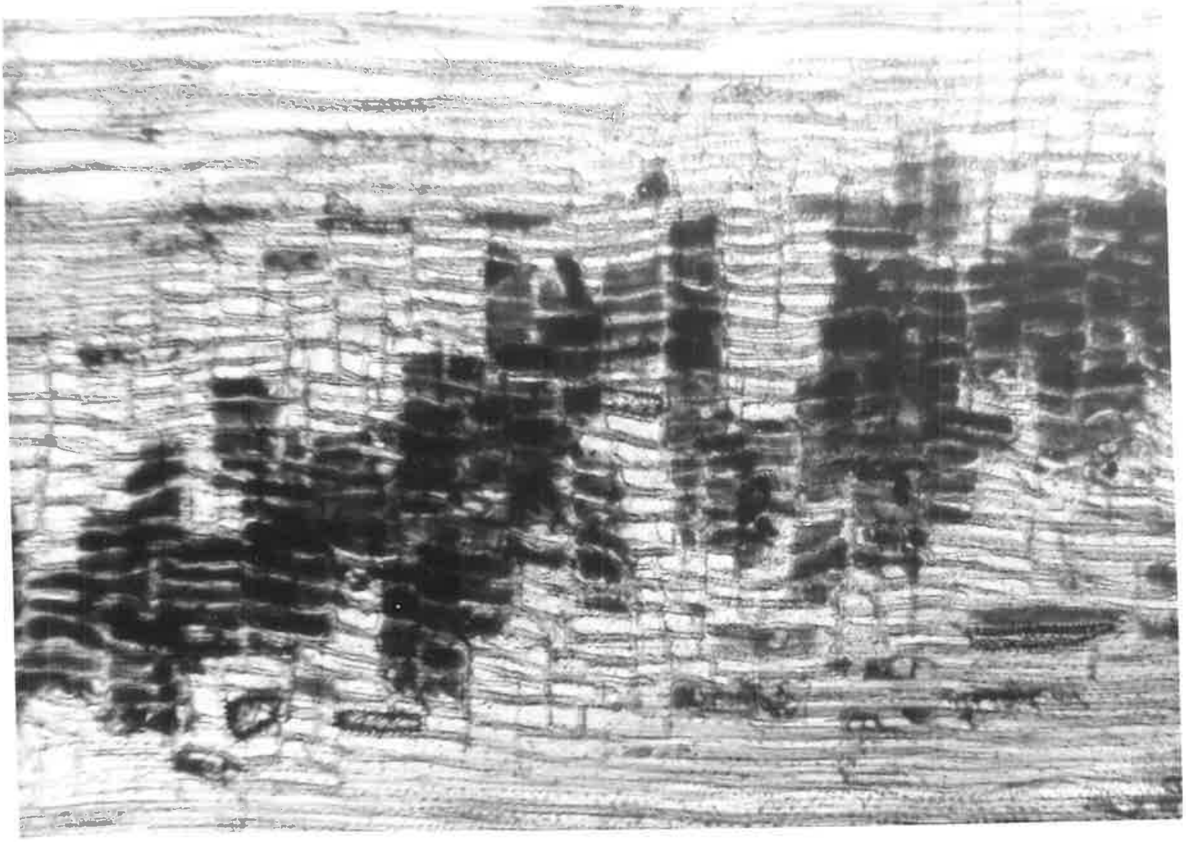


PLATE 5.

Radial longitudinal section of the stem of *Haloragodendron monospermum* (X200). (from Orchard 2389)

Tangential longitudinal section of the stem of *Haloragodendron monospermum* (X200). (from Orchard 2389)



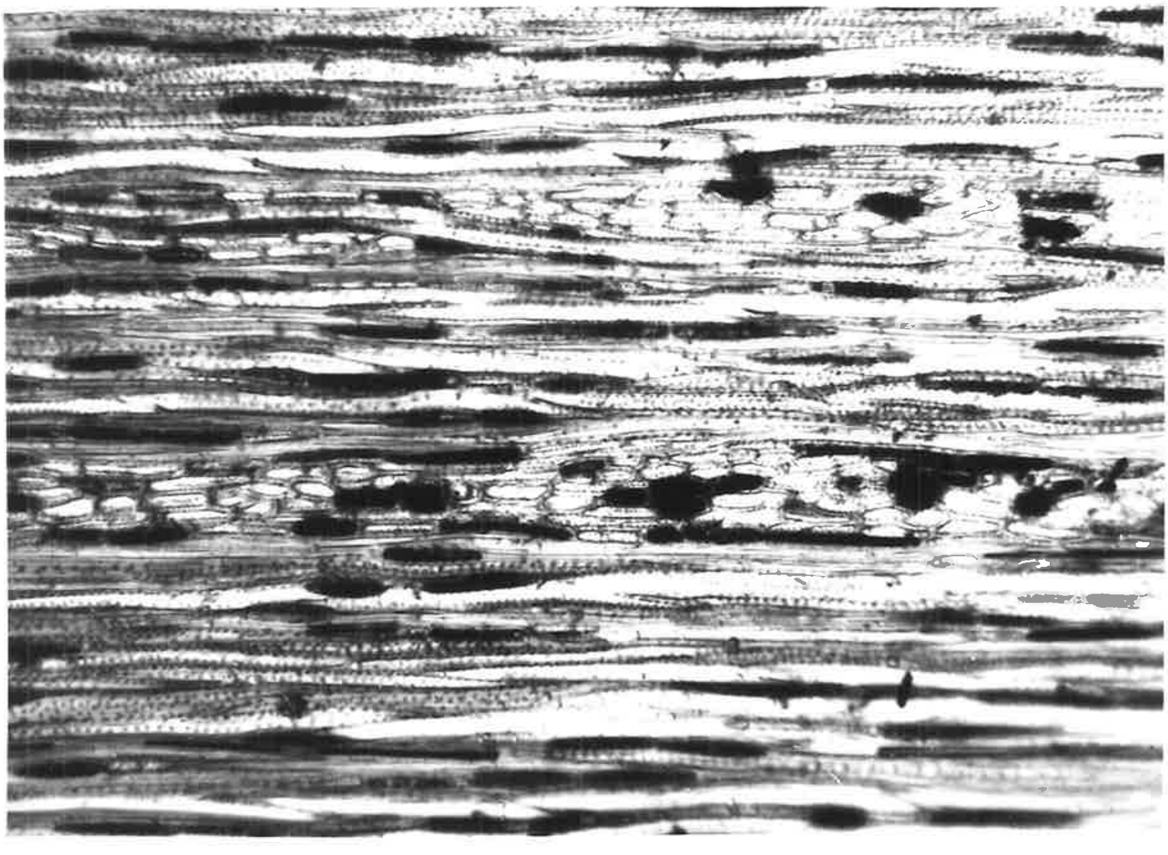


PLATE 6.

Radial longitudinal section of the root of *Haloragodendron monospermum* (X200).
(from Orchard 2391)

Tangential longitudinal section of the root of *Haloragodendron monospermum* (X200).
(from Orchard 2391).

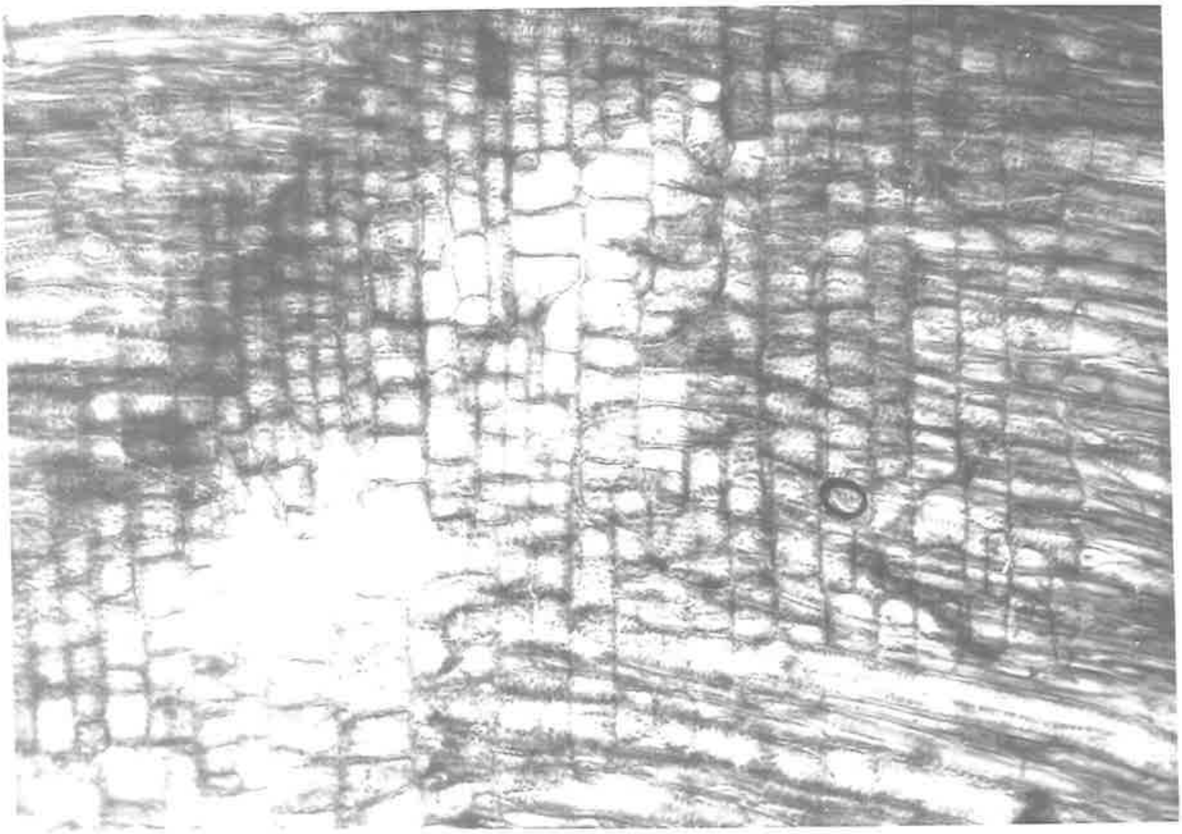
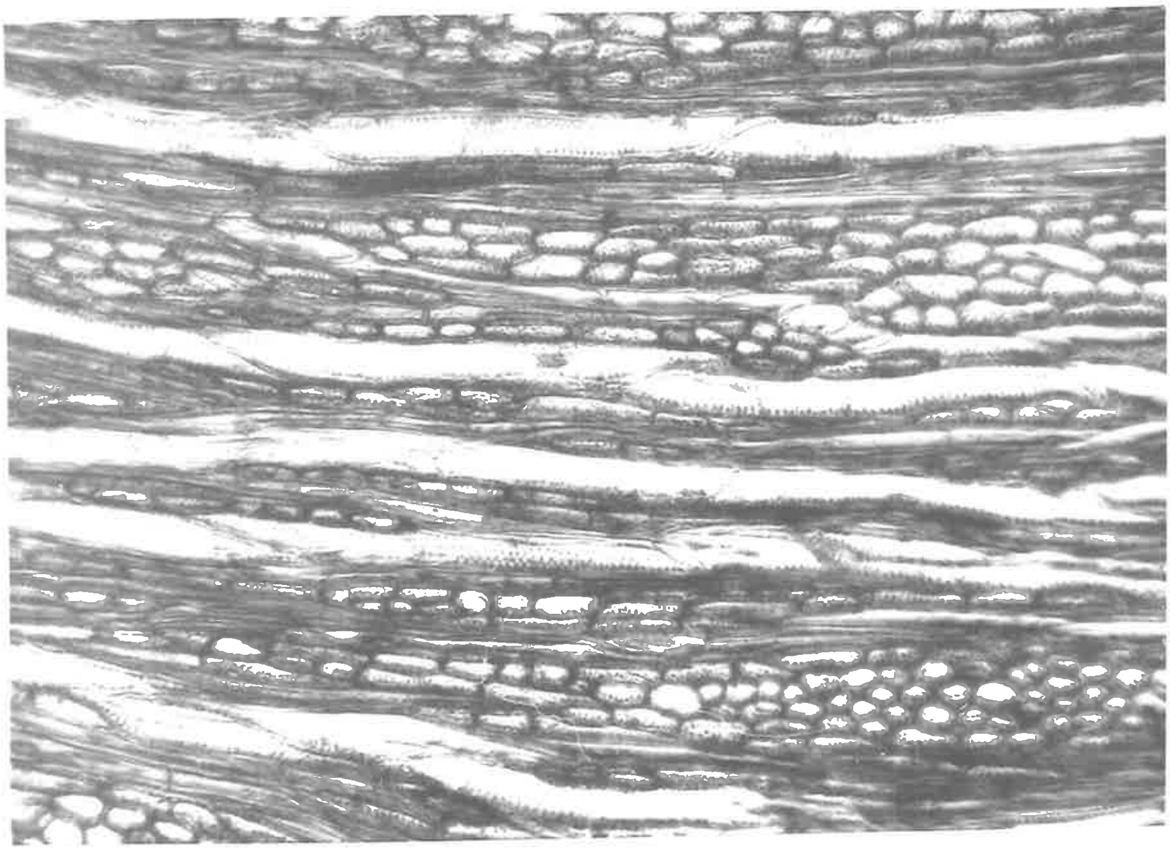
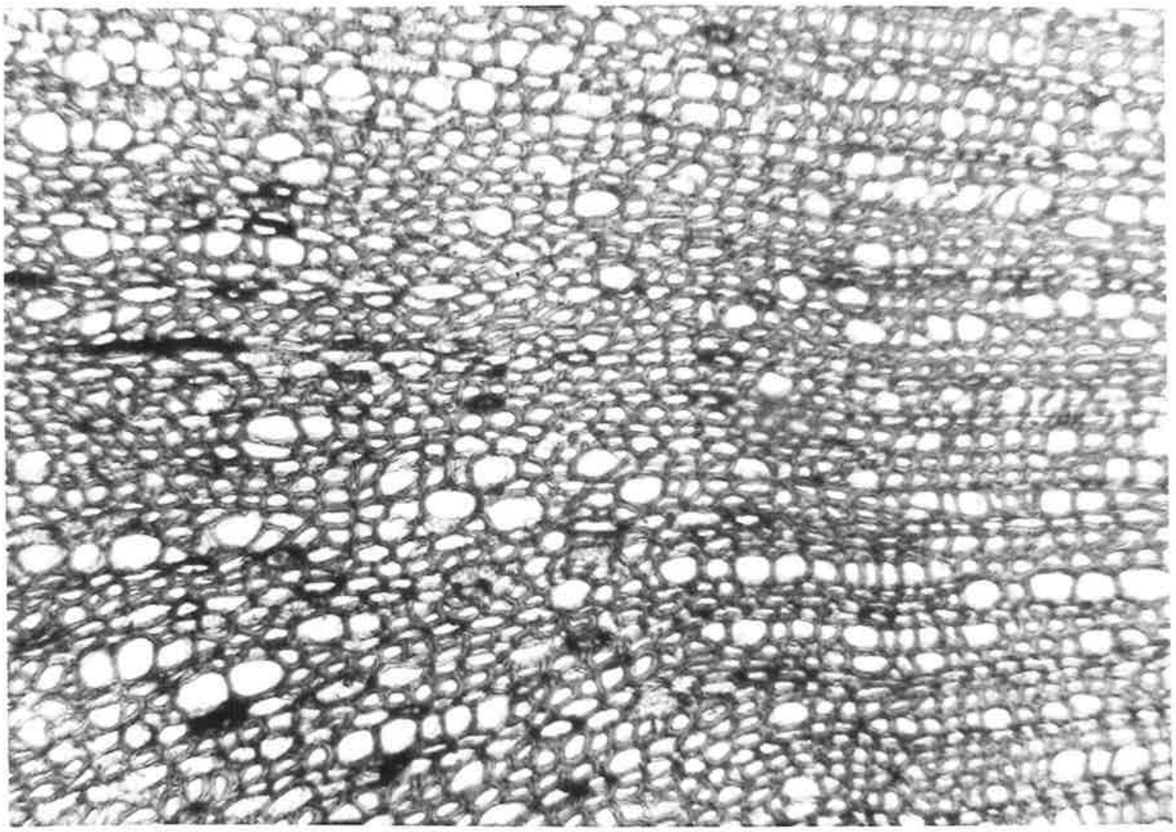



PLATE 7.

Transverse section of the stem of *Glischrocaryon flavescens* (X200). (from Orchard 1227).

Transverse section of the root of *Glischrocaryon flavescens* (X200). (from Orchard 1227).



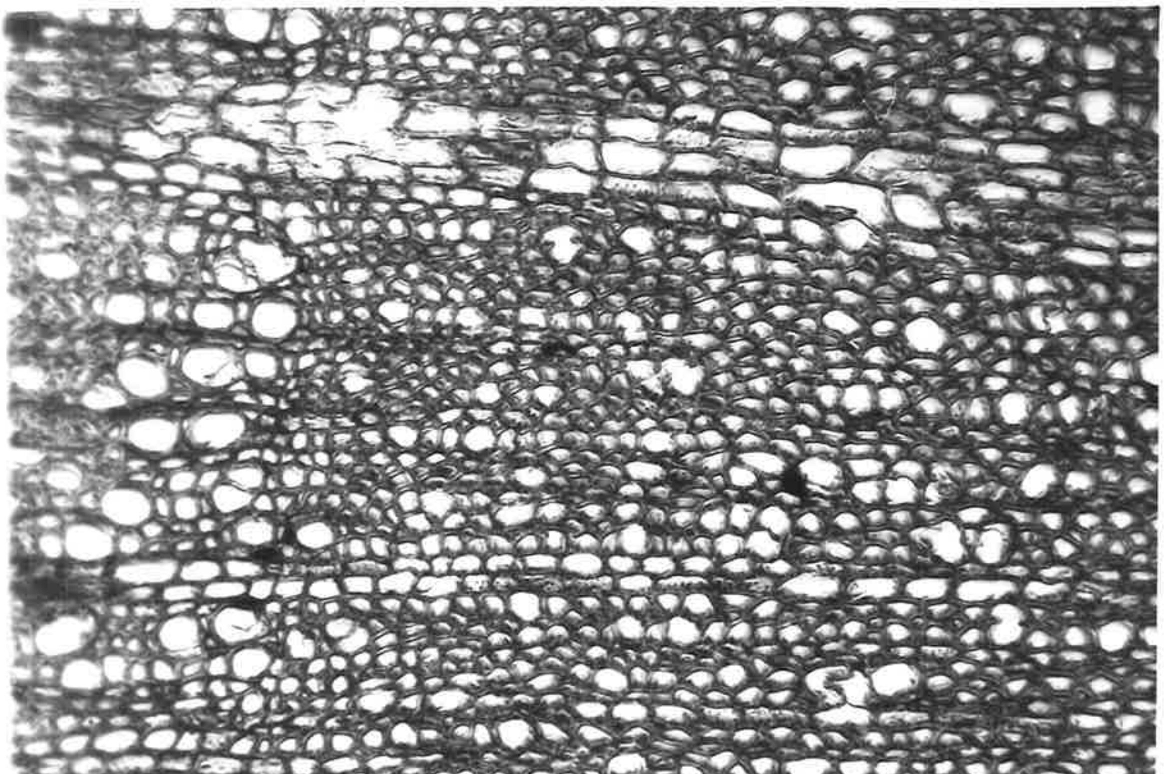
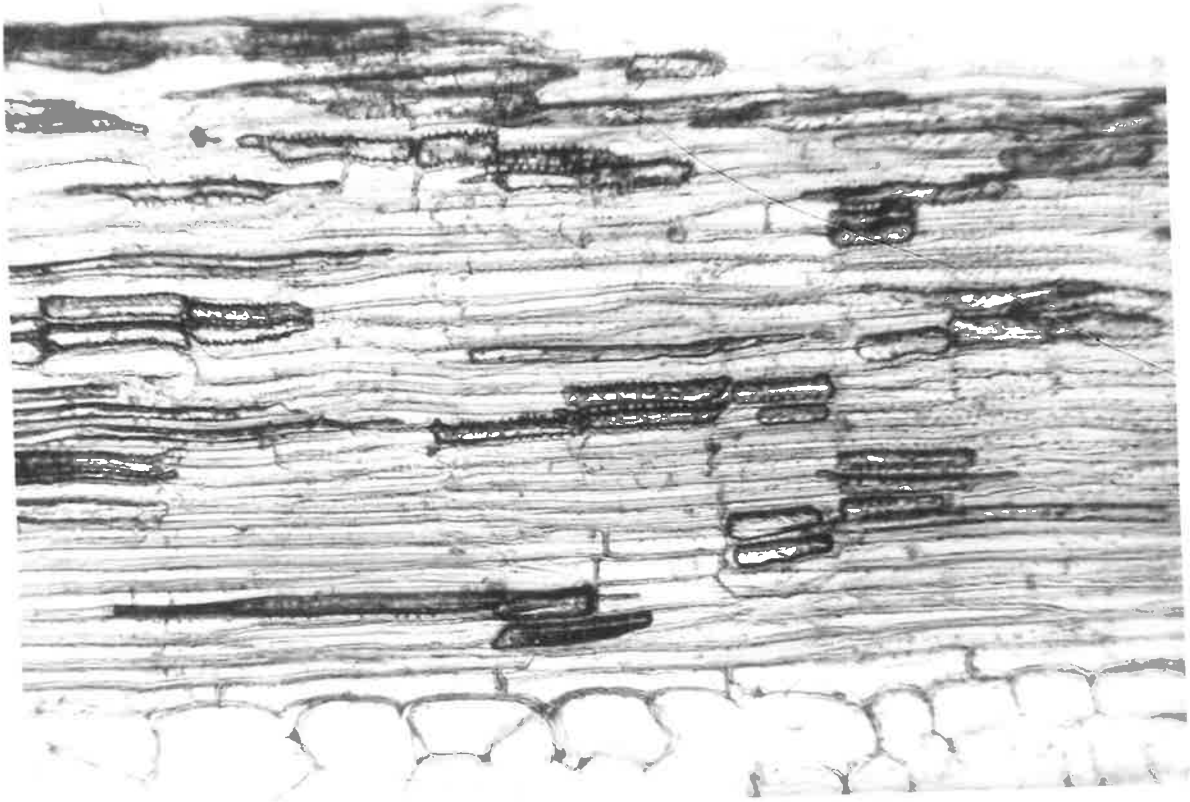


PLATE 8.

Radial longitudinal section of the stem of *Glischrocaryon flavescens* (X200). (from Orchard 1227).

Tangential longitudinal section of the stem of *Glischrocaryon flavescens* (X200). (from Orchard 1227).



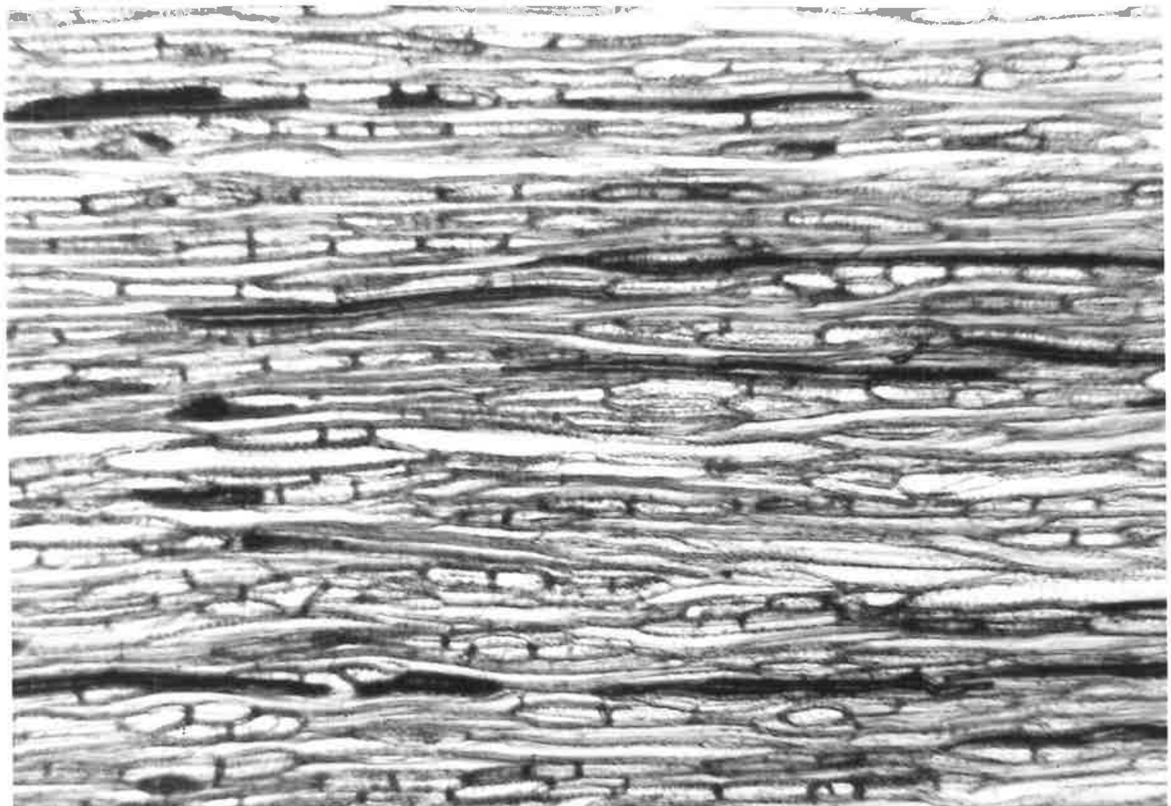


PLATE 9.

Radial longitudinal section of the root of *Glischrocaryon flavescens* (X200). (from Orchard 1227).

Tangential longitudinal section of the root of *Glischrocaryon flavescens* (X200). (from Orchard 1227).

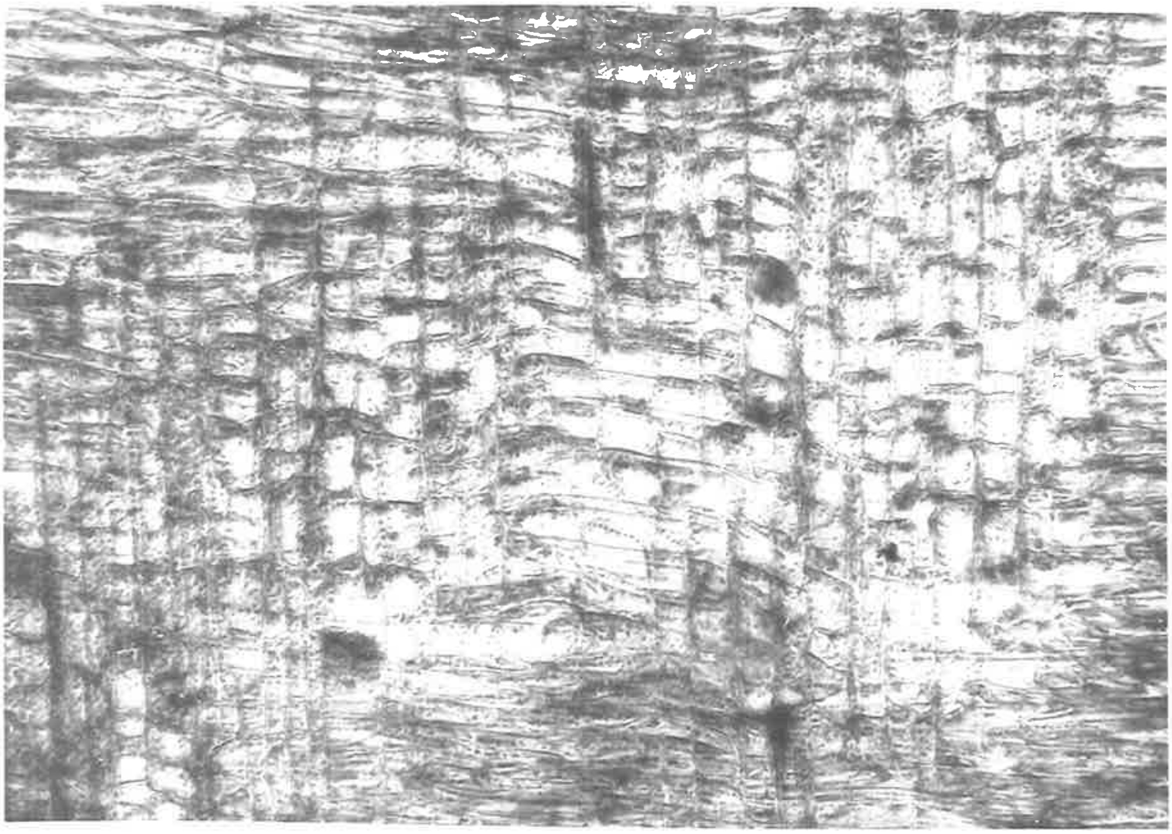
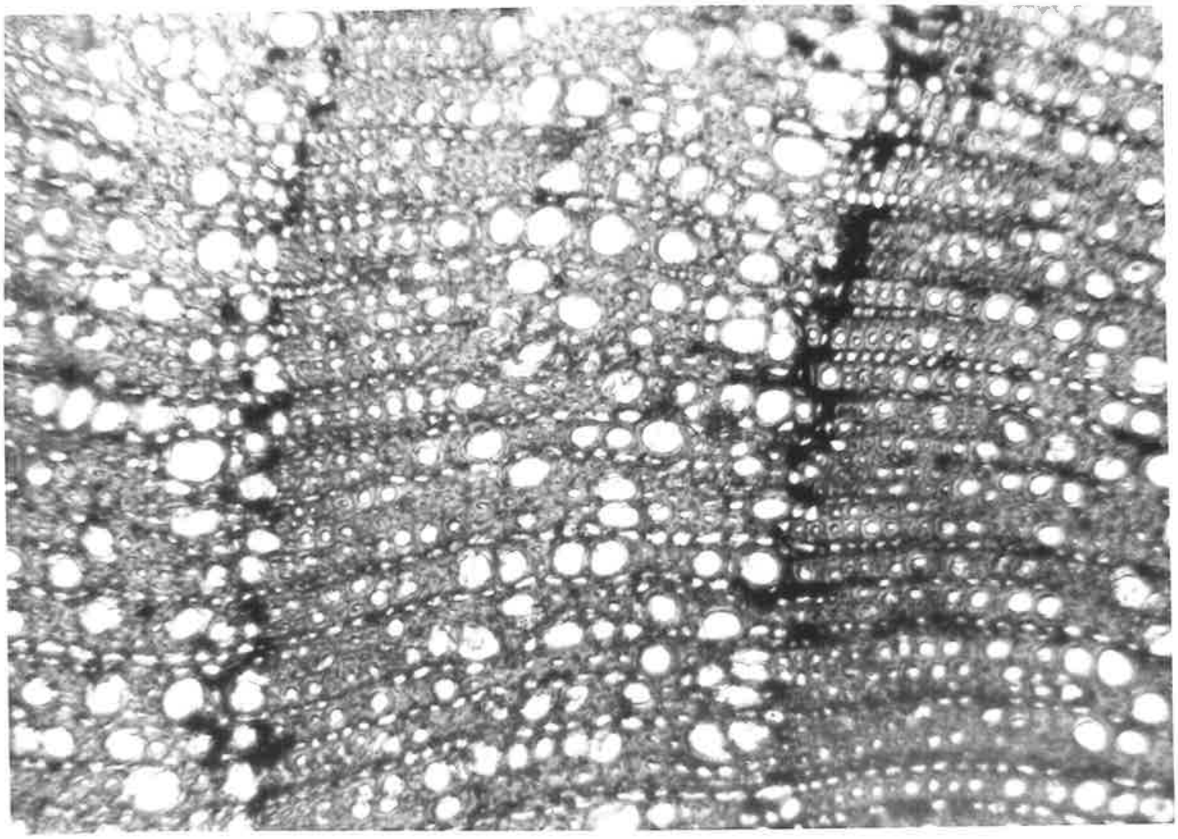


PLATE 10.

Transverse section of the stem of *Gonocarpus pycnostachyus* (X200). (from Orchard 1079).

Transverse section of the root of *Gonocarpus pycnostachyus* (X200). (from Orchard 1079).



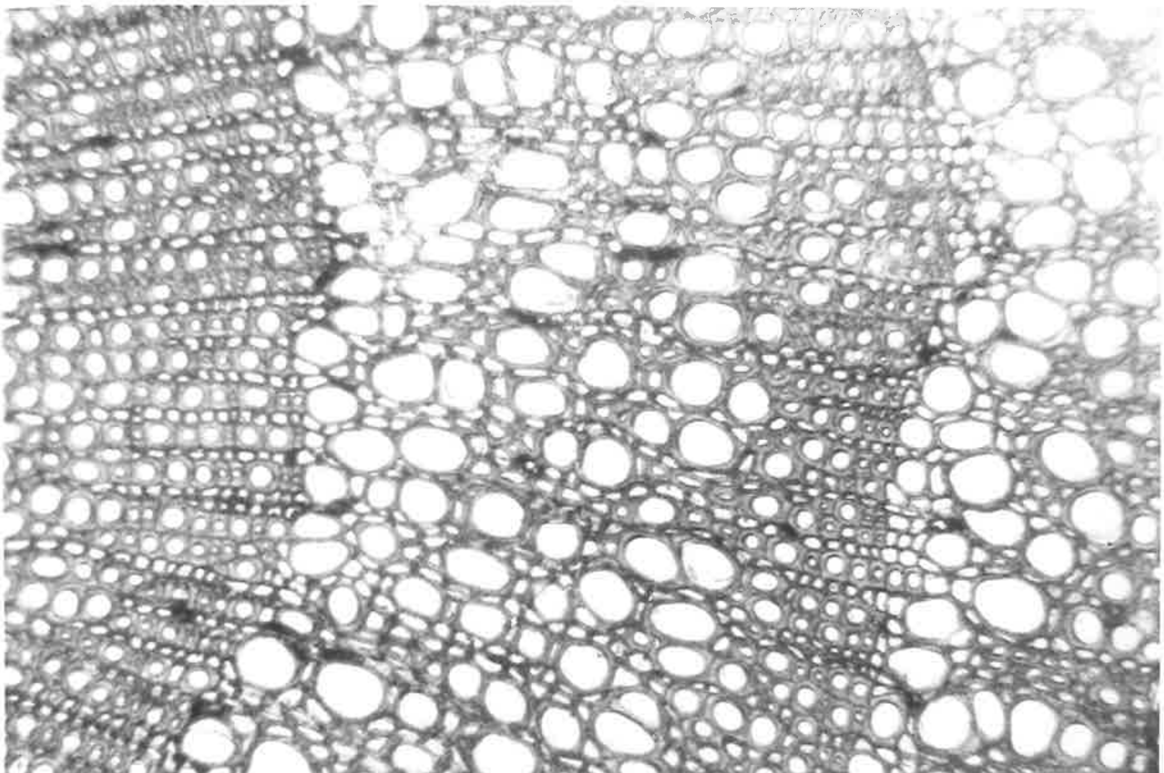
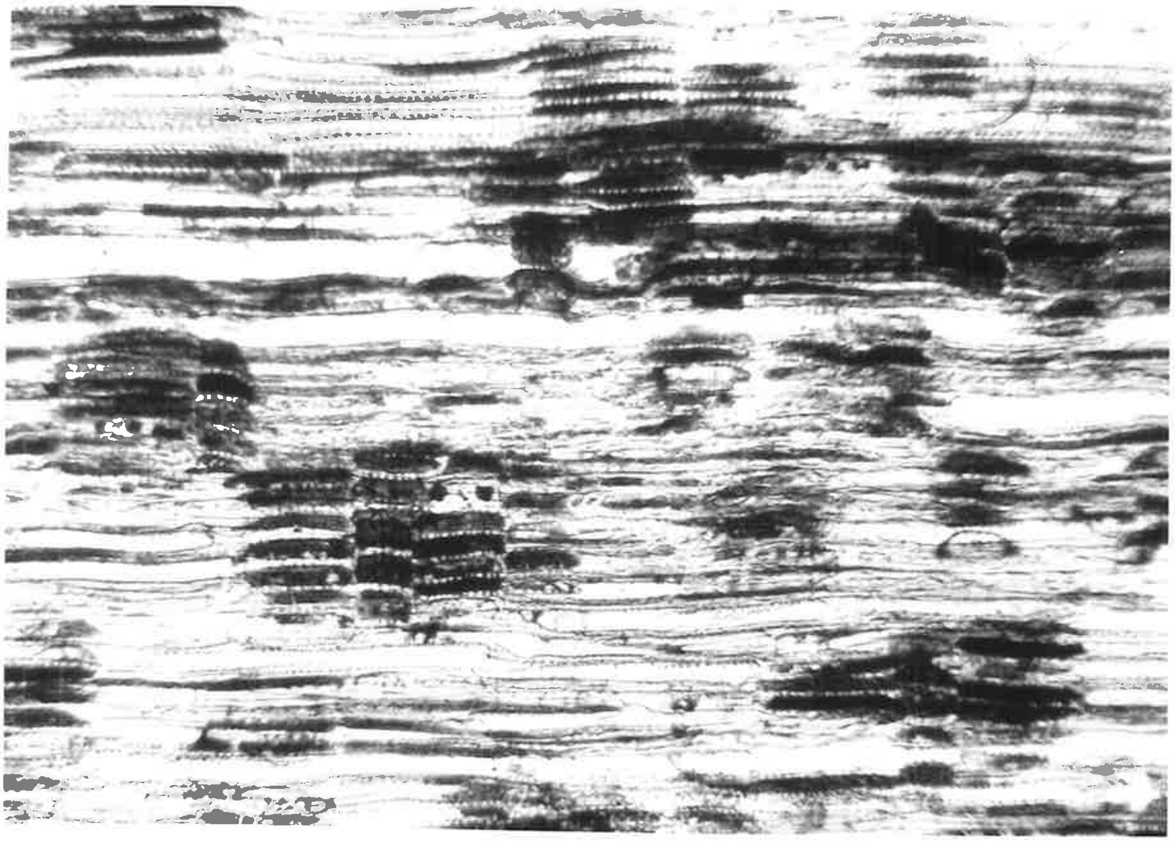


PLATE 11.

Radial longitudinal section of the stem of *Gonocarpus pycnostachyus* (X200). (from Orchard 1079).

Tangential longitudinal section of the stem of *Gonocarpus pycnostachyus* (X200). (from Orchard 1079).



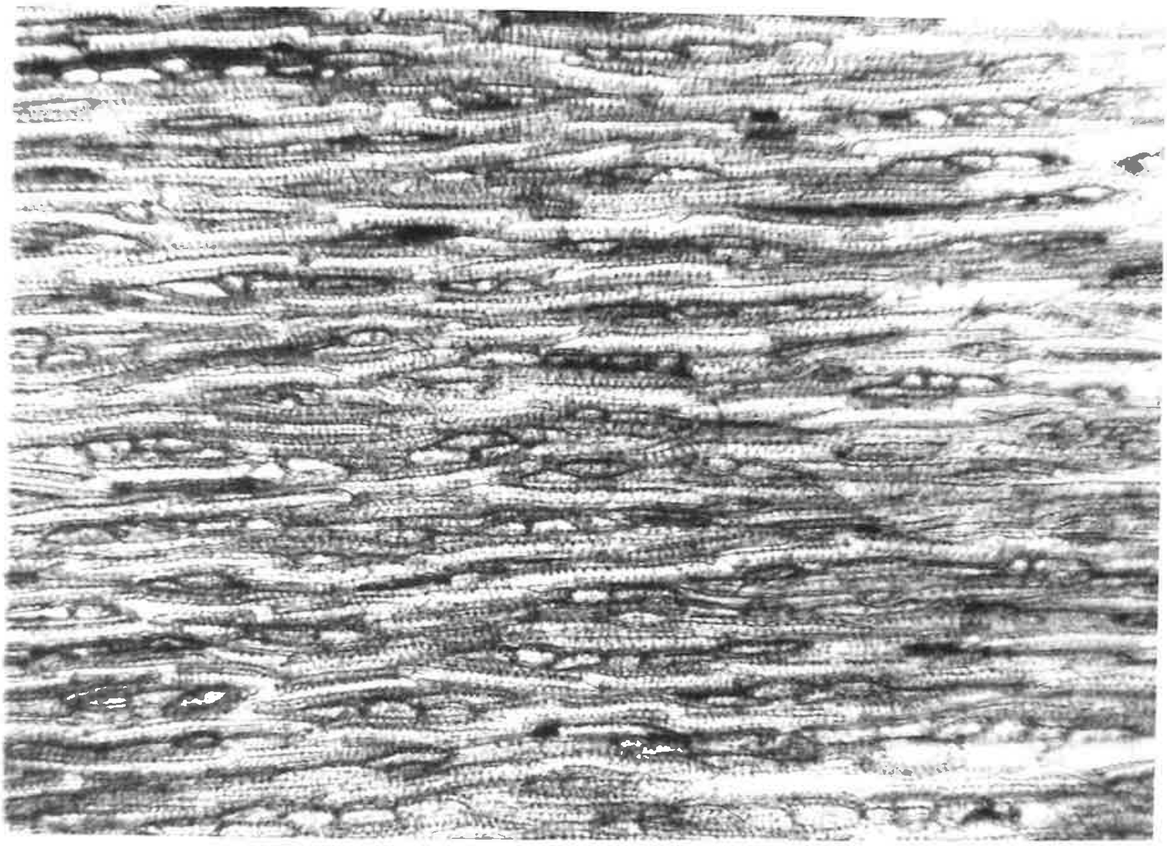
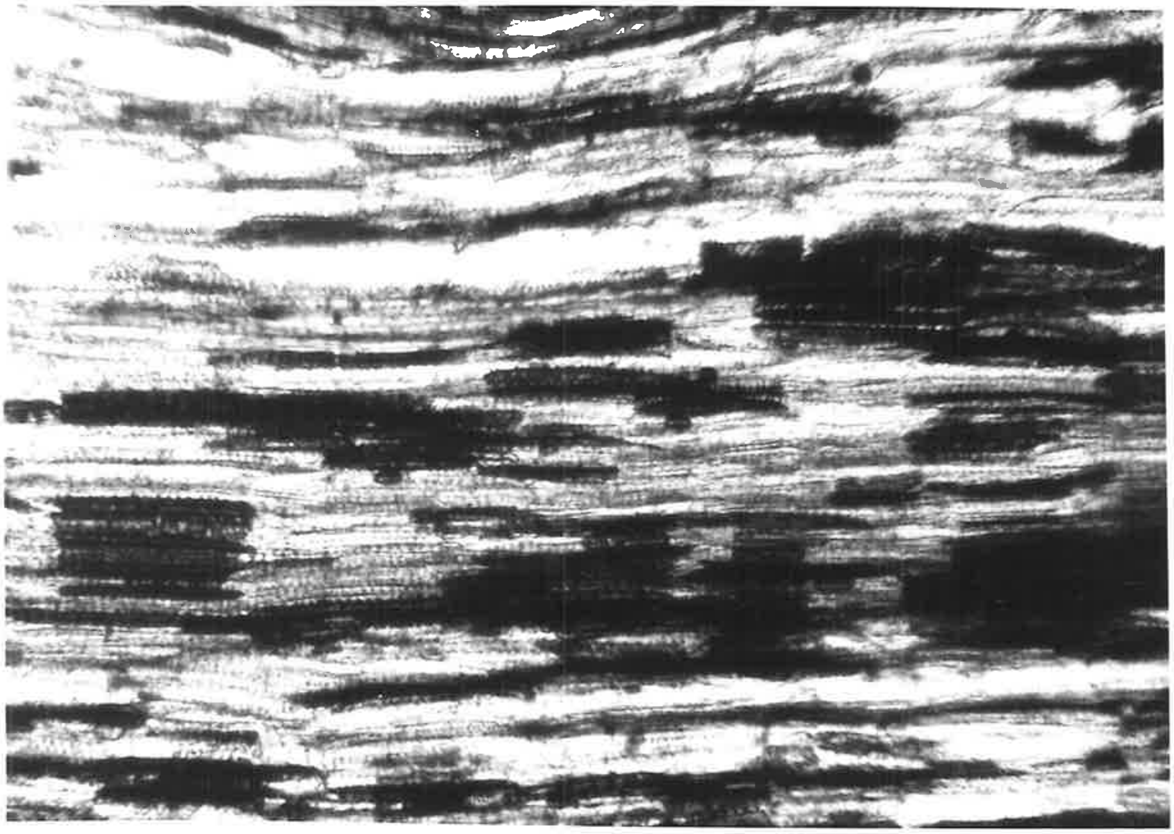


PLATE 12.

Radial longitudinal section of the root of *Gonocarpus pycnostachyus* (X200). (from Orchard 1079).

Tangential longitudinal section of the root of *Gonocarpus pycnostachyus* (X200). (from Orchard 1079).



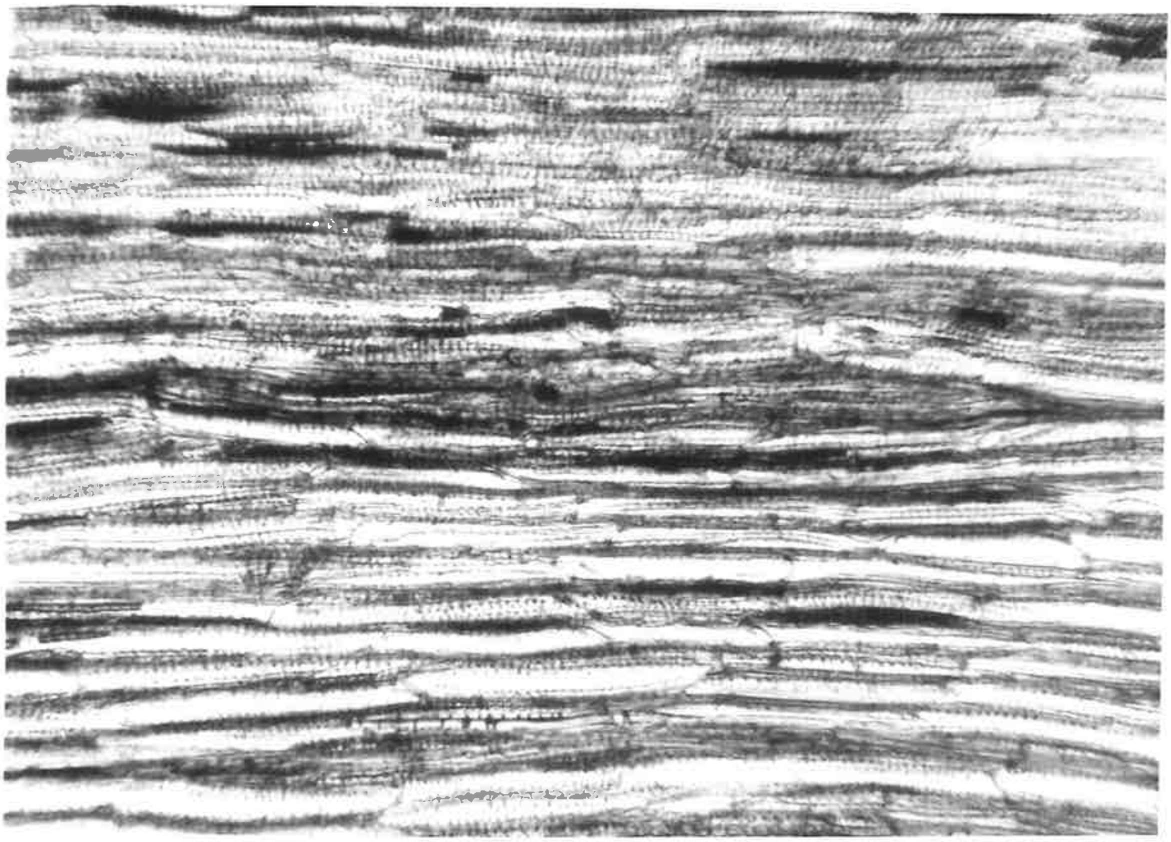


Figure 17. Inflorescence structure in *Haloragodendron*.

A. *Haloragodendron racemosum* (from Orchard 1285).

B. *Haloragodendron monospermum* (from Orchard 2389).

(Secondary and higher order bracts omitted).

○ functional flowers of main inflorescence.

o rudimentary flowers of main inflorescence.

● functional flowers of lateral inflorescences.

• rudimentary flowers of lateral inflorescences.

FIGURE 17

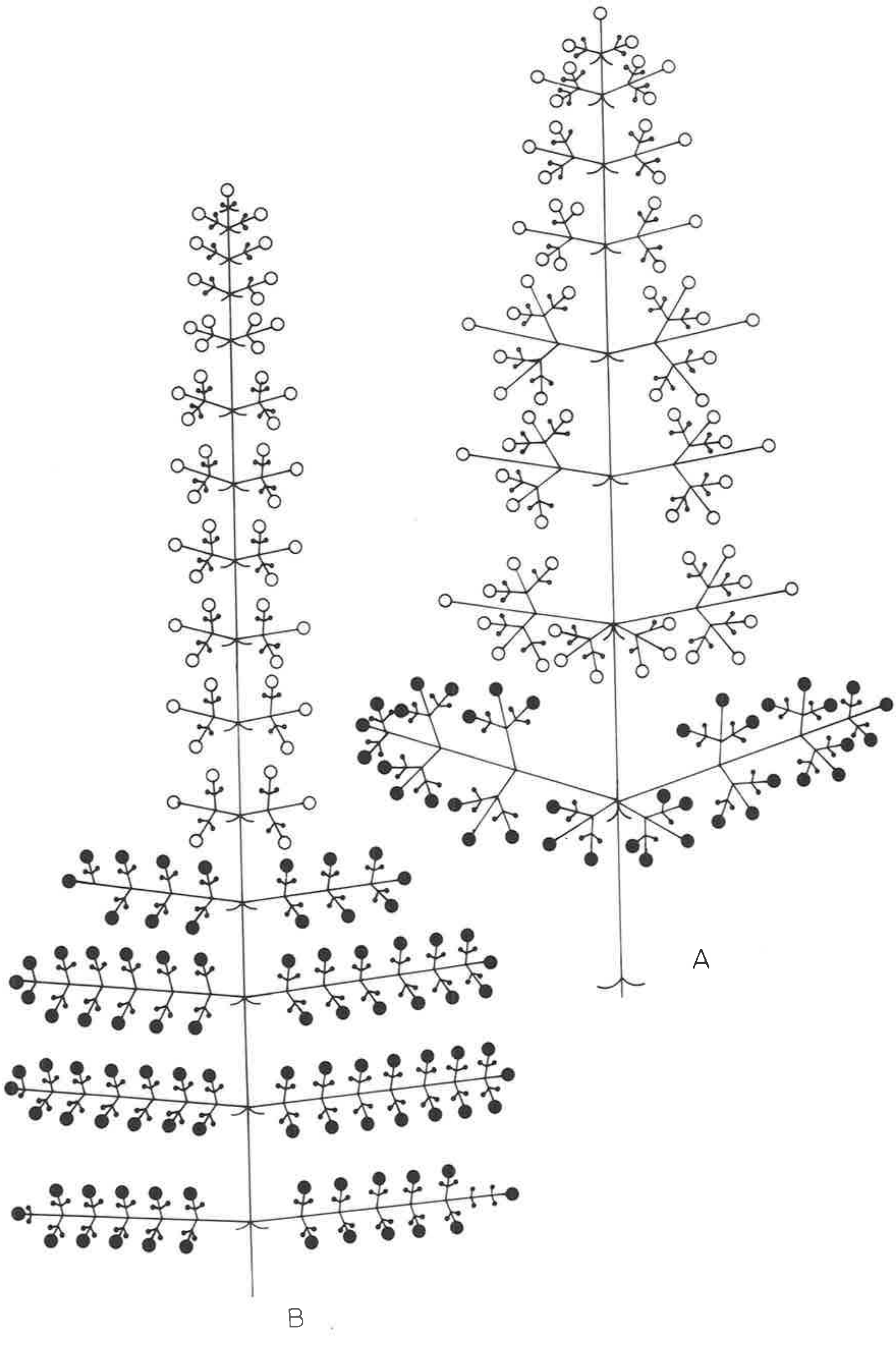


Figure 18. Inflorescence structure in *Haloragodendron*.

A. *Haloragodendron lucasii* (from Blakely, AD96920067).

B. *Haloragodendron glandulosum* (from Aplin 2705).

C. *Haloragodendron glandulosum* (from Eichler 21106).

(Secondary and higher order bracts omitted in C.)

◯ functional flowers of main inflorescence.

o rudimentary flowers of main inflorescence.

● functional flowers of lateral inflorescences.

• rudimentary flowers of lateral inflorescences.

FIGURE 18

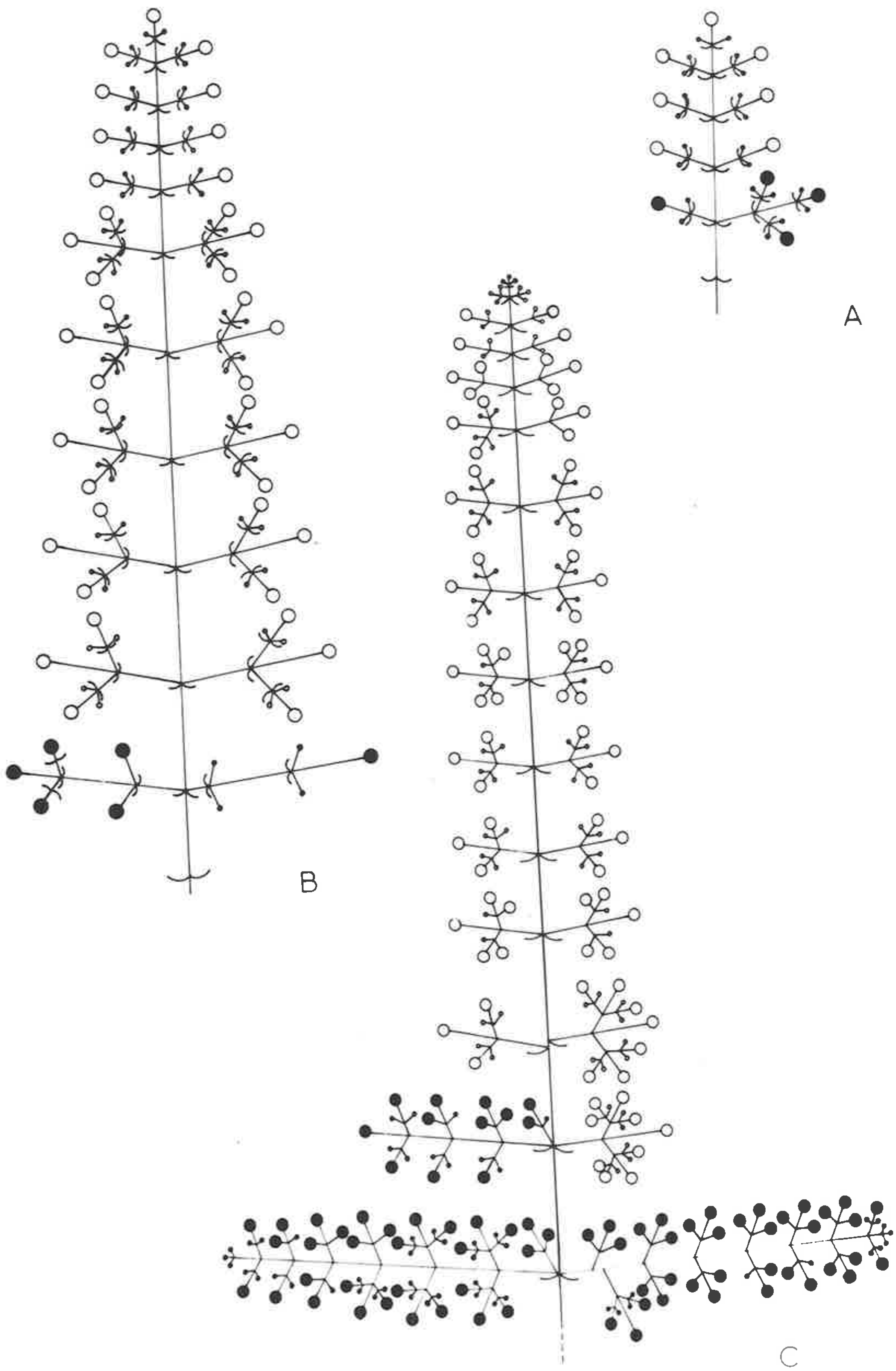


Figure 19. Inflorescence structure in *Glischrocaryon*.

A. *Glischrocaryon aureum* var. *angustifolium* (from Orchard 1702).

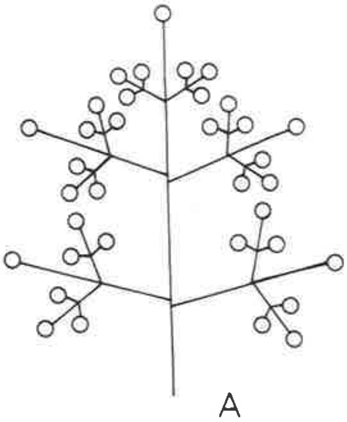
B. *Glischrocaryon flavescens* (from Orchard 1227).

(All bracts omitted).

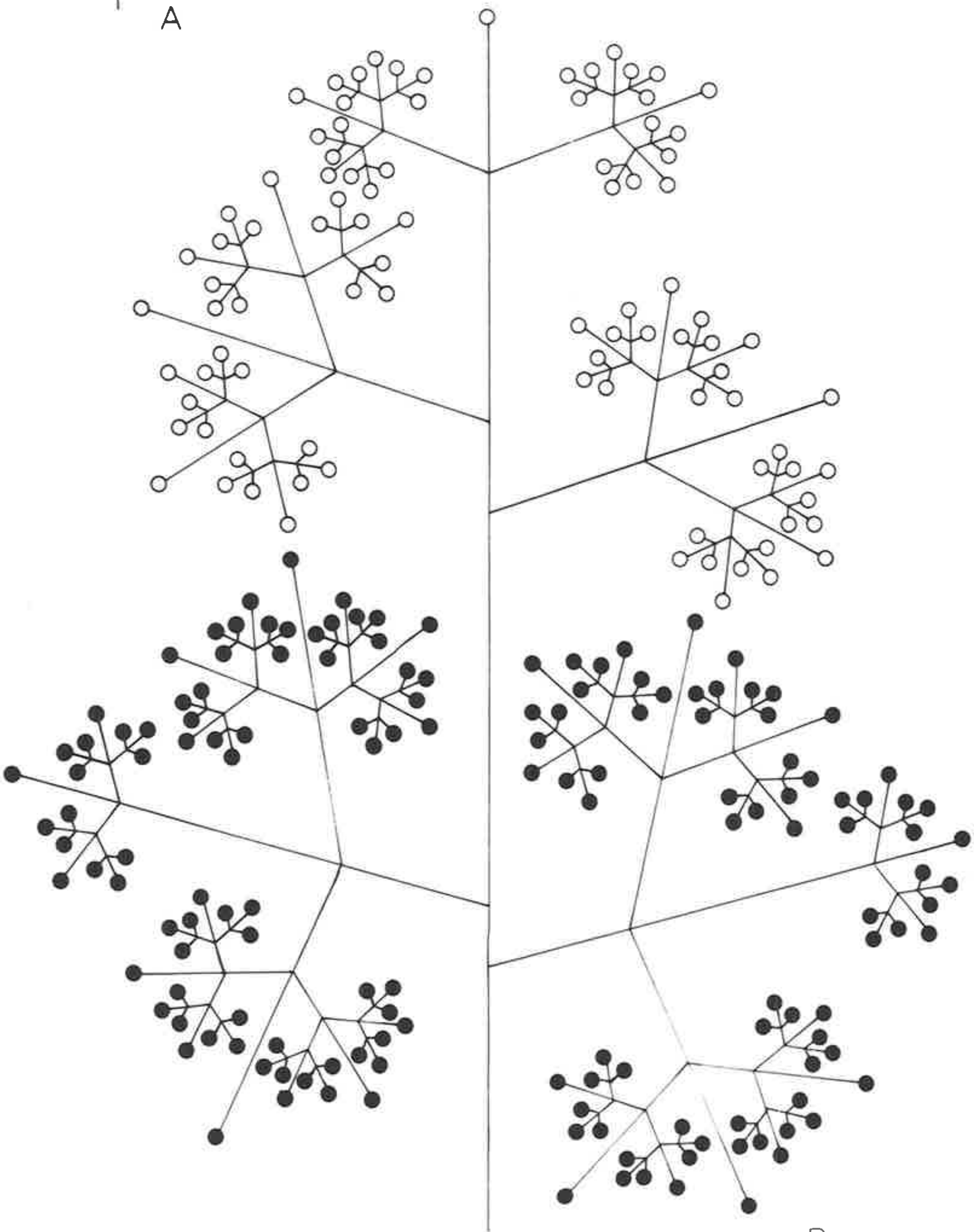
○ flowers of main inflorescence.

● flowers of lateral inflorescences.

FIGURE 19



A



B

Figure 20. Inflorescence structure in *Glischrocaryon behrii*.

A. from Czornij 79.

B. from Donner 179.

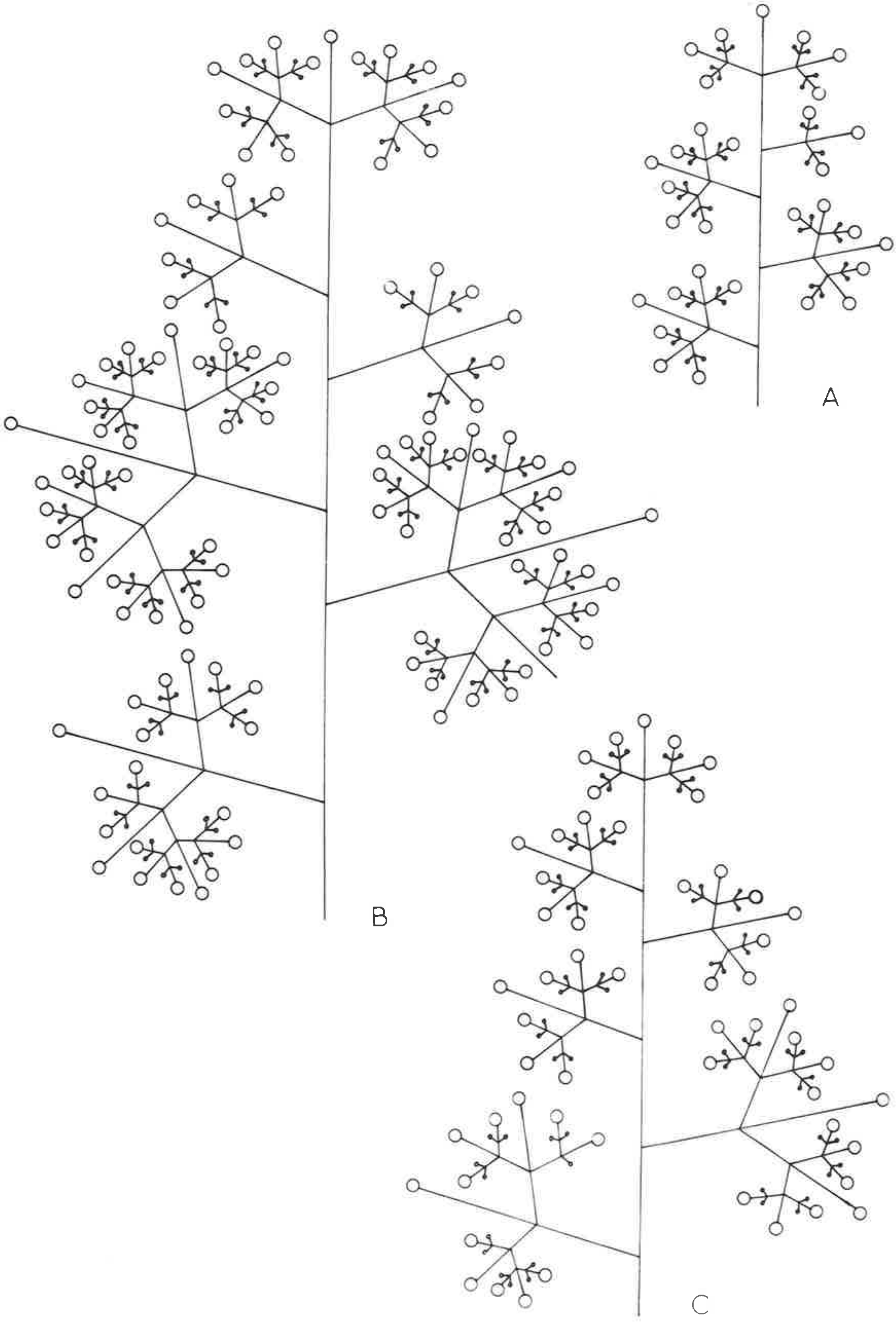
C. from Kuchel 1412.

(All bracts omitted).

◯ functional flowers.

o rudimentary flowers.

FIGURE 20



<u>Figure 21.</u> Flowers and fruits of *Haloragis* species.

A,B. *Haloragis acutangula* f. *acutangula* (from Copley 2444, 2445, resp.).

C. *Haloragis acutangula* f. *annulata* (from Orchard 2050).

D. *Haloragis acutangula* f. *obturbinata* (from Copley 2475).

E. *Haloragis acutangula* f. *semiangulata* (from Orchard 2044).

F. *Haloragis acutangula* f. *subacutangula* (from Orchard 2045)

G. *Haloragis acutangula* f. *tetraglebosa* (from Orchard 2067).

H,I. *Haloragis acutangula* f. *tetraptera* (from Orchard 2035(type), 2048 resp.)

J. *Haloragis odontocarpa* f. *pterocarpa* (from type, Orchard 1859).

K. *Haloragis gossei* (from Symon 4387).

L,M. *Haloragis exalata* var. *laevis* (L. from Williamson NSW99249; M. from Walter NSW99248).

N,O. *Haloragis exalata* var. *exalata* (N. from Orchard 2011; O. from Orchard 2014).

P,Q. *Haloragis exalata* var. *velutina* (P. from Davis NSW99250; Q. from Bailey BRI080044).

FIGURE 21

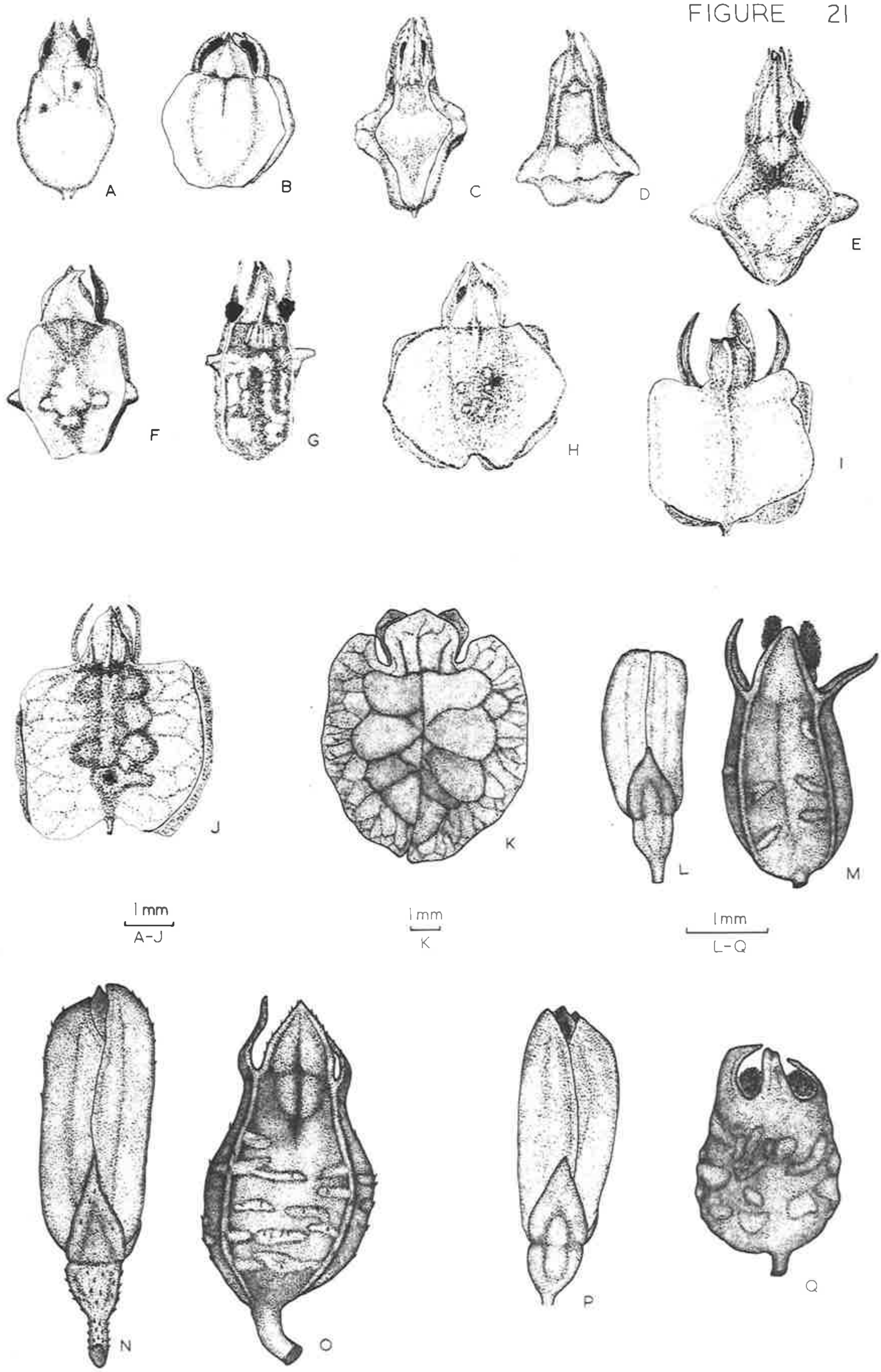


Figure 22. *Haloragis eichleri* (from type specimen, Eichler 20806).

A. Habit.

B. Portion of lower branch, showing adventitious roots.

C. Tip of inflorescence.

D. Flower (fully developed bud).

E. Petal.

F. Stamen.

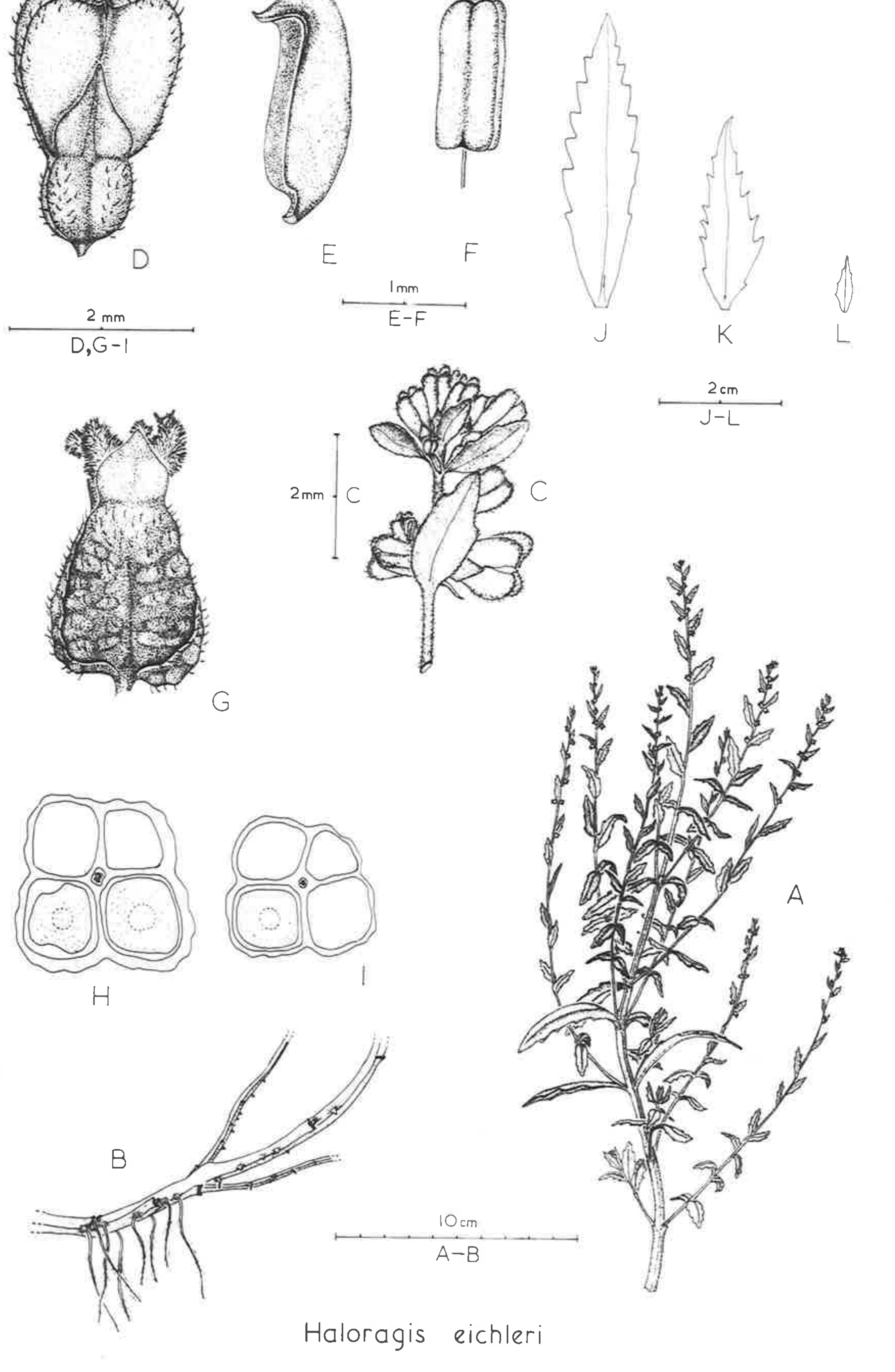
G. Fruit.

H, I. Transverse sections of fruits.

J, K. Leaves.

L. Primary bract.

FIGURE 22



Haloragis eichleri

Figure 23. A-I. *Haloragis myriocarpa* (from type specimen, Copley 3369).

A. Habit.

B. Flower.

C. Fruit.

D. Transverse section of fruit.

E. Rootstock.

F. Portion of inflorescence.

G,H. Leaves.

I. Primary Bract.

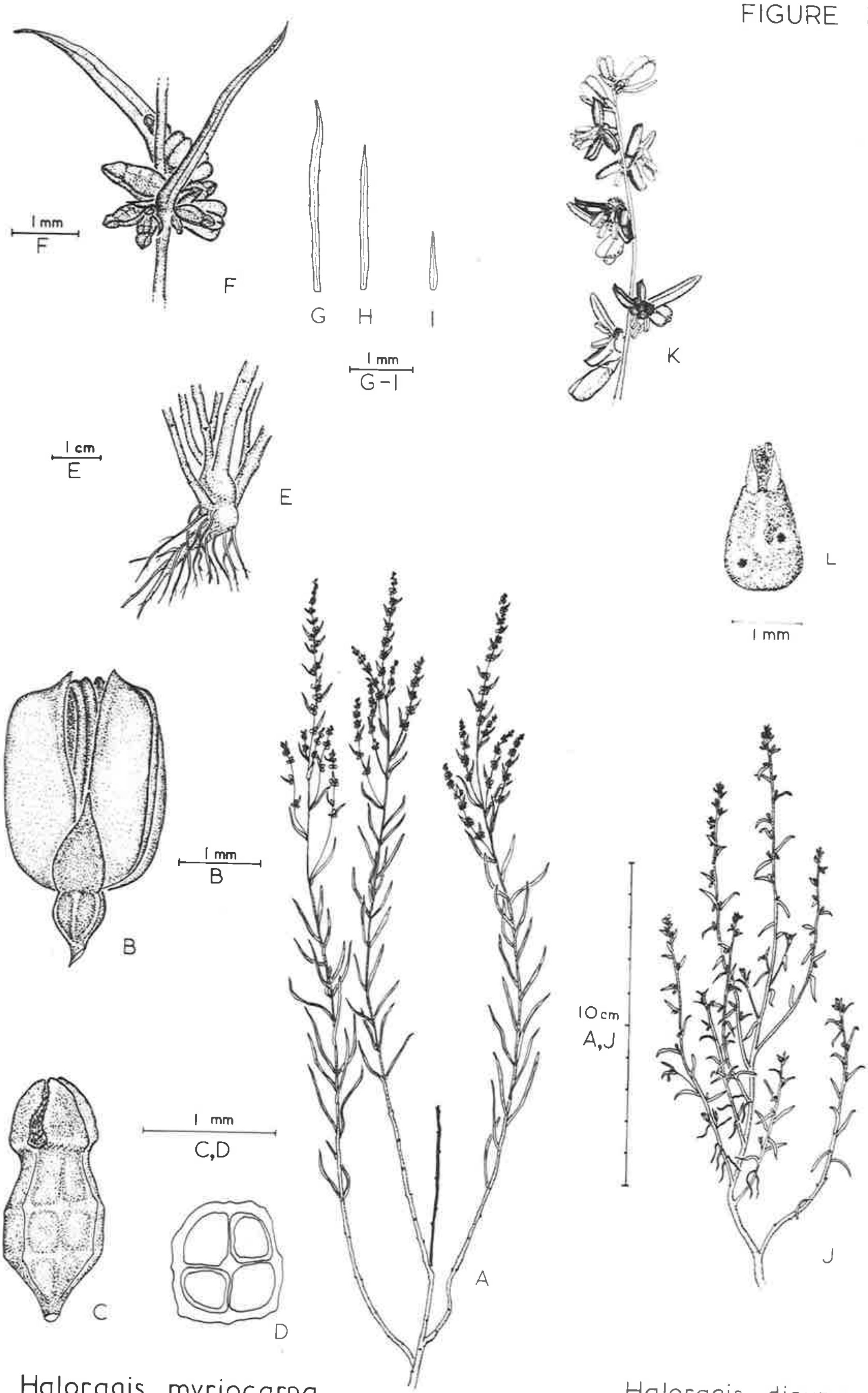
J-L. *Haloragis digyna* (from Orchard 2993).

J. Habit.

K. Inflorescence.

L. Fruit.

FIGURE 23



Haloragis myriocarpa

Haloragis digyna

Figure 24.

A-Y. Leaves and bracts of *Haloragis* species.

A-D. *Haloragis uncatipila* (from type specimen, Orchard 900).

A-C. Leaves

D. Primary bract.

E-G. *Haloragis aspera* (from type specimen, Mitchell CGE).

E-F. Leaves.

G. Primary bract.

H-I. Leaves of *Haloragis aspera* (from Mueller, NSW ex W; isotype of *H. heterophylla* var. *rigida*).

J-M. *Haloragis aspera* (from Stuart, LE; lectotype of *H. heterophylla* var. *capreolicornis*).

J-L. Leaves

M. Primary bract.

N-Q. *Haloragis aspera* (from Koch 295; type of *H. heterophylla* var. *glaucifolia*).

N-P. Leaves.

Q. Primary bract.

R-U. *Haloragis aspera* (from Wilkes, US; holotype of *H. pinnatifida)*.

R-T. Leaves.

U. Primary bract.

V-Y. *Haloragis heterophylla* (from Wilkes, US; holotype of *H. filiformis)*.

V-X. Leaves.

Y. Primary bracts.

AA-GG. *Gonocarpus* species.

AA. Fruit of *Gonocarpus hexandrus* ssp. *integrifolius*.(from Koch 2166).

BB. Flower of *Gonocarpus hexandrus* ssp. *serratus* (from Koch 2259).

CC-DD. *Gonocarpus micranths* ssp. *micranthus*.

CC. Flower (from Eichler 16631).

DD. Habit (from Orchard 2015).

EE-FF. *Gonocarpus micranthus* ssp. *ramosissimus*.

EE. Habit (from Boyd AD95809056).

FF. Flower (from Boyd AD95809056).

GG. Flower (from Bailey BRI080051).

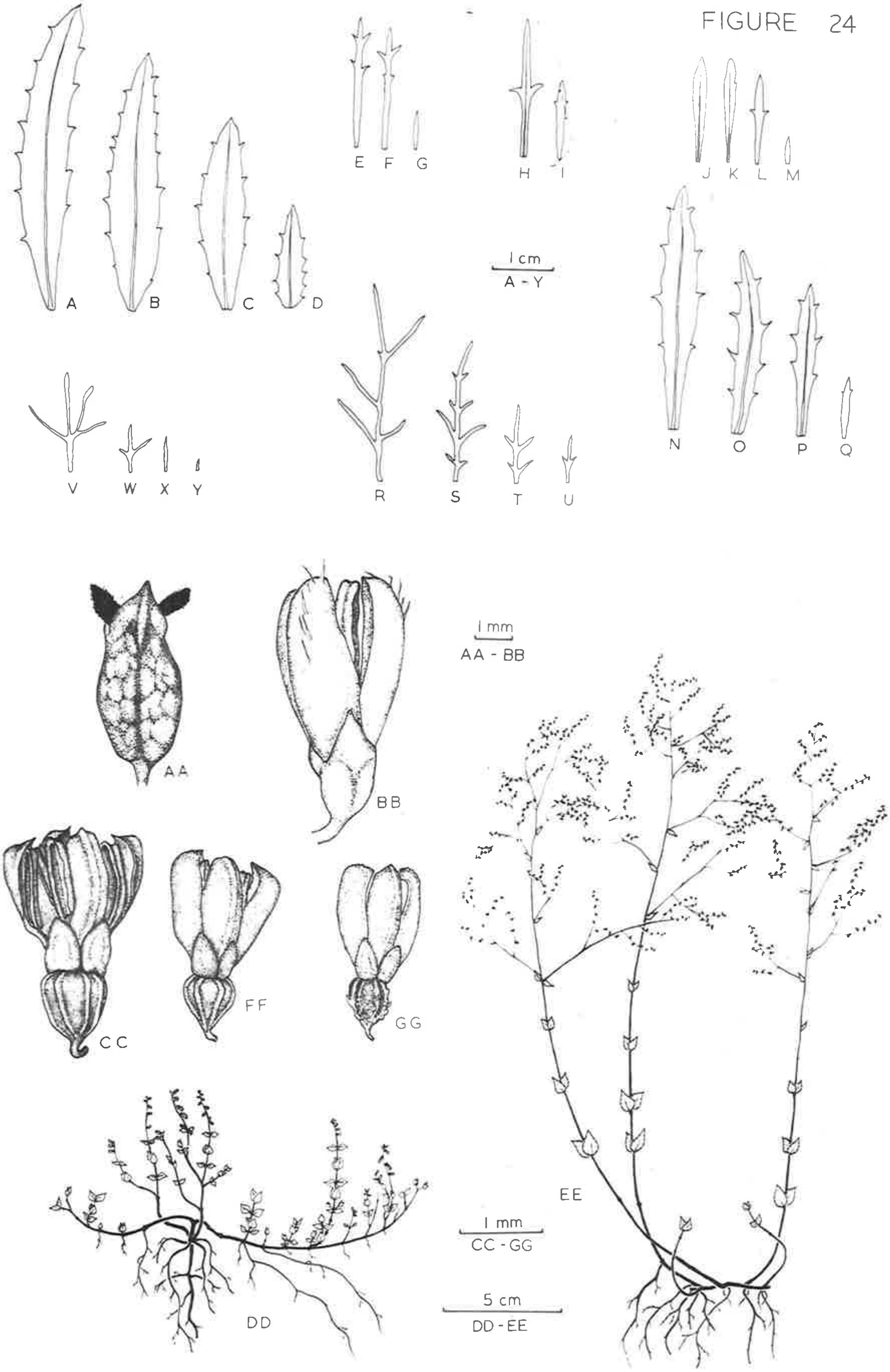


FIGURE 24
A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V
W
X
Y
1 cm
A - Y
AA
BB
1 mm
AA - BB
CC
FF
GG
DD
EE
1 mm
CC - GG
5 cm
DD - EE

<u>Figure 25.</u> Flowers and fruits of *Haloragodendron* and *Glischrocaryon*.

A,B. *Haloragodendron racemosum* (from Orchard 1285).

A. Flower.

B. Stamen.

C. Fruit of *Haloragodendron baeuerlenii* (from Baeuerlen,K).

D,E. *Haloragodendron monospermum*

D. Fruit (from Wrigley, CBG023487)

E. Flower (from Gauba, CBG013194).

F,G. *Haloragodendron lucasii* (from Blakely, AD96920067).

F. Fruit.

G. Flower.

H-K. *Glischrocaryon aurem* var. *angustifolium*.

H. Abnormal (wingless) fruit (from Orchard 1701).

I. Flower (from Orchard 1702).

J. Fruit (from Orchard 1702).

K. Fruit (from Orchard 1703).

L. Fruit of *Glischrocaryon roei* (from Orchard 1520).

M. Fruit of *Glischrocaryon behrii* (from Orchard 1805).

FIGURE 25

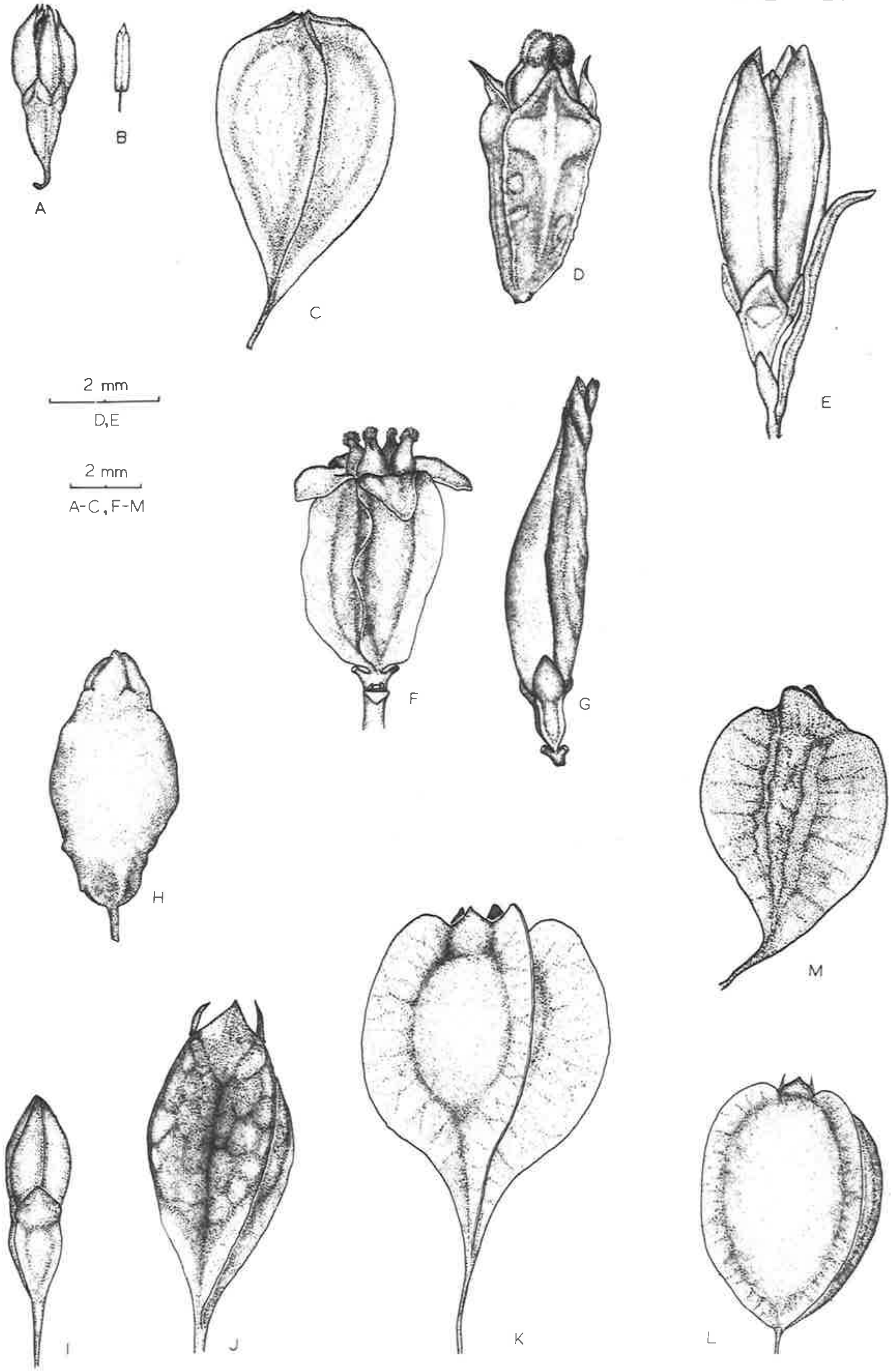


Figure 26. *Gonocarpus elatus*.

A. Habit (from Orchard 1813).

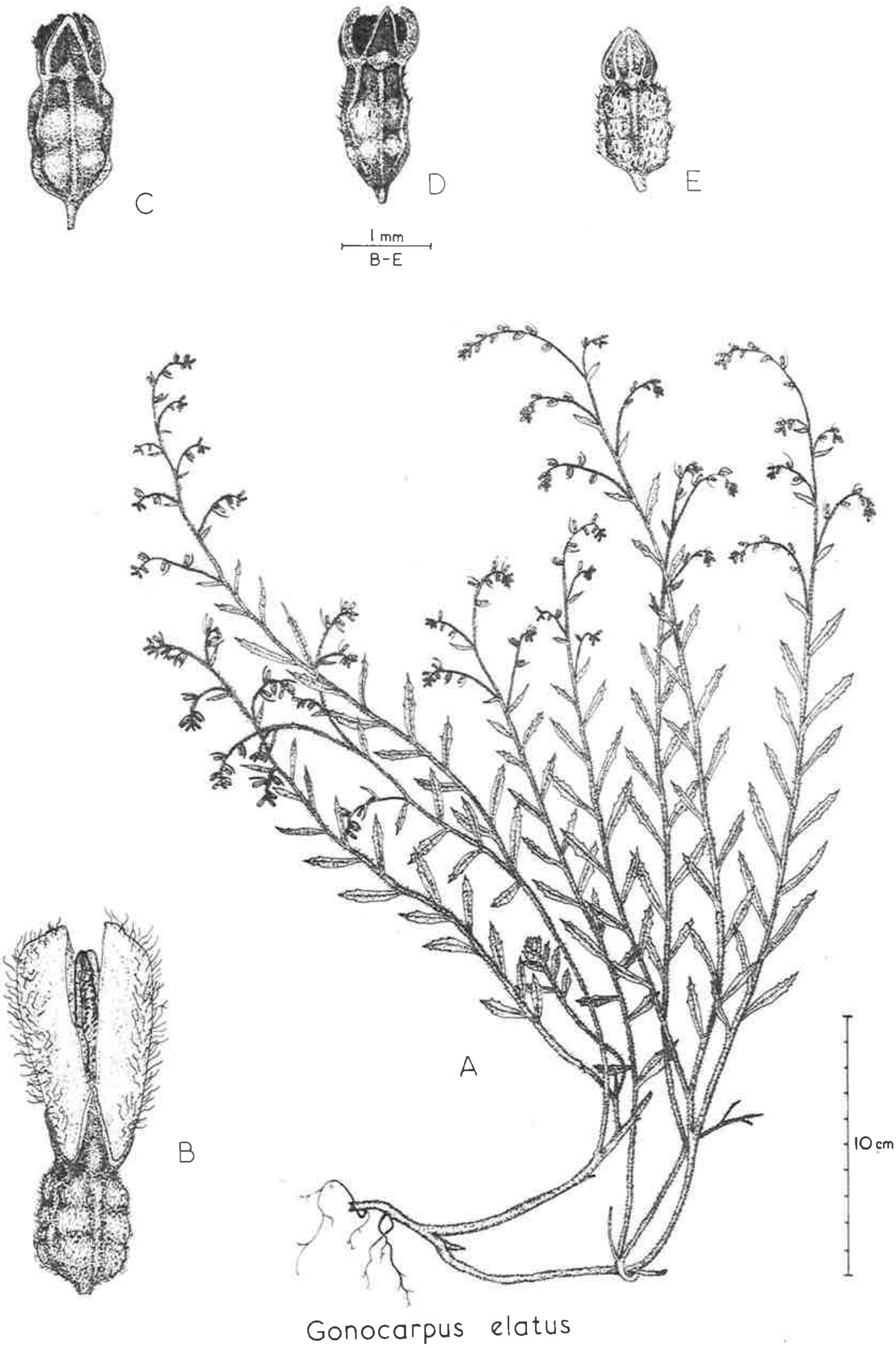
B. Flower (from Whibley 379).

C. Fruit (from Cleland AD96803154).

D. Fruit (from Gauba AD96911102).

E. Fruit (from Hall AD96501335).

FIGURE 26



Gonocarpus elatus

PLATE 13.

Holotype of *Haloragis exalata* ssp. *velutina*.


Holo
Iso
Lecto
- TYPE of
NATIONAL HERBARIUM OF NEW SOUTH WALES.
Loc. Dalmorton near Grafton N.S.W.
Coll. J. L. Boorman.
Date 1-1909

PLATE 14.

Holotype of *Haloragis eichleri*.


Herb. AD
Holo
Iso
Lecto
- TYPE of

PLATE 15.

Holotype of *Haloragis uncatipila*.

Herb. AD 97124268

STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE

Northern Territory. Barkly tableland.

Stuart Highway, ... miles (ca. 24 km) north of Tennant Creek.

Isolated plants ... growing in open disturbed areas ... red sandy loam.

Collector's No.
Date

Holo
Iso
Lecto
- TYPE of

PLATE 16.

Holotype of *Haloragis myriocarpa*.

Herb. AD | 97127110

Holo
Iso
Lecto
- TYPE of

3369

Duplicate from
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE

Leg. | Collector's No
Date

Communication of new determinations will be greatly appreciated by the Adelaide Herbarium

3369

PLATE 17.

Holotype of *Haloragodendron glandulosum*.


Herb AD
97144017
STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE
Holo
Iso
Lecto
- TYPE of
Leg.
Collector's No.
Date

PLATE 18.

Haloragodendron glandulosum

Plant at right: Eichler 21105 (holotype).

Plant at left: Eichler 21106.

PLATE 19.

Glischrocaryon flavescens.

Lectotype of *Loudonia flavescens*.

Lecto - TYPE of
MEL 39531
73
BOTANICAL MUSEUM OF MELBOURNE.
Loudonia flavescens
Drummond
W. A.
FERD. MUELLER, PH. & M.D.

PLATE 20.

Glischrocaryon flavescens.

Lectotype of *Loudonia citrina*.

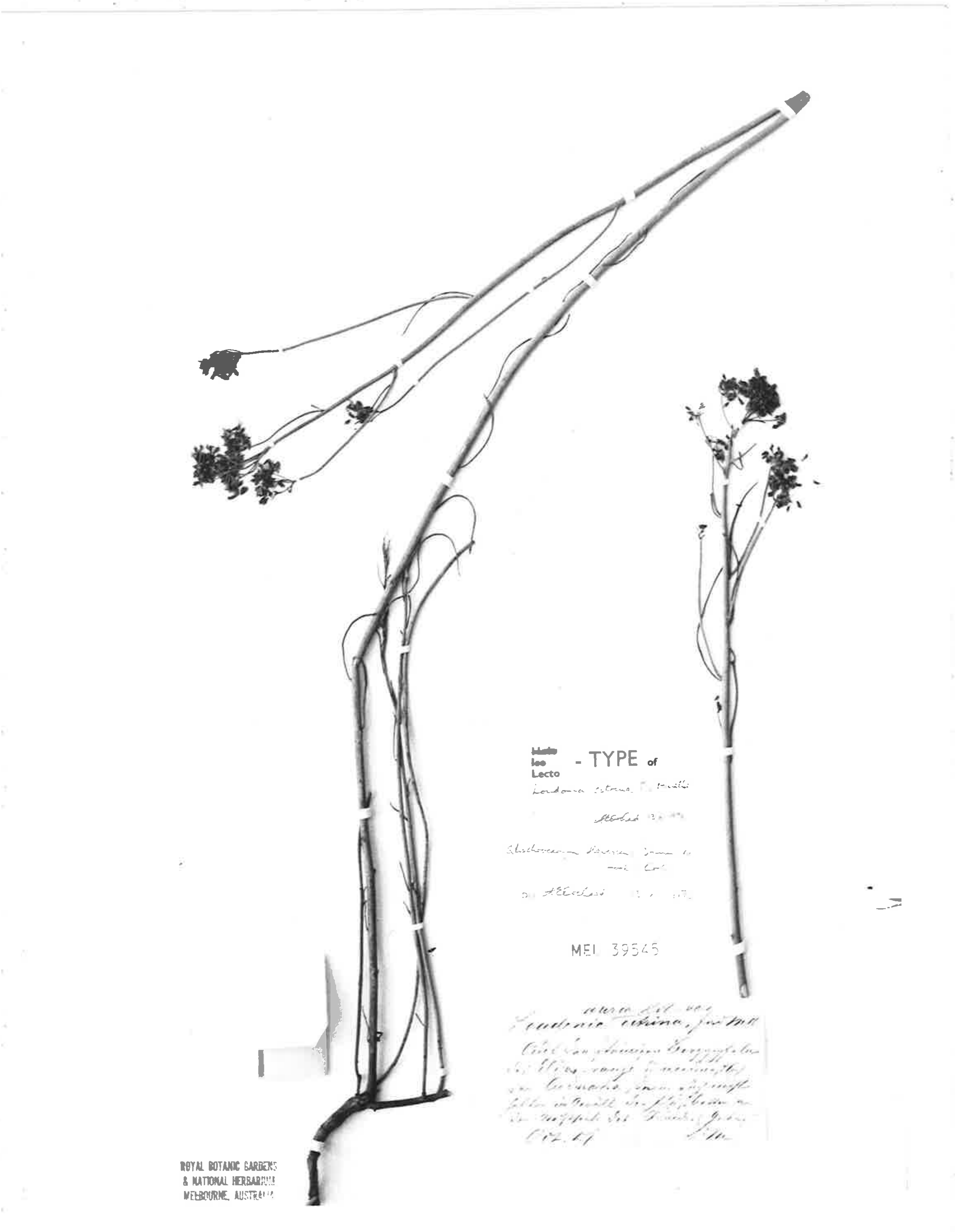
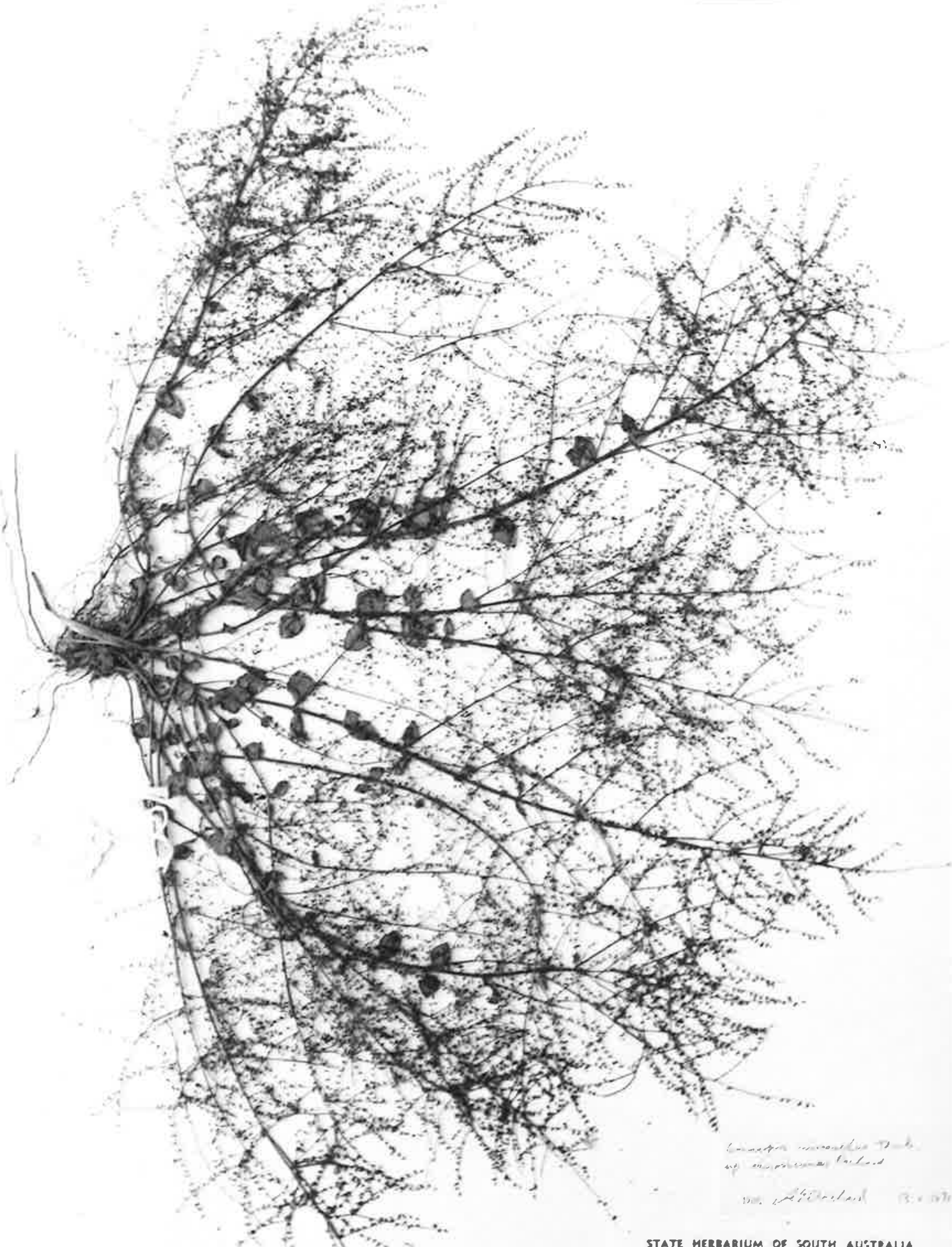

Holo
Iso
Lecto
- TYPE of
MEL 39545
ROYAL BOTANIC GARDENS
& NATIONAL HERBARIUM
MELBOURNE, AUSTRALIA

PLATE 21.

Holotype of *Gonocarpus micranthus* ssp. *ramosissimus*

Herb. AD	97016199



[illegible]

STATE HERBARIUM OF SOUTH AUSTRALIA
ADELAIDE

[illegible]

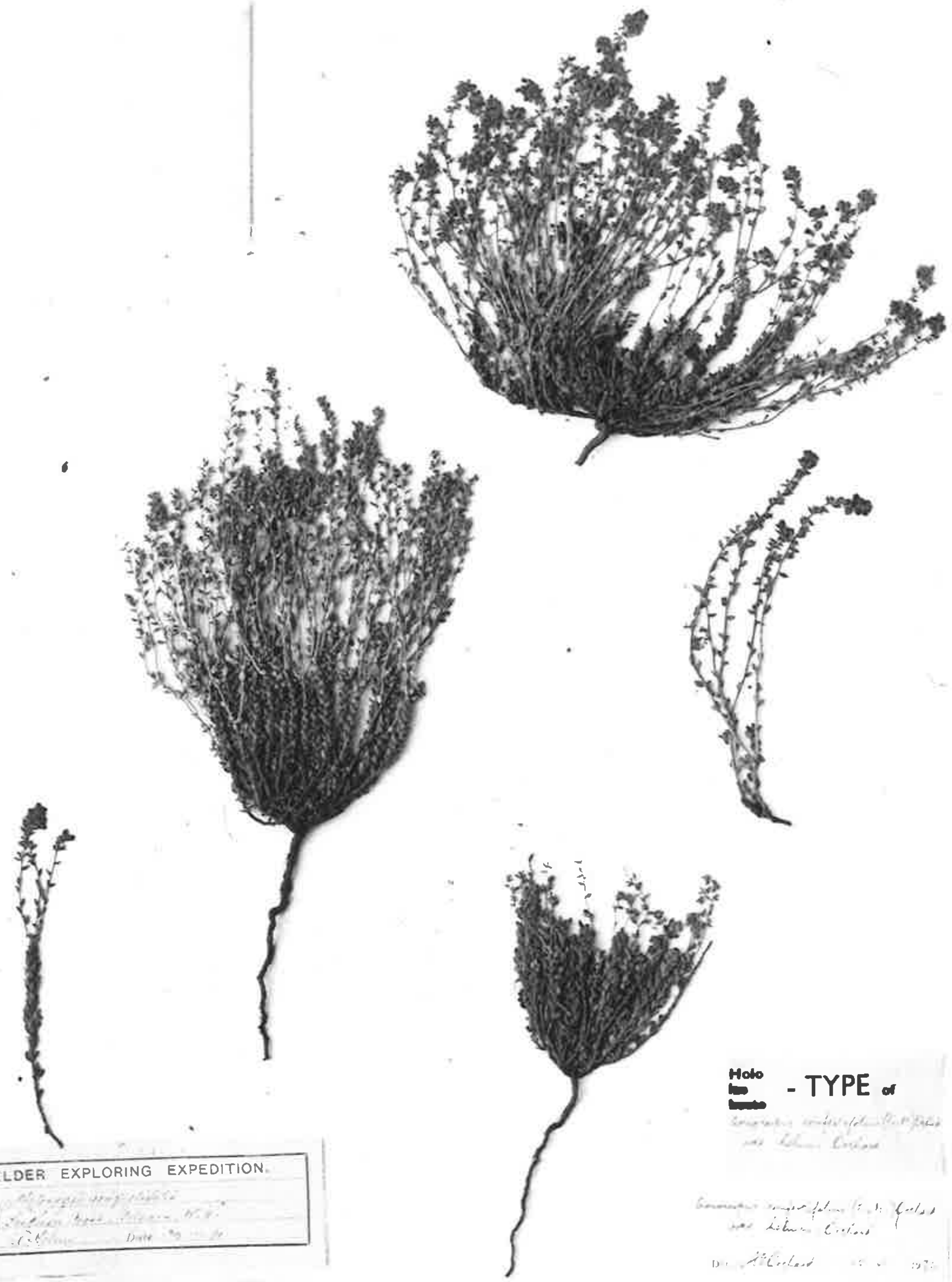
Log. [illegible] Collector's No. [illegible]
Date [illegible]

Holo - TYPE of
[illegible]

PLATE 22.

Holotype of *Gonocarpus confertifolius* var. *helmsii*.

Herb. AD	96819032



Holo
[redacted]
[redacted]
- TYPE of

[illegible]

[illegible]

Det. [illegible] 197[illegible]

ELDER EXPLORING EXPEDITION.

Name [illegible]
Loc. [illegible]
Coll. [illegible] Date [illegible]

ELDER EXPLORING EXPEDITION.

Name [illegible]
Loc. [illegible]
Coll. [illegible] Date [illegible]

Locality Date
Size
Nature of Habitat
Botanical Name Haloragis [illegible]
Common or Native Name
Finder's Name

MAP 1

Distribution of: *Haloragis exalata.*

○ var. *exalata.*

+ var. *laevis*

× ssp. *velutina*

● *H. stricta*

▲ *H. serra*

▽ *H. eichleri*

△ *H. gossei*

MAP 2

Distribution of: *Haloragis odontocarpa*

× flowers only

● f. *odontocarpa*

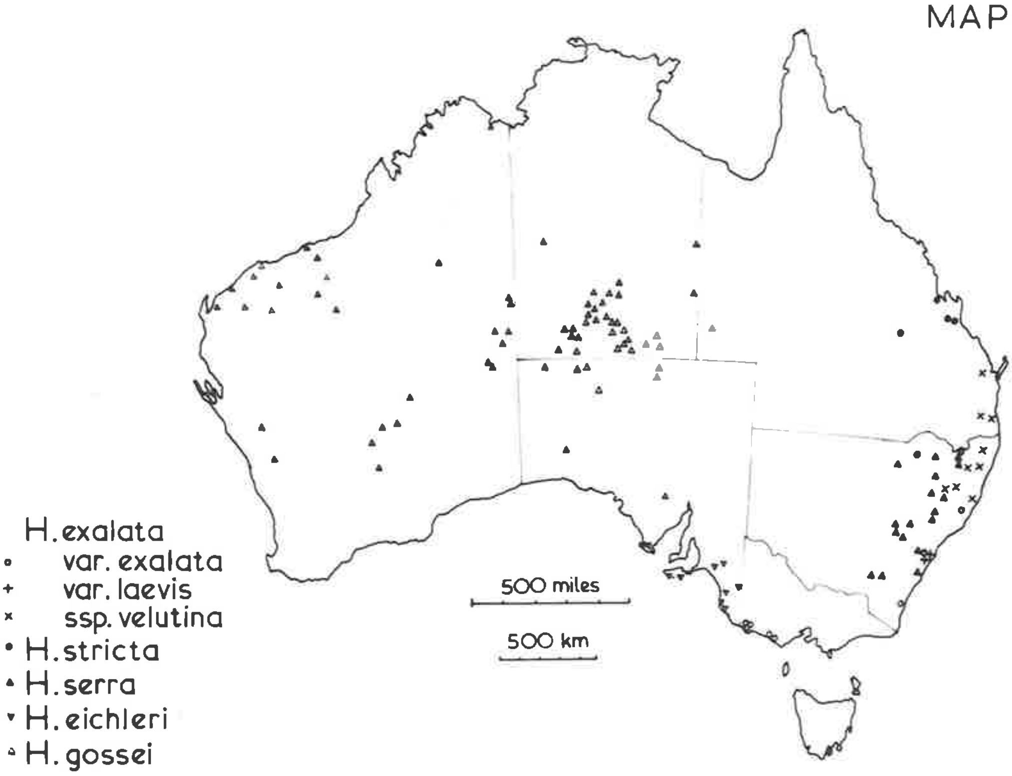
△ f. *rugosa*

○ f. *pterocarpa*

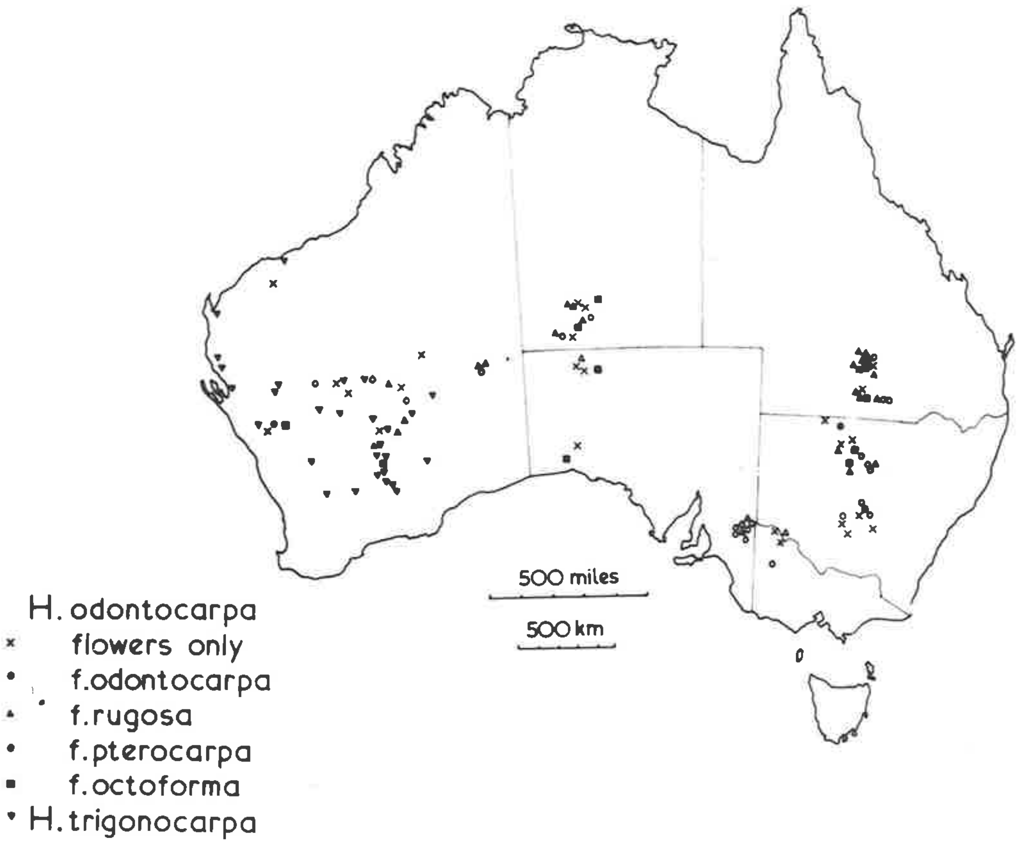
■ f. *octoforma*

▼ *H. trigonocarpa*

MAP 1


500 miles
500 km
H. exalata
var. exalata
var. laevis
ssp. velutina
H. stricta
H. serra
H. eichleri
H. gossei

MAP 2


500 miles
500 km
H. odontocarpa
flowers only
f. odontocarpa
f. rugosa
f. pterocarpa
f. octoforma
H. trigonocarpa

MAP 3

Distribution of: *Haloragis erecta*

H. prostrata

H. masatierrana

H. masafuerana

MAP 4.

New Zealand distribution of:

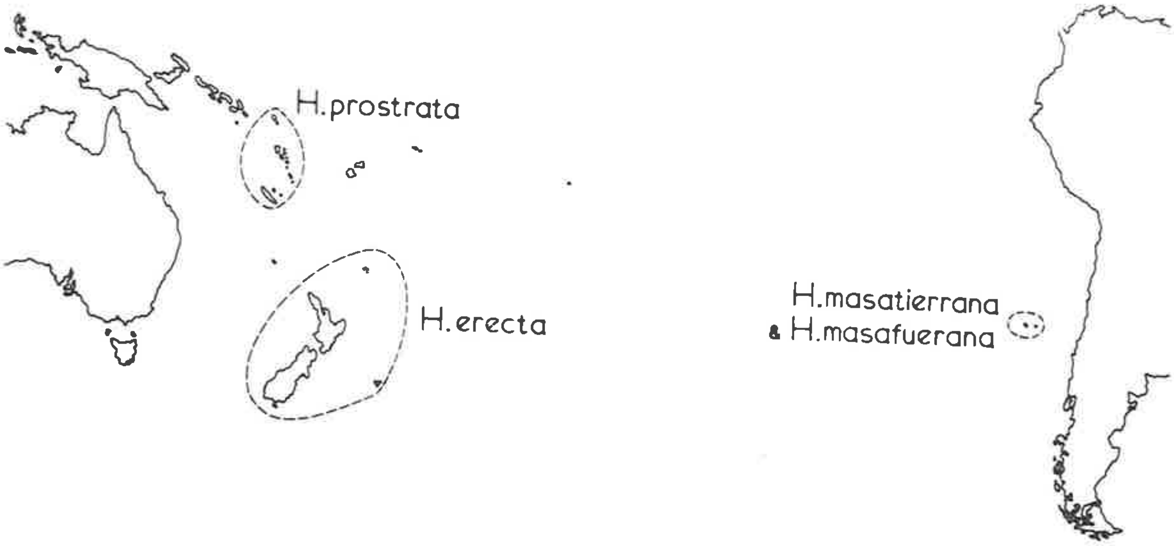
Haloragis erecta

● ssp. *erecta*

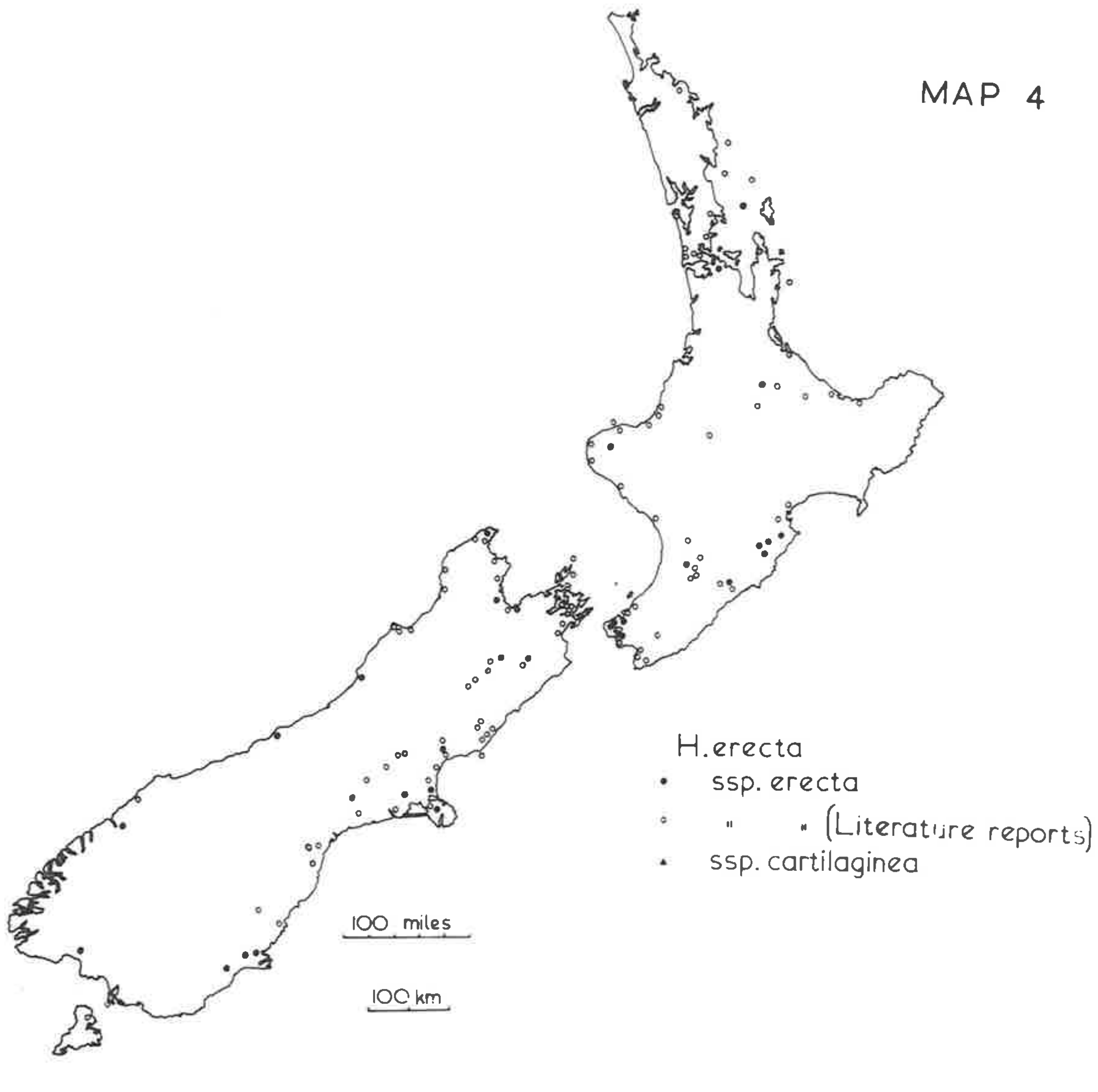
○ " " (Literature reports, after Forde, 1964).

▲ ssp. *cartilaginea*

MAP 3


H.prostrata
H.erecta
H.masatierrana
& H.masafuerana

MAP 4


H.erecta
ssp. erecta
" " (Literature reports)
ssp. cartilaginea
100 miles
100 km

MAP 5.

Distribution of: *Haloragis acutangula*

▲ f. *acutangula*

▲ f. *annulata*

▲ f. *dentata*

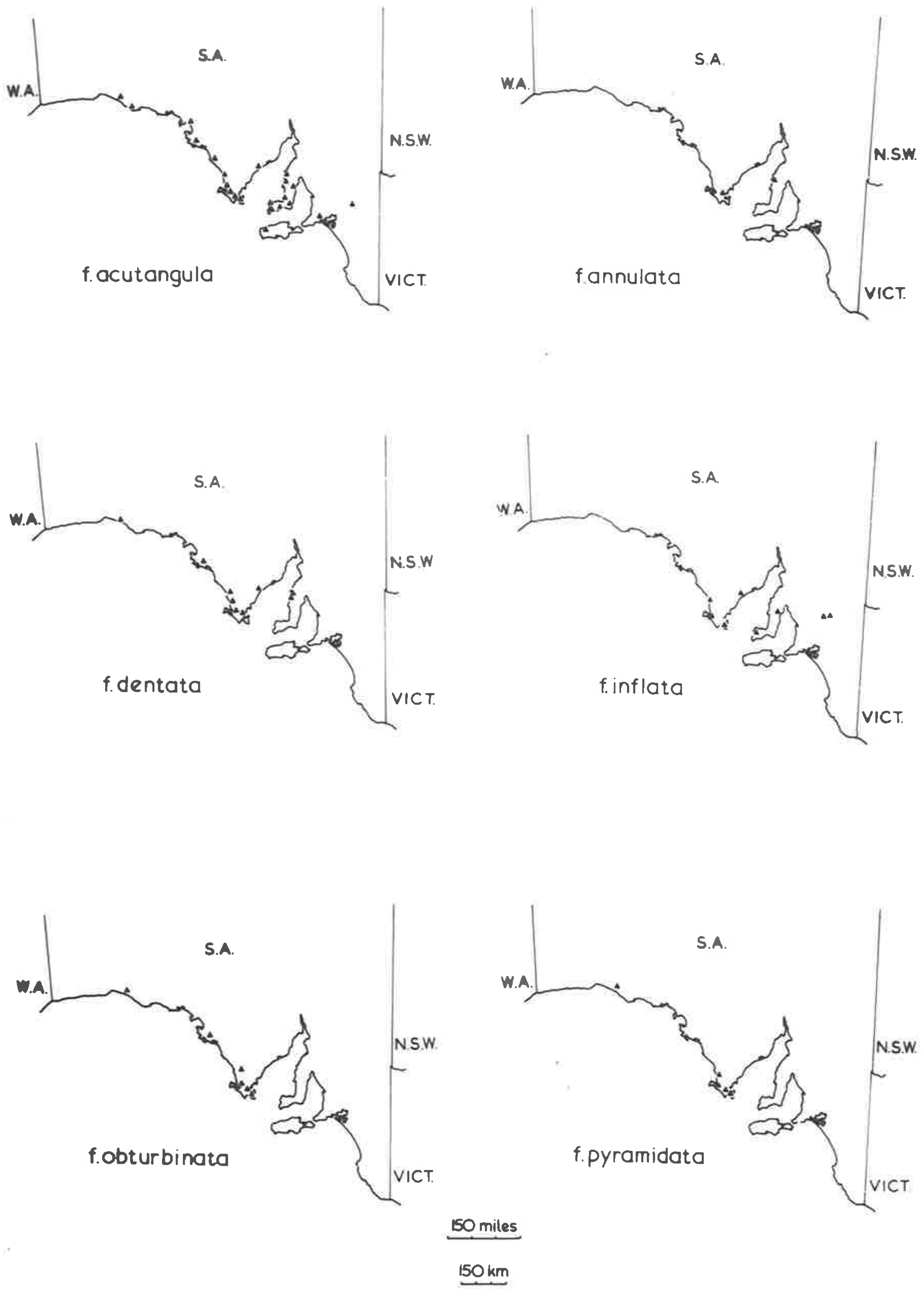
▲ f. *inflata*

▲ f. *obturbinata*

▲ f. *pyramidata*

MAP 5

H. acutangula



MAP 6

Distribution of: *Haloragis acutangula*

▲ f. *semiangulata*

▲ f. *subacutangula*

▲ f. *tetraglebosa*

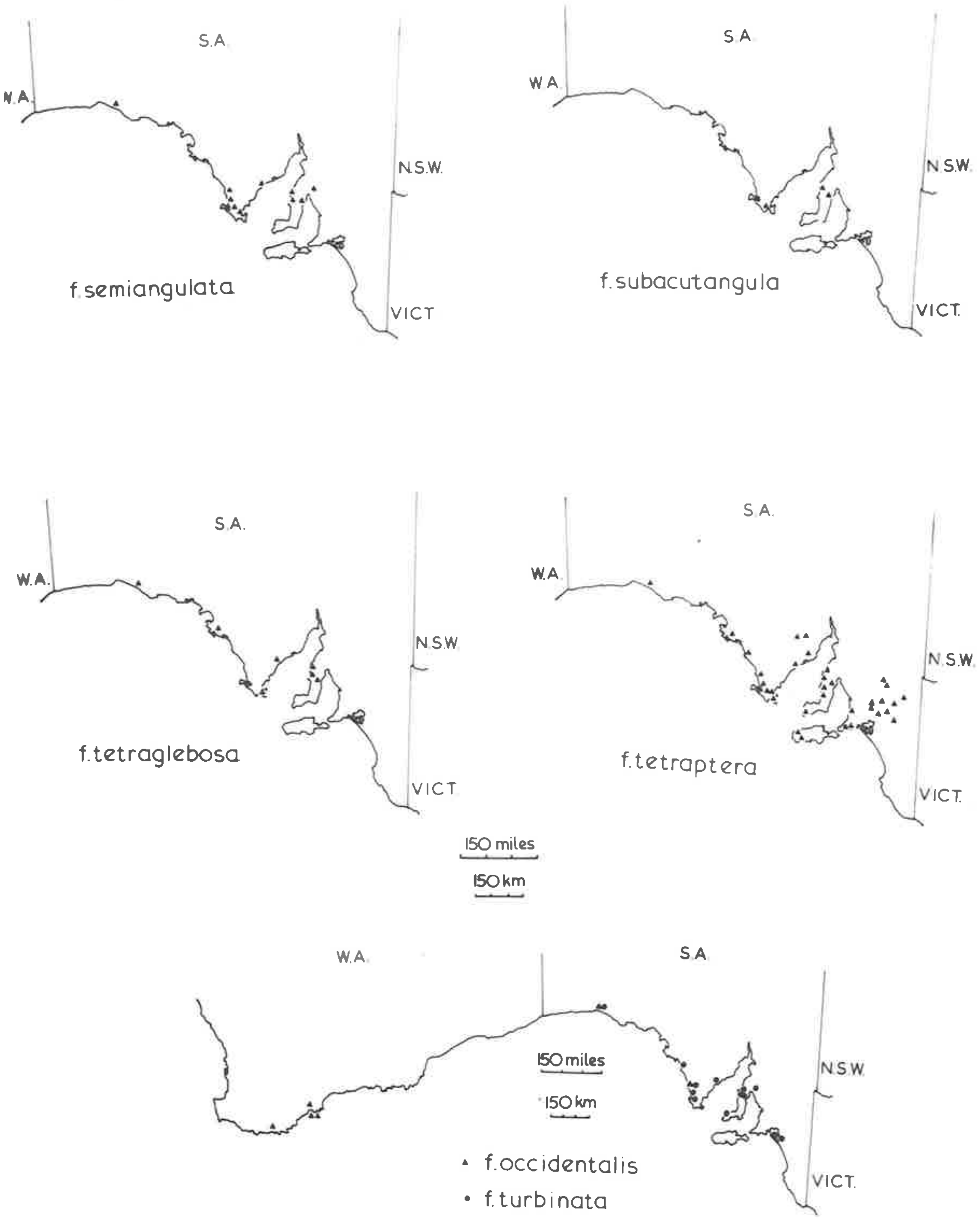
▲ f. *tetraptera*

▲ f. *occidentalis*

● f. *turbinata*

MAP 6

H. acutangula



MAP 7

Distribution of: Δ *Haloragis aspera*

o *H. foliosa*

∇ *H. platycarpa*

● *H. aculeolata*

▲ *H. scoparia*

MAP 8.

Distribution of: Δ *Haloragis uncatipila*

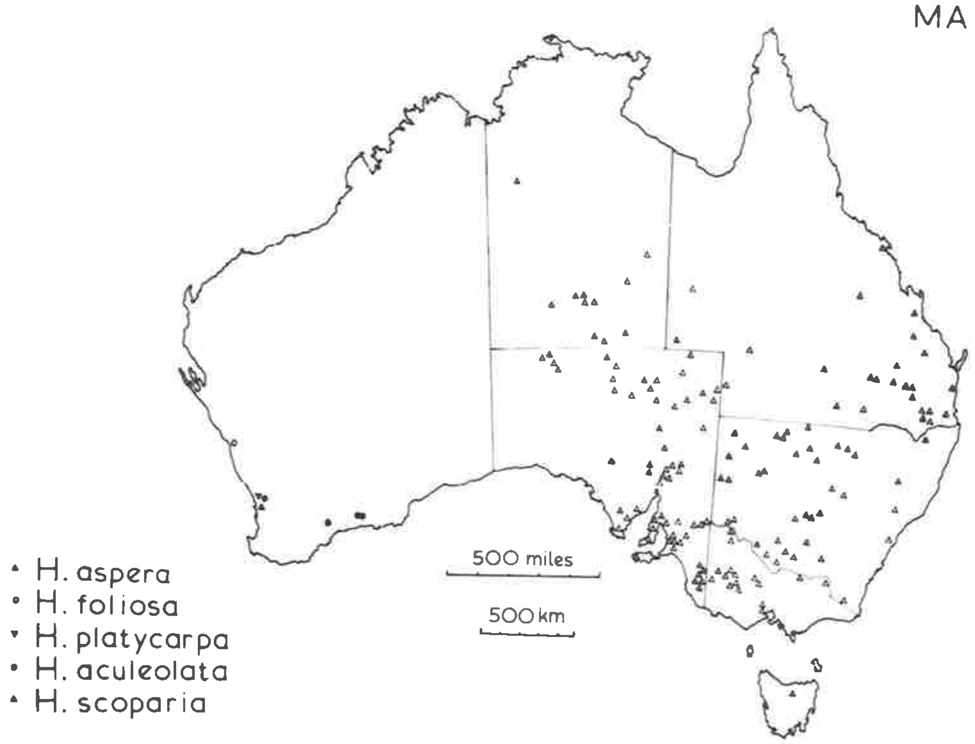
H. glauca

● f. *glauca*

⊗ f. *sclopetifera*

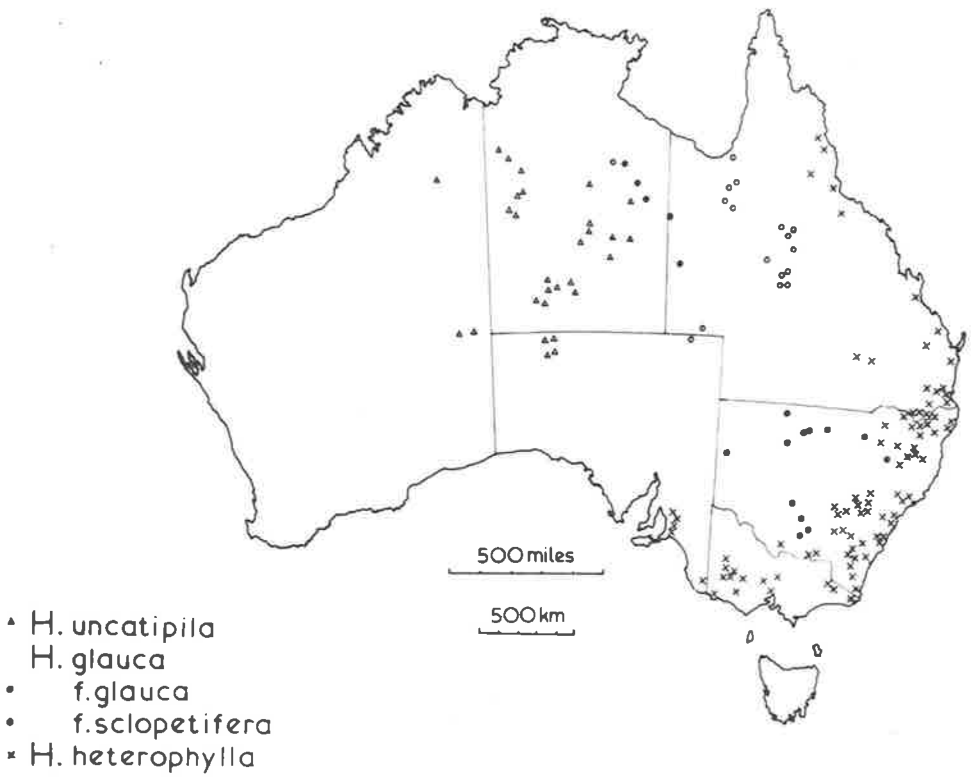
× *H. heterophylla*

MAP 7



500 miles
500 km
• H. aspera
• H. foliosa
• H. platycarpa
• H. aculeolata
• H. scoparia

MAP 8



500 miles
500 km
• H. uncatipila
H. glauca
• f. glauca
• f. sclopetifera
× H. heterophylla

MAP 9

Distribution of: ▲ *Haloragis myriocarpa*

● *H. digyna*

○ *H. tenuifolia*

△ *H. brownii*

MAP 10.

Distribution of: ● *Gonocarpus elatus*

G. hexandrus

△ ssp. *hexandrus*

▲ ssp. *serratus*

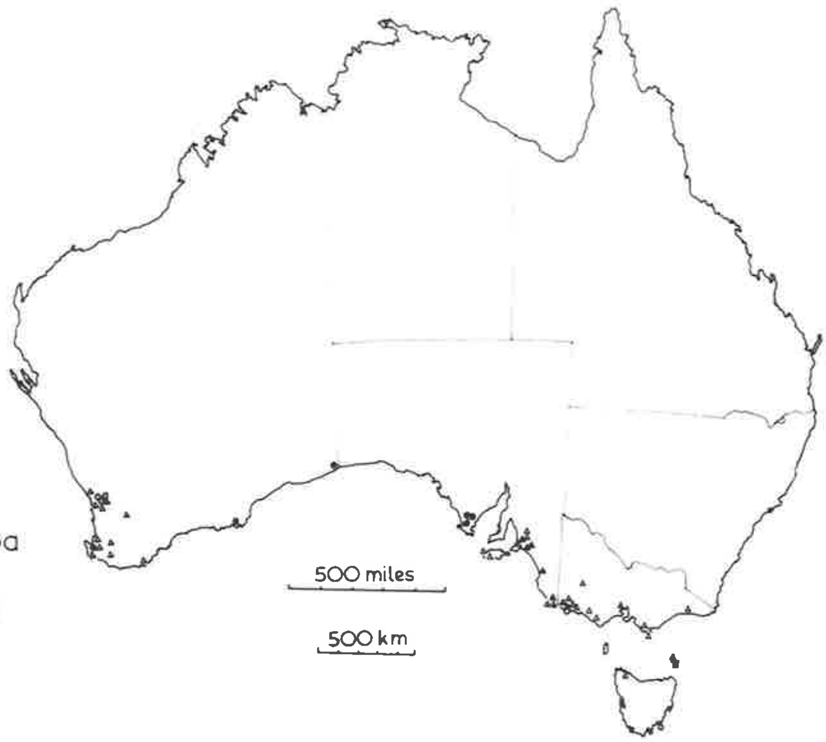
▼ ssp. *integrifolius*

G. confertifolius

\+ var. *confertifolius*

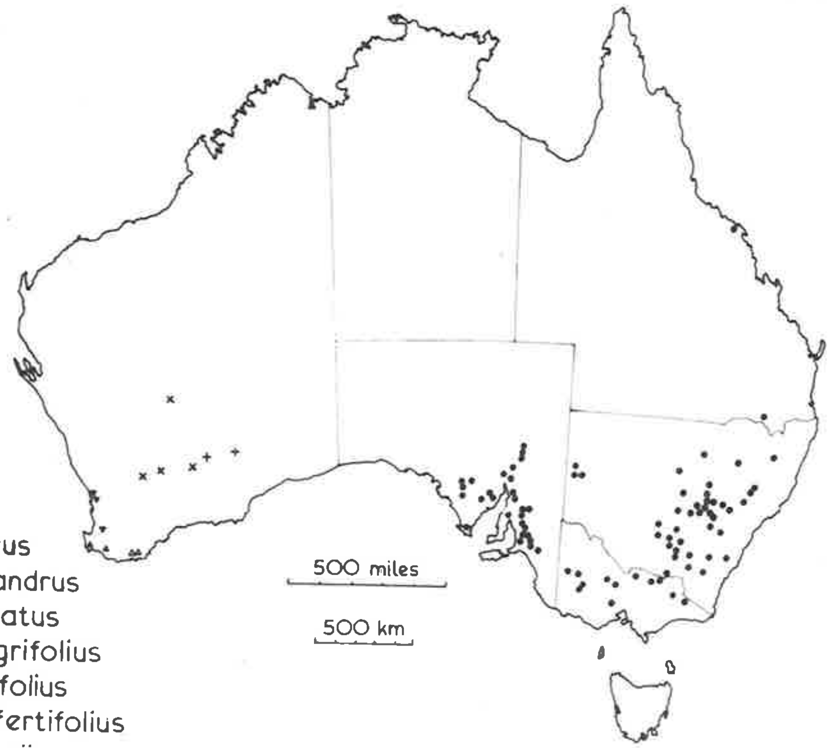
× var. *helmsii*

MAP 9



• H. myriocarpa
• H. digyna
∘ H. tenuifolia
▲ H. brownii

MAP 10



• G. elatus
G. hexandrus
▲ ssp. hexandrus
▲ ssp. serratus
▼ ssp. integrifolius
G. confertifolius
+ var. confertifolius
× var. helmsii

MAP 11.

Distribution of: ▼ *Glischrocaryon behrii*

● *G. flavescens*

▲ *G. roei*

× *G. aureum* var. *aureum*

+ *G. aureum* var. *angustifolium*.

MAP 12.

Distribution of: ▼ *Haloragodendron racemosum*

▲ *H. baeuerlenii*

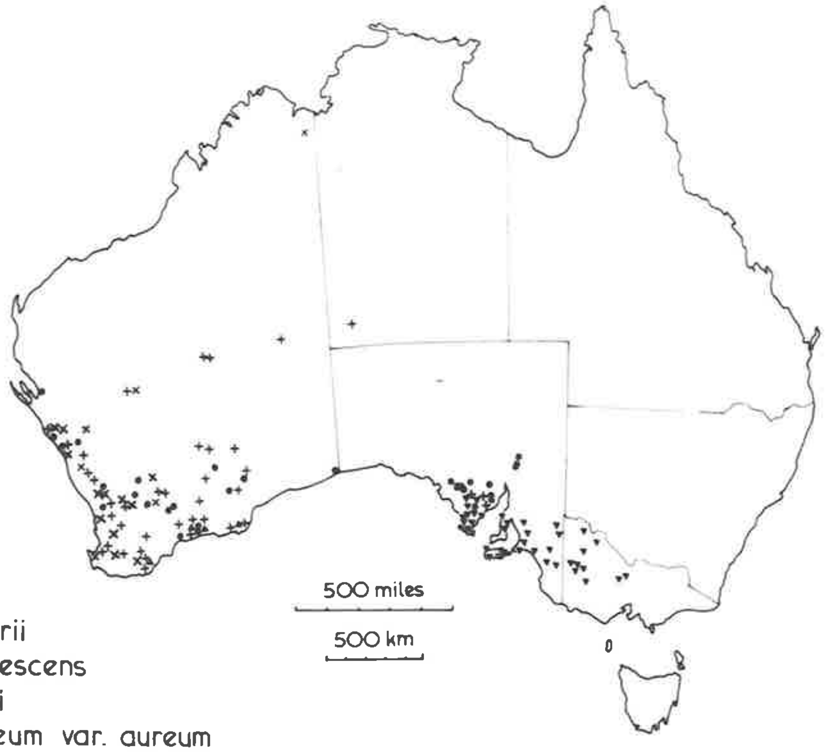
● *H. monospermum*

× *H. lucasii*

+ *H. glandulosum*

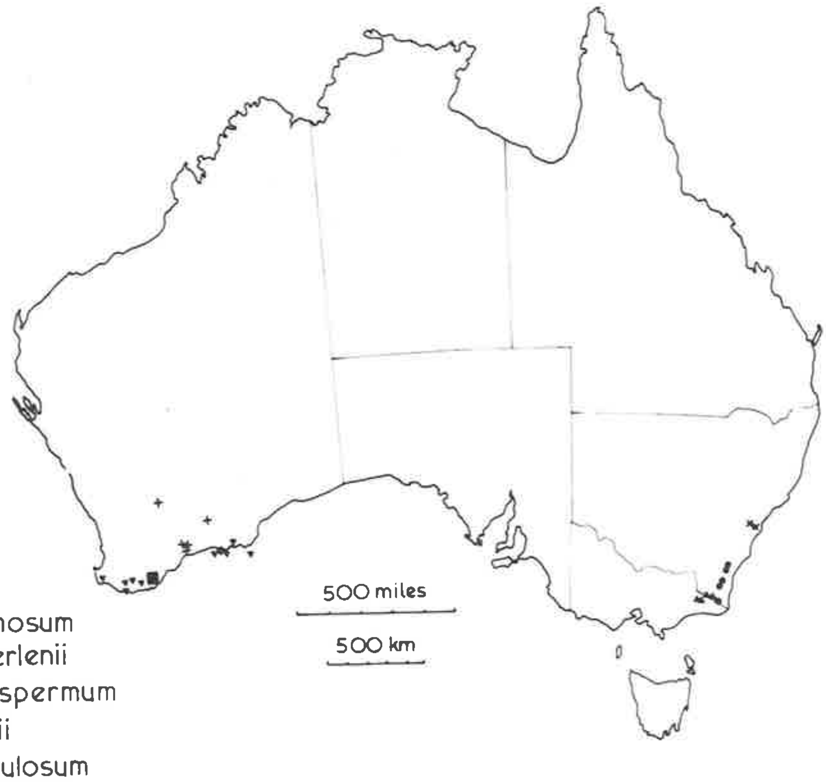
■ *Meziella trifida*

MAP 11



• G. behrii
• G. flavescens
• G. roei
× G. aureum var. aureum
+ G. aureum var. angustifolium

MAP 12



• H. racemosum
• H. baeuerlenii
• H. monospermum
× H. lucasii
+ H. glandulosum
■ M. trifida

MAP 13.

Distribution of *Gonocarpus micranthus* ssp. *micranthus*, adapted from Caspers (1966).

MAP 14.

Australian distribution of:

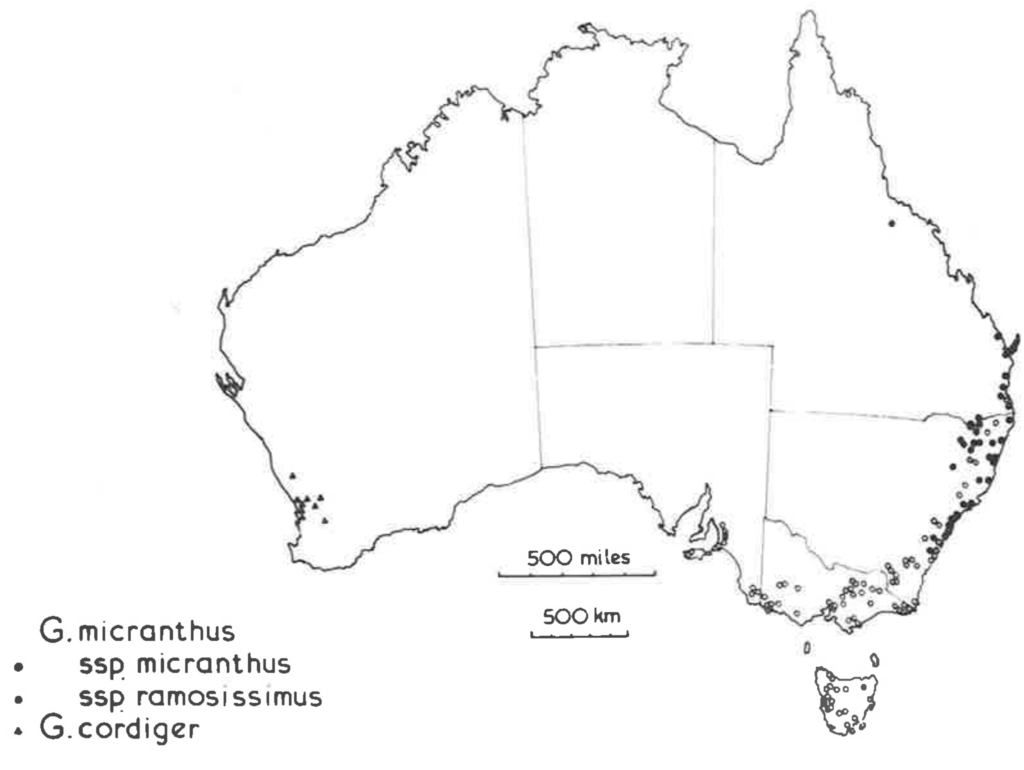
○ *Gonocarpus micranthus* ssp. *micranthus*

● *G. micranthus* ssp. *ramosissimus*

▲ *G. cordiger*

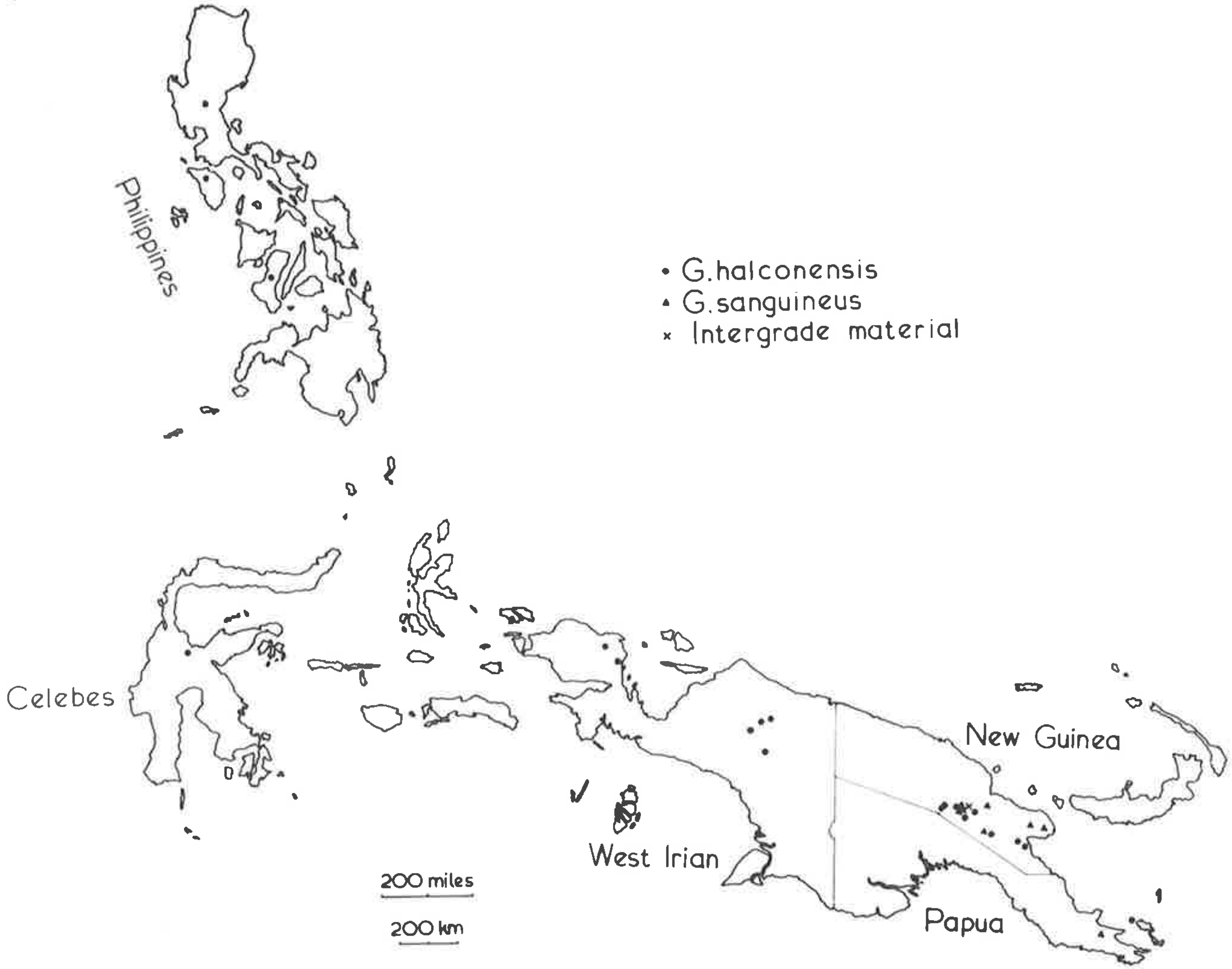
MAP 13

MAP 14


500 miles
500 km
G. micranthus
ssp. micranthus
ssp. ramosissimus
G. cordiger

MAP 15.

Distribution of:	●	*Gonocarpus halconensis*
	▲	*G. sanguineus*
	×	*Intergrade material*


• G.halconensis
▴ G.sanguineus
× Intergrade material
Philippines
Celebes
New Guinea
West Irian
Papua
200 miles
200 km

MAP 15

Figure 27. Relationships of the species of *Haloragis*.
The solid lines represent affinity, the broken lines represent doubtful affinity.

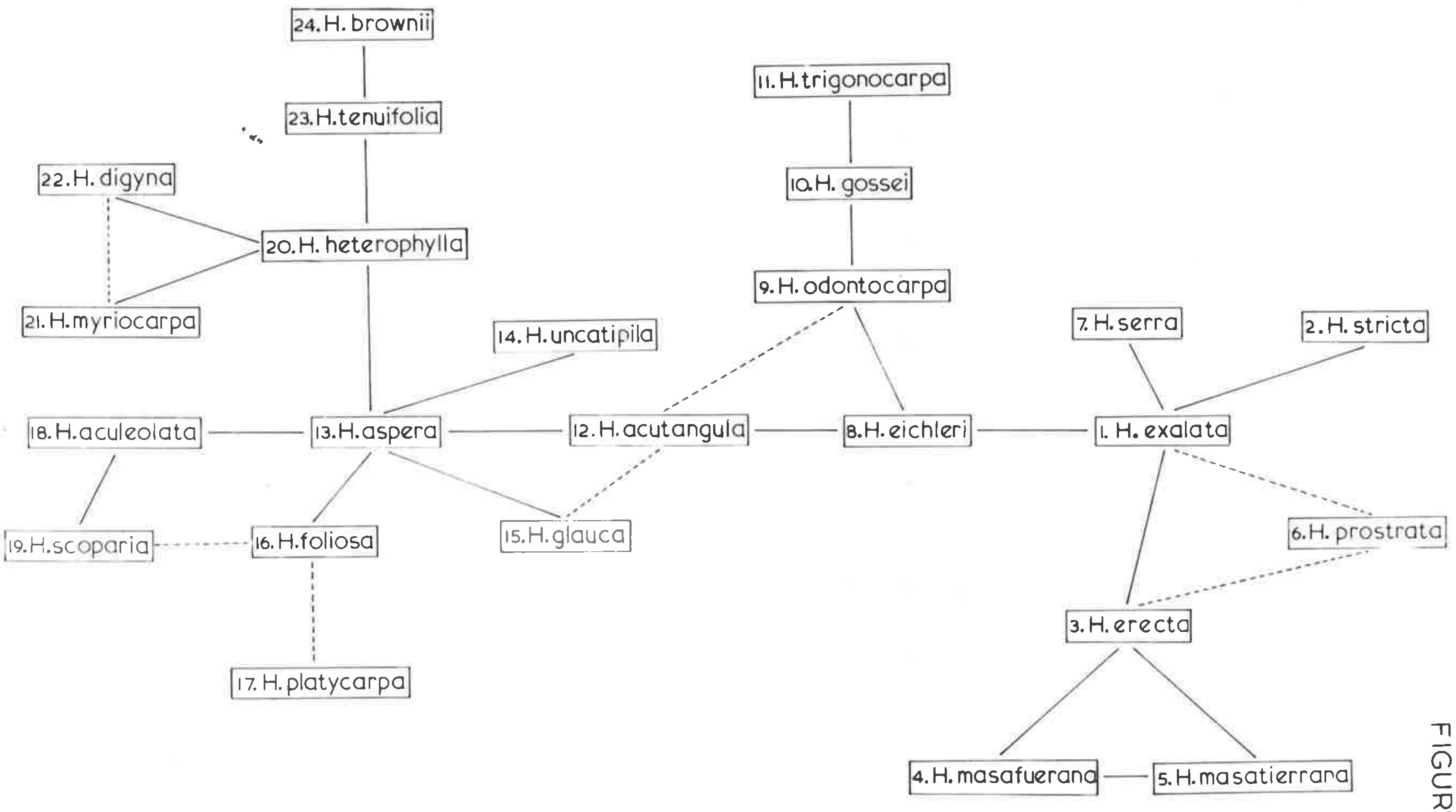

24. H. brownii
23. H. tenuifolia
22. H. digyna
20. H. heterophylla
21. H. myriocarpa
11. H. trigonocarpa
10. H. gossei
9. H. odontocarpa
14. H. uncatipila
7. H. serra
2. H. stricta
18. H. aculeolata
13. H. aspera
12. H. acutangula
8. H. eichleri
1. H. exalata
19. H. scoparia
16. H. foliosa
15. H. glauca
6. H. prostrata
3. H. erecta
17. H. platycarpa
4. H. masafuerana
5. H. masatierrana

FIGURE 27

Figure 28. Correlation of characters in *Haloragis* species.

+ = opposite leaves.

no + = alternate leaves.

white symbols = herbaceous plants

shaded symbols = woody plants

○ = 4-locular ovary

△ = 3-locular ovary

□ = 2-locular ovary

 = 4-locular ovary, 1 locule aborting.

 = 2-3-locular ovary.

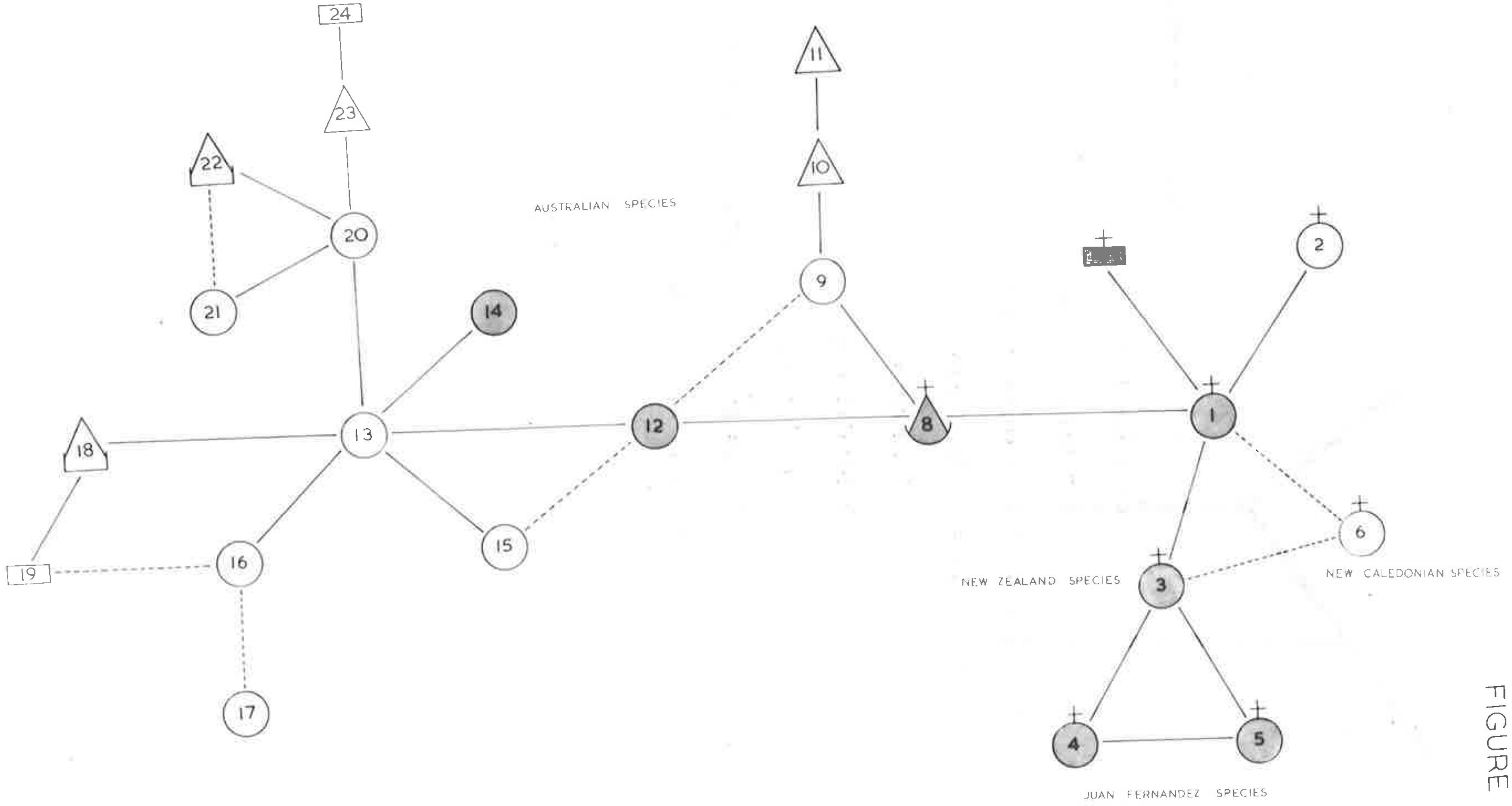

AUSTRALIAN SPECIES
NEW ZEALAND SPECIES
NEW CALEDONIAN SPECIES
JUAN FERNANDEZ SPECIES
24
23
22
20
21
14
13
18
19
16
17
15
12
11
10
9
8
[redacted]
2
1
6
3
4
5

FIGURE 28